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ADMINISTRATIVE REGULATIONS

CALIFORNIA CODE OF REGULATIONS
TITLE 24, PART 1

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ARTICLE 1 – ENERGY BUILDING REGULATIONS

10-101 – SCOPE

(a) This article contains administrative regulations relating to the energy building regulations in Title 24, Part 6. This article applies to all residential and nonresidential buildings.

(b) Nothing in this article lessens any necessary qualifications or responsibilities of licensed or registered building professionals or other designers or builders, or the duties of enforcement agencies that exist under state or local law.

(c) If any provision of the regulations in this article or the Building Energy Efficiency Standards, Title 24, Part 6, of the California Code of Regulations is found invalid by a court of competent jurisdiction, the remainder of these regulations shall remain in effect.

NOTE: Authority: Sections 25402 and 25402.1, Public Resources Code. Reference: Sections 25402 and 25402.1, Public Resources Code.

10-102 – DEFINITIONS

In this article the following definitions apply:

ACCEPTANCE REQUIREMENTS are "acceptance requirements for code compliance" as defined in Section 100.1(b) of Part 6.

ACCEPTANCE TEST TECHNICIAN (ATT) is a Field Technician as defined in Section 10-102 who is certified by an authorized Acceptance Test Technician Certification Provider to perform acceptance testing of either lighting controls or mechanical systems pursuant to the requirements of Sections 10-103.1 or 10-103.2, respectively. ATTs are authorized to perform only those acceptance tests for which they are certified by an ATTCP; ATTs certified to perform acceptance testing of lighting controls are sometimes referred to as “lighting control ATTs”, and ATTs certified to perform acceptance testing of mechanical systems are sometimes referred to as “mechanical ATTs”. (See “Field Technician” and “Acceptance Test Technician Certification Provider”.)

ACCEPTANCE TEST EMPLOYER (ATE) is a person or entity who employs an Acceptance Test Technician and is certified by an authorized Acceptance Test Technician Certification Provider pursuant to the requirements of Sections 10-103.1 or 10-103.2. ATEs are authorized to employ only those ATTs for which they are certified by an ATTCP; ATEs certified to employ ATTs that perform acceptance testing of lighting controls are sometimes referred to as “lighting control ATEs”, and ATEs certified to employ ATTs that perform acceptance testing of mechanical systems are sometimes referred to as “mechanical ATEs”. (See “Acceptance Test Technician” and “Acceptance Test Technician Certification Provider”.)

ACCEPTANCE TEST TECHNICIAN CERTIFICATION PROVIDER (ATTCP) is an agency, organization or entity approved by the Energy Commission to train, certify and oversee ATTs and ATEs relating to either lighting controls or mechanical systems according to the requirements of Sections 10-103.1 or 10-103.2, respectively. ATTCPs are authorized to certify only those ATTs and ATEs for which they are approved by the Energy Commission; ATTCPs approved to certify ATTs and ATEs relating to the acceptance testing of lighting controls are sometimes referred to as “lighting control ATTCPs”, and ATTCPs approved to certify ATTs and ATEs relating to the acceptance testing of mechanical systems are sometimes referred to as “mechanical ATTCPs”. (See “Acceptance Test Technician” and “Acceptance Test Employer”.)

ACM means **ALTERNATIVE CALCULATION METHOD** are compliance software, or alternative component packages, or exceptional methods approved by the Commission under Section 10-109. ACMs are also referred to as Compliance Software.

ACM APPROVAL MANUALS are the documents establishing the requirements for Energy Commission approval of Compliance Software used to demonstrate compliance with the Building Energy Efficiency Standards for Residential and Nonresidential Buildings currently adopted by the Energy Commission.

ACM REFERENCE MANUAL is the document establishing the procedures required to implement Sections 140.1 and 150.1 of Title 24, Part 6 of the California Code of Regulations in Compliance Software.

ADDITIONALITY is a property of solar offsets whereby the offset causes additional benefits beyond what would occur as a result of all other actions, and which would exclusively benefit the building or property for which the offset substitutes for compliance obligations that would otherwise be required for that building or property, and those benefits would not ever be transferred to other buildings or property.

ALTERNATIVE COMPONENT PACKAGE is a set of building measures whose aggregate calculated energy use is less than or equal to the maximum allowed Energy Budget.

APPLIANCE EFFICIENCY REGULATIONS are the regulations in Title 20, Section 1601 et. seq. of the California Code of Regulations.

APPROVED CALCULATION METHOD is compliance software, or alternative component packages, or exceptional methods approved under Section 10-109.

BUILDING ENERGY EFFICIENCY STANDARDS are those regulations contained in Title 24, Part 6 of the California Code of Regulations.

BUILDING PERMIT is an electrical, plumbing, mechanical, building, or other permit or approval, that is issued by an enforcement agency, and that authorizes any construction that is subject to Part 6.

CALIFORNIA ENERGY COMMISSION is the California State Energy Resources Conservation and Development Commission.

COMMISSION is the California State Energy Resources Conservation and Development Commission.

COMPLEX MECHANICAL SYSTEM is defined here for the purposes of complying with the Design Phase Review component of Section 10-103(a)1. Complex Mechanical Systems are systems that include 1) fan systems each serving multiple thermostatically controlled zones, or 2) built-up air handler systems (non-unitary or nonpackaged HVAC equipment), or 3) hydronic or steam heating systems, or 4) hydronic cooling systems. Complex systems are NOT the following: unitary or packaged equipment listed in Tables 110.2-A, 110.2-B, 110.2-C, and 110.2-E, that each serve one zone, or two-pipe, heating only systems serving one or more zones.

COMPLIANCE APPROACH is any one of the allowable methods by which the design and construction of a building may be demonstrated to be in compliance with Part 6. The compliance approaches are the performance compliance approach and the prescriptive compliance approach. The requirements for each compliance approach are set forth in Section 100.0(e)2 of Part 6.

COMPLIANCE DOCUMENT is any of the documents specified in Section 10-103(a) utilized to demonstrate compliance with Part 6 (i.e., Certificate of Compliance, Certificate of Installation, Certificate of Acceptance, and Certificate of Verification).

COMPLIANCE SOFTWARE is software that has been approved pursuant to Section 10-109 of Part 1.

CONDITIONED FLOOR AREA is the “conditioned floor area” as defined in Section 100.1(b) of Part 6.

CRRC-1 is the Cool Roof Rating Council document titled “Product Rating Program”.

DATA REGISTRY is a web service with a user interface and database maintained by a Registration Provider that complies with the applicable requirements in Reference Joint Appendix JA7, with guidance from the Data Registry Requirements Manual, and provides for registration of residential or nonresidential compliance documentation used for demonstrating compliance with Part 6.

RESIDENTIAL DATA REGISTRY is a data registry that is maintained by a HERS Provider that provides for registration, when required by Part 6 of all residential compliance documentation and the nonresidential Certificate of Verification.

NONRESIDENTIAL DATA REGISTRY is a data registry that is maintained by a Registration Provider approved by the Commission that provides for registration, when required by Part 6 of all nonresidential compliance documentation, excluding all Certificates of Acceptance recorded by an acceptance test technician certification provider (10-103.1 and 10-103.2). However, nonresidential data registries may not provide for registration of nonresidential Certificates of Verification.

DATA REGISTRY REQUIREMENTS MANUAL is a document that provides additional detailed guidance regarding the functional and technical aspects of the data registry requirements given in Joint Appendix JA7.

DOCUMENTATION AUTHOR is a person who prepares a Title 24 Part 6 compliance document that must subsequently be reviewed and signed by a responsible person in order to certify compliance with Part 6.

ENERGY BUDGET is the "energy budget" as defined in Section 100.1(b) of Part 6.

ENERGY COMMISSION is the California State Energy Resources Conservation and Development Commission.

ENFORCEMENT AGENCY is the city, county, or state agency responsible for issuing a building permit.

EXCEPTIONAL METHOD is a method for estimating the energy performance of building features that cannot be adequately modeled using existing Compliance Software and that is approved by the Executive Director.

EXECUTIVE DIRECTOR is the executive director of the Commission.

FIELD TECHNICIAN is a person who performs acceptance tests in accordance with the specifications in Reference Nonresidential Appendix NA7, and reports the results of the acceptance tests on the Certificate of Acceptance in accordance with the requirements of Section 10-103(a)4.

HERS is the California Home Energy Rating System as described in Title 20, Chapter 4, Article 8, Section 1670.

HERS PROVIDER is an organization that administers a home energy rating system as described in Title 20, Chapter 4, Article 8, Section 1670.

HERS PROVIDER DATA REGISTRY is a data registry maintained by a HERS provider.

HERS RATER is a person who has been trained, tested, and certified by a HERS Provider to perform the field verification and diagnostic testing required for demonstrating compliance with the Part 6 as described in Title 20, Chapter 4, Article 8, Section 1670(i).

HVAC SYSTEM is the "HVAC system" as defined in Section 100.1(b) of Part 6.

MANUFACTURED DEVICE is the "manufactured device" as defined in Section 100.1(b) of Part 6.

NFRC 100 is the National Fenestration Rating Council document titled "NFRC 100: Procedure for Determining Fenestration Product U-factors." (2017) NFRC 100 includes procedures for the Component Modeling Approach (CMA) and site-built fenestration formerly included in a separate document, NFRC 100-SB.

NFRC 200 is the National Fenestration Rating Council document titled "NFRC 200: Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence." (2017),

NFRC 202 is the National Fenestration Rating Council document titled "NFRC 202: Procedures for Determining Translucent Fenestration Product Visible Transmittance at Normal Incidence." (2017).

NFRC 203 is the National Fenestration Rating Council document titled "NFRC 203: Procedure for Determining Visible Transmittance of Tubular Daylighting Devices." (2017),

NFRC 400 is the National Fenestration Rating Council document titled "NFRC 400: Procedure for Determining Fenestration Product Air Leakage." (2017).

PART 6 is Title 24, Part 6 of the California Code of Regulations.

PUBLIC ADVISER is the Public Adviser of the Commission.

R-VALUE is the measure of the thermal resistance of insulation or any material or building component expressed in ft^2-hr-°F/Btu.

RECORD DRAWINGS are drawings that document the as installed location and performance data on all lighting and space conditioning system components, devices, appliances and equipment, including but not limited to wiring sequences, control sequences, duct and pipe distribution system layout and sizes, space conditioning system terminal device layout and airflow rates, hydronic system and flow rates, and connections for the space conditioning system. Record drawings are sometimes referred to as "as built" drawings.

REFERENCE APPENDICES are the support document for the Building Energy Efficiency Standards and the ACM Approval Manuals. The document consists of three sections: the Reference Joint Appendices (JA), the Reference Residential Appendices (RA), and the Reference Nonresidential Appendices (NA) currently adopted by the Energy Commission.

REFERENCE JOINT APPENDICES are the Reference Joint Appendices currently adopted by the Energy Commission.

REFERENCE NONRESIDENTIAL APPENDICES are the Reference Nonresidential Appendices currently adopted by the Energy Commission.

REFERENCE RESIDENTIAL APPENDICES are the Reference Residential Appendices currently adopted by the Energy Commission.

REGISTERED DOCUMENT is a document that has been submitted to a residential or nonresidential data registry for retention, and the data registry has assigned a unique registration number to the document.

REGISTRATION PROVIDER is an organization that administers a data registry service that conforms to the requirements in Reference Joint Appendix JA7.

STANDARD DESIGN BUILDING is a "Standard Design Building" as defined in Section 100.1(b) of Part 6.

NOTE: Authority: Sections 25402 and 25402.1, and 25213, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402 and 25402.1, 25402.4, 25402.5, 25402.8 and 25943, Public Resources Code.

10-103 – PERMIT, CERTIFICATE, INFORMATIONAL, AND ENFORCEMENT REQUIREMENTS FOR DESIGNERS, INSTALLERS, BUILDERS, MANUFACTURERS, AND SUPPLIERS

(a) **Documentation.** For all buildings other than healthcare facilities, the following documentation is required to demonstrate compliance with Part 6. This documentation shall meet the requirements of Section 10-103(a) or alternatives approved by the Executive Director. Healthcare facilities shall instead comply with the applicable provisions of Chapter 7.

1. **Certificate of Compliance.** For all buildings, the Certificate of Compliance described in Section 10-103 shall be signed by the person who is eligible under Division 3 of the Business and Professions Code to accept responsibility for the building design (*responsible person*); and submitted in accordance with Sections 10-103(a)1 and 10-103(a)2 to certify conformance with Part 6. If more than one person has responsibility for the building design, each person shall sign the Certificate of Compliance document(s) applicable to that portion of the design for which the person is responsible. Alternatively, the person with chief responsibility for the building design shall prepare and sign the Certificate of Compliance document(s) for the entire building design. Subject to the requirements of Sections 10-103(a)1 and 10-103(a)2, persons who prepare Certificate of Compliance documents (*documentation authors*) shall sign a declaration statement on the documents they prepare to certify the information provided on the documentation is accurate and complete. In accordance with applicable requirements of 10-103(a)1, the signatures provided by *responsible persons* and *documentation authors* shall be original signatures on paper documents or electronic signatures on electronic documents conforming to the electronic signature specifications in Reference Joint Appendix JA7.

   For all Nonresidential buildings, the Design Review Kickoff Certificate(s) of Compliance and the Construction Document Design Review Checklist Certificate(s) of Compliance shall be reviewed and signed by a licensed professional engineer or licensed architect, or a licensed contractor representing services performed by or under the direct supervision of a licensed engineer or architect, as specified in the provisions of Division 3 of the Business and Professions Code. For buildings less than 10,000 square feet, this signer may be the engineer or architect of record. For buildings greater than 10,000 square feet but less than 50,000 square feet, this signer shall be a qualified in-house engineer or architect with no other project involvement or a third-party engineer, architect, or contractor. For buildings greater than 50,000 square feet and all buildings with complex mechanical systems serving more than 10,000 square feet, this signer shall be a third-party engineer, architect, or contractor.

   A. All Certificate of Compliance documentation shall conform to a format and informational order and content approved by the Energy Commission.

      These documents shall:

      i. Identify the energy features, performance specifications, materials, components, and manufactured devices required for compliance with Part 6.

      ii. Identify the building project name and location. The building project name and location identification on the Certificate of Compliance shall be consistent with the building project name and location identification given on the other applicable building design plans and specifications submitted to the enforcement agency for approval with the building permit application.

      iii. Display the unique registration number assigned by the data registry if Section 10-103(a)1 requires the document to be registered.

      iv. Include a declaration statement to the effect that the building energy features, performance specifications, materials, components, and manufactured devices for the building design identified on the Certificate of Compliance indicate the building is in compliance with the requirements of Title 24, Parts 1 and 6, and the building design features identified on the

Certificate of Compliance are consistent with the building design features identified on the other applicable compliance documents, worksheets, calculations, plans, and specifications submitted to the enforcement agency for approval with the building permit application.

v. Be signed by the *documentation author* to certify the documentation is accurate and complete. When document registration is required by Section 10-103(a)1, the signature shall be an electronic signature on an electronic document in accordance with the electronic signature specifications in Reference Joint Appendix JA7.

vi. Be signed by the *responsible person* eligible under Division 3 of the Business and Professions Code to accept responsibility for the design to certify conformance with Part 6. When document registration is required by Section 10-103(a)1, the signature shall be an electronic signature on an electronic document in accordance with the electronic signature specifications in Reference Joint Appendix JA7.

B. For all low-rise residential buildings for which compliance requires HERS field verification, the person(s) responsible for the Certificate(s) of Compliance shall submit the Certificate(s) for registration and retention to a HERS provider data registry. The submittals to the HERS provider data registry shall be made electronically in accordance with the specifications in Reference Joint Appendix JA7.

Contingent upon availability and approval of an electronic document repository by the Executive Director, Certificate of Compliance documents that are registered and retained by a HERS provider data registry shall also be automatically transmitted by the data registry, to an electronic document repository for retention in accordance with the specifications in Reference Joint Appendix JA7.

C. For alterations to existing residential buildings for which HERS field verification is not required, including but not limited to water heater and window replacements, and for additions to existing residential buildings that are less than 300 square feet for which HERS field verification is not required, the enforcement agencies may at their discretion not require any Certificate of Compliance documentation, or may develop simplified Certificate of Compliance documentation for demonstrating compliance with the Standards.

Exemptions from submitting compliance documentation shall not be deemed to grant authorization for any work to be done in any manner in violation of this code or other provisions of law.

D. Contingent upon approval of data registry(s) by the Commission, all nonresidential buildings, high-rise residential buildings, and hotels and motels, when designated to allow use of an occupancy group or type regulated by Part 6 the person(s) responsible for the Certificate(s) of Compliance shall submit the Certificate(s) for registration and retention to a data registry approved by the Commission. The submittals to the approved data registry shall be made electronically in accordance with the specifications in Reference Joint Appendix JA7.

Contingent upon availability and approval of an electronic document repository by the Executive Director, Certificate of Compliance documents that are registered and retained by an approved data registry shall also be automatically transmitted by the data registry to an electronic document repository for retention in accordance with the specifications in Reference Joint Appendix JA7.

2. **Application for a building permit.** Each application for a building permit subject to Part 6 shall contain at least one copy of the documents specified in Sections 10-103(a)2A, 10-103(a)2B, and 10-103(a)2C.

A. For all newly constructed buildings, additions, alterations, or repairs regulated by Part 6 the applicant shall submit the applicable Certificate(s) of Compliance to the enforcement agency for approval. The certificate(s) shall conform to the requirements of Section 10-103(a)1, and shall be approved by the local enforcement agency, in accordance with all applicable requirements of Section 10-103(d), by stamp or authorized signature prior to issuance of a building permit. A copy of the Certificate(s) of Compliance shall be included with the documentation the builder provides to the building owner at occupancy as specified in Section 10-103(b).

For alterations to existing residential buildings for which HERS field verification is required, and when the enforcement agency does not require building design plans to be submitted with the application for a building permit, the applicable Certificate of Compliance documentation specified in Section 10-103(a)1 is not required to be approved by the enforcement agency prior to issuance of a building permit, but shall be approved by the enforcement agency prior to final inspection of the dwelling unit, and shall be made available to the enforcement agency for all applicable inspections, or made available for viewing on an approved data registry.

When the enforcement agency requires building design plans to be submitted with the application for a building permit, the applicable Certificate of Compliance documents shall be incorporated into the building design plans. When Section 10-103(a)1 requires document registration, the certificate(s) that are incorporated into the building design plans shall be copies of the registered Certificate of Compliance documents from a HERS provider data registry, or a data registry approved by the Commission.

B. When the enforcement agency requires building design plans and specifications to be submitted with the application for a building permit, the plans shall conform to the specifications for the features, materials, components, and manufactured devices identified on the Certificate(s) of Compliance, and shall conform to all other applicable requirements of Part 6. Plans and specifications shall be submitted to the enforcement agency for any other feature, material, component, or manufactured device that Part 6 requires be indicated on the building design plans and specifications. Plans and specifications submitted with each application for a building permit for Nonresidential buildings, High-rise Residential buildings and Hotels and Motels shall provide acceptance requirements for code compliance of each feature, material, component or manufactured device when acceptance requirements are required under Part 6. Plans and specifications for Nonresidential buildings, High-rise Residential buildings and Hotels and Motels shall require, and indicate with a prominent note on the plans, that within 90 days after the Enforcement Agency issues a permanent final occupancy permit, record drawings be provided to the building owner.

   For all buildings, if the specification for a building design feature, material, component, or manufactured device is changed before final construction or installation, such that the building may no longer comply with Part 6 the building must be brought back into compliance, and so indicated on amended plans, specifications, and Certificate(s) of Compliance that shall be submitted to the enforcement agency for approval. Such characteristics shall include the efficiency (or other characteristic regulated by Part 6) of each building design feature, material, component, or device.

C. The enforcement agency shall have the authority to require submittal of any supportive documentation that was used to generate the Certificate(s) of Compliance, including but not limited to the electronic input file for the compliance software tool that was used to generate performance method Certificate(s) of Compliance; or any other supportive documentation that is necessary to demonstrate that the building design conforms to the requirements of Part 6.

3. **Certificate of Installation.** For all buildings, the person in charge of the construction or installation, who is eligible under Division 3 of the Business and Professions Code to accept responsibility for the construction or installation of features, materials, components, or manufactured devices regulated by Part 6 or the Appliance Efficiency Regulations (*responsible person*) shall sign and submit Certificate of Installation documentation as specified in Section 10-103(a)3 to certify conformance with Part 6. If more than one person has responsibility for the construction or installation, each person shall sign and submit the Certificate of Installation documentation applicable to the portion of the construction or installation for which they are responsible; alternatively, the person with chief responsibility for the construction or installation shall sign and submit the Certificate of Installation documentation for the entire construction or installation scope of work for the project. Subject to the requirements of Section 10-103(a)3, persons who prepare Certificate of Installation documentation (*documentation authors*) shall sign a declaration statement on the documents they prepare to certify the information provided on the documentation is accurate and complete. In accordance with applicable requirements of 10-103(a)3, the signatures provided by *responsible persons* and *documentation authors* shall be original signatures on paper

documents or electronic signatures on electronic documents conforming to the electronic signature specifications in Reference Joint Appendix JA7.

A. Delegation of Signature Authority. Except where prohibited by law, including but not limited to any requirements under Division 3 of the Business and Professions Code, the *Responsible Person* may delegate signature authority to third parties (*Authorized Representatives*) provided that there is a written agreement:

i. Between the *Responsible Person* and the person to be designated as the *Authorized Representative*.

ii. Specifying that the *Authorized Representative* may sign Certificates of Installation on behalf of the *Responsible Person*.

iii. Specifying that the legal responsibility for construction or installation in the applicable classification for the scope of work specified on the Certificate of Installation document(s) remains with the Responsible Person.

iv. That is signed by both the *Responsible Person* and the *Authorized Representative*.

v. That is retained by the HERS Provider to which all compliance documents are submitted for the building to which the Certificate of Installation documentation pertains.

vi. That is maintained in the HERS Provider Data Registry such that it is accessible for verification by, included but not limited to, the Energy Commission and enforcement agencies.

B. **Format.** All Certificate of Installation documentation shall conform to a format and informational order and content approved by the Energy Commission.

These documents shall:

i. Identify the features, materials, components, manufactured devices, and system performance diagnostic results required to demonstrate compliance with Part 6 and the Appliance Efficiency Regulations.

ii. State the number of the building permit under which the construction or installation was performed.

iii. Display the unique registration number assigned by the data registry if Section 10-103(a)3 requires the document to be registered.

iv. Include a declaration statement indicating that the constructed or installed features, materials, components or manufactured devices (the installation) identified on the Certificate of Installation conforms to all applicable codes and regulations, and the installation conforms to the requirements given on the plans and specifications approved by the enforcement agency.

v. Be signed by the *documentation author* to certify the documentation is accurate and complete. When document registration is required by Section 10-103(a)3, the signature shall be an electronic signature on an electronic document in accordance with the electronic signature specifications in Reference Joint Appendix JA7.

vi. Be signed by the *Responsible Person* eligible under Division 3 of the Business and Professions Code to accept responsibility for construction or installation in the applicable classification for the scope of work specified on the Certificate of Installation document(s), or shall be signed by their *Authorized Representative*. When document registration is required by Section 10-103(a)3, the signature shall be an electronic signature on an electronic document in accordance with the electronic signature specifications in Reference Joint Appendix JA7.

C. For all low-rise residential buildings, the person(s) responsible for the Certificate(s) of Installation, or their *Authorized Representative(s)*, shall submit the following Certificate of Installation documentation that is applicable to the building to a HERS provider data registry for registration and retention in accordance with procedures specified in Reference Residential Appendix RA2:

i. All Certificates of Installation for which compliance requires HERS field verification.

ii. All other Certificates of Installation, except those exempted by the Energy Commission.

The submittals to the HERS provider data registry shall be made electronically in accordance with the specifications in Reference Joint Appendix JA7.

Contingent upon availability and approval of an electronic document repository by the Executive Director, Certificate of Installation documents that are registered and retained by a HERS provider data registry shall also be automatically transmitted by the data registry to an electronic document repository for retention in accordance with the specifications in Reference Joint Appendix JA7.

D. For alterations to existing residential buildings for which HERS field verification is not required, including but not limited to water heater and window replacements, and for additions to existing residential buildings that are less than 300 square feet for which HERS field verification is not required, the enforcement agencies may, at their discretion, not require any Certificate of Installation documentation, or may develop simplified Certificate of Installation documentation for demonstrating compliance with the Standards.

Exemptions from submitting compliance documentation shall not be deemed to grant authorization for any work to be done in any manner in violation of this code or other provisions of law.

E. Contingent upon approval of data registry(s) by the Commission, all nonresidential buildings, high-rise residential buildings, and hotels and motels, when designated to allow use of an occupancy group or type regulated by Part 6 the person(s) responsible for the Certificate(s) of Installation, except those documents exempted by the Energy Commission, shall submit the Certificate(s) for registration and retention to a data registry approved by the Commission. The submittals to the approved data registry shall be made electronically in accordance with the specifications in Reference Joint Appendix JA7.

Contingent upon availability and approval of an electronic document repository by the Executive Director, Certificate of Installation documents that are registered and retained by an approved data registry shall also be automatically transmitted by the data registry to an electronic document repository for retention in accordance with the specifications in Reference Joint Appendix JA7.

F. **Availability.** For all buildings, a copy of the Certificate(s) of Installation shall be posted, or made available with the building permit(s) issued for the building, or made available for viewing on an approved data registry, and shall be made available to the enforcement agency for all applicable inspections. When document registration is required by Section 10-103(a)3, registered copies of the Certificate(s) of Installation from a HERS provider data registry or a data registry approved by the Commission shall be posted or made available with the building permit(s) issued for the building, and shall be made available to the enforcement agency for all applicable inspections. If construction on any portion of the building subject to Part 6 will be impossible to inspect because of subsequent construction, the enforcement agency may require the Certificate(s) of Installation to be posted upon completion of that portion. A copy of the Certificate(s) of Installation shall be included with the documentation the builder provides to the building owner at occupancy as specified in Section 10-103(b).

4. **Certificate of Acceptance.** For all nonresidential buildings, high-rise residential buildings, and hotels and motels, when designated to allow use of an occupancy group or type regulated by Part 6 the person in charge of the acceptance testing, who is eligible under Division 3 of the Business and Professions Code to accept responsibility for the applicable scope of system design, or construction, or installation of features, materials, components, or manufactured devices regulated by Part 6 or the Appliance Efficiency Regulations (*responsible person*), shall sign and submit all applicable Certificate of Acceptance documentation in accordance with Section 10-103(a)4 and Reference Nonresidential Appendix NA7 to certify conformance with Part 6. If more than one person has responsibility for the acceptance testing, each person shall sign and submit the Certificate of Acceptance documentation applicable to the portion of the construction or installation, for which they are responsible; alternatively, the person with chief responsibility for the system design, construction or installation, shall sign and submit the Certificate of Acceptance documentation for the entire construction or installation scope of work for the project.

Subject to the requirements of Section 10-103(a)4, persons who prepare Certificate of Acceptance documentation (*documentation authors*) shall sign a declaration statement on the documents they prepare to certify the information provided on the documentation is accurate and complete. Persons who perform acceptance test procedures in accordance with the specifications in Reference Nonresidential Appendix NA7, and report the results of the acceptance tests on the Certificate of Acceptance (*field technicians*) shall sign a declaration statement on the documents they submit to certify the information provided on the documentation is true and correct. In accordance with applicable requirements of Section 10-103(a)4, the signatures provided by *responsible persons*, *field technicians*, and *documentation authors* shall be original signatures on paper documents or electronic signatures on electronic documents conforming to the electronic signature specifications in Reference Joint Appendix JA7.

A. All Certificate of Acceptance documentation shall conform to a format and informational order and content approved by the Energy Commission.

   These documents shall:

   i. Identify the features, materials, components, manufactured devices, and system performance diagnostic results required to demonstrate compliance with the acceptance requirements to which the applicant must conform as indicated in the plans and specifications submitted under Section 10-103(a)2, and as specified in Reference Nonresidential Appendix NA7.

   ii. State the number of the building permit under which the construction or installation was performed.

   iii. Display the unique registration number assigned by the data registry if Section 10-103(a)4 requires the document to be registered.

   iv. Include a declaration statement indicating that the features, materials, components or manufactured devices identified on the Certificate of Acceptance conform to the applicable acceptance requirements as indicated in the plans and specifications submitted under Section 10-103(a), and with applicable acceptance requirements and procedures specified in the Reference Nonresidential Appendix NA7, and confirms that Certificate(s) of Installation described in Section 10-103(a)3 has been completed and is posted or made available with the building permit(s) issued for the building, or made available for viewing on an approved data registry.

   v. Be signed by the *documentation author* to certify the documentation is accurate and complete. When document registration is required by Section 10-103(a)4, the signature shall be an electronic signature on an electronic document in accordance with the electronic signature specifications in Reference Joint Appendix JA7.

   vi. Be signed by the *field technician* who performed the acceptance test procedures and reported the results on the Certificate of Acceptance. When document registration is required by Section 10-103(a)4, the signature shall be an electronic signature on an electronic document in accordance with the electronic signature specifications in Reference Joint Appendix JA7.

   vii. Be signed by the *responsible person* in charge of the acceptance testing who is eligible under Division 3 of the Business and Professions Code to accept responsibility for the system design, construction or installation in the applicable classification for the scope of work identified on the Certificate of Acceptance, or shall be signed by their authorized representative. When document registration is required by Section 10-103(a)4, the signature shall be an electronic signature on an electronic document in accordance with the electronic signature specifications in Reference Joint Appendix JA7.

B. Contingent upon approval of data registry(s) by the Commission, for all nonresidential buildings, high-rise residential buildings, and hotels and motels, when designated to allow use of an occupancy group or type regulated by Part 6 the person(s) responsible for the Certificate(s) of Acceptance shall submit the Certificate(s) for registration and retention to a data registry approved by the Commission, excluding all Certificates of Acceptance recorded by an acceptance test technician certification

provider (10-103.1 and 10-103.2). The submittals to the approved data registry shall be made electronically in accordance with the specifications in Reference Joint Appendix JA7.

Contingent upon availability and approval of an electronic document repository by the Executive Director, Certificate of Acceptance documents that are registered and retained by an approved data registry shall also be automatically transmitted by the data registry, to an electronic document repository for retention in accordance with the specifications in Reference Joint Appendix JA7.

C. A copy of the ~~registered~~ Certificate(s) of Acceptance shall be posted, or made available with the building permit(s) issued for the building, ~~or made available for viewing on an approved data registry,~~ and shall be made available to the enforcement agency for all applicable inspections. If construction on any portion of the building subject to Part 6 will be impossible to inspect because of subsequent construction, the enforcement agency may require the Certificate(s) of Acceptance to be posted upon completion of that portion. A copy of the Certificate(s) of Acceptance shall be included with the documentation the builder provides to the building owner at occupancy as specified in Section 10-103(b).

5. **Certificate of Field Verification and Diagnostic Testing (Certificate of Verification).** For all buildings for which compliance requires HERS field verification, a certified HERS Rater shall conduct all required HERS field verification and diagnostic testing in accordance with applicable procedures specified in Reference Appendices RA2, RA3, NA1, and NA2. All applicable Certificate of Verification documentation shall be completed, signed, and submitted by the certified HERS Rater who performed the field verification and diagnostic testing services (*responsible person*) in accordance with the requirements of Section 10-103(a)5, and Reference Appendices RA2, and NA1, to certify conformance with Part 6. If more than one rater has responsibility for the HERS verification for the building, each rater shall sign and submit the Certificate of Verification documentation applicable to the portion of the building for which they are responsible. Subject to the requirements of Section 10-103(a)5, persons who prepare Certificate of Verification documentation (*documentation authors*) shall sign a declaration statement on the documents they prepare to certify the information provided on the documentation is accurate and complete. The signatures provided by *responsible persons* and *documentation authors* shall be electronic signatures on electronic documents.

A. **Format.** All Certificate of Verification documentation shall conform to a format and informational order and content approved by the Energy Commission.

These documents shall:

i. Identify the installed features, materials, components, manufactured devices, or system performance diagnostic results that require HERS verification for compliance with Part 6 as specified on the Certificate(s) of Compliance for the building.

ii. State the number of the building permit under which the construction or installation was performed,

iii. Display the unique registration number assigned by the HERS provider data registry, and provide any additional information required by Reference Appendices RA2, RA3, NA1, and NA2.

iv. Include a declaration statement indicating that the installed features, materials, components or manufactured devices requiring HERS verification conform to the applicable requirements in Reference Appendices RA2, RA3, NA1, NA2, and the requirements specified on the Certificate(s) of Compliance approved by the local enforcement agency, and confirms the same features, materials, components or manufactured devices are identified on the applicable Certificate(s) of Installation signed and submitted by the person(s) responsible for the construction or installation as described in Section 10-103(a)3.

v. Be signed by the *documentation author* to certify the documentation is accurate and complete. The signatures shall be electronic signatures on electronic documents in accordance with the electronic signature specifications in Reference Joint Appendix JA7.

vi. Be signed by the HERS Rater who performed the field verification and diagnostic testing services (*responsible person)*. The signatures shall be electronic signatures on electronic documents in accordance with the electronic signature specifications in Reference Joint Appendix JA7.

B. For all buildings for which compliance requires HERS field verification, the certified HERS Rater responsible for the Certificate(s) of Verification shall submit the Certificates for registration and retention to a HERS provider data registry in accordance with the applicable procedures in Reference Appendices RA2 and NA1.

The submittals to the HERS provider data registry shall be made electronically in accordance with the specifications in Reference Joint Appendix JA7.

Contingent upon availability and approval of an electronic document repository by the Executive Director, Certificate of Verification documents that are registered and retained by a HERS provider data registry shall also be automatically transmitted by the data registry, to an electronic document repository for retention in accordance with the specifications in Reference Joint Appendix JA7.

C. **Availability.** For all buildings, a copy of the registered Certificate(s) of Verification shall be posted, or made available with the building permit(s) issued for the building, or made available for viewing on an approved data registry, and shall be made available to the enforcement agency for all applicable inspections. If construction on any portion of the building subject to Part 6 will be impossible to inspect because of subsequent construction, the enforcement agency may require the Certificate(s) of Verification to be posted upon completion of that portion. A copy of the registered Certificate(s) of Verification shall be included with the documentation the builder provides to the building owner at occupancy as specified in Section 10-103(b).

EXCEPTION to Section 10-103(a): Enforcing agencies may exempt nonresidential buildings that have no more than 1,000 square feet of conditioned floor area in the entire building and an occupant load of 49 persons or less from the documentation requirements of Section 10-103(a), provided a statement of compliance with Part 6 is submitted and signed by a licensed engineer or the licensed architect with chief responsibility for the design.

(b) **Compliance, Operating, Maintenance, and Ventilation Information to be provided by Builder.**

1. **Compliance information.**

A. For low-rise residential buildings, at final inspection, the enforcement agency shall require the builder to leave in the building, copies of the completed, signed, and submitted compliance documents for the building owner at occupancy. For low-rise residential buildings, such information shall, at a minimum, include copies of all Certificate of Compliance, Certificate of Installation, and Certificate of Verification documentation submitted. These documents shall be in paper or electronic format and shall conform to the applicable requirements of Section 10-103(a).

B. For nonresidential buildings, high-rise residential buildings and hotels and motels, at final inspection, the enforcement agency shall require the builder to leave in the building, copies of the completed, signed, and submitted compliance documents for the building owner at occupancy. For nonresidential buildings, high-rise residential buildings and hotels and motels, such information shall include copies of all Certificate of Compliance, Certificate of Installation, Certificate of Acceptance and Certificate of Verification documentation submitted. These documents shall be in paper or electronic format and shall conform to the applicable requirements of Section 10-103(a).

2. **Operating information.** At final inspection, the enforcement agency shall require the builder to leave in the building, for the building owner at occupancy, operating information for all applicable features, materials, components, and mechanical devices installed in the building. Operating information shall include instructions on how to operate the features, materials, components, and mechanical devices correctly and efficiently. The instructions shall be consistent with specifications set forth by the Executive Director. For low-rise residential buildings, such information shall be contained in a folder or manual which provides all information specified in Section 10-103(b). This operating information shall be in paper or electronic format.

For dwelling units, buildings or tenant spaces that are not individually owned and operated, or are centrally operated, such information shall be provided to the person(s) responsible for operating the feature, material, component or mechanical device installed in the building. This operating information shall be in paper or electronic format.

3. **Maintenance information.** At final inspection, the enforcement agency shall require the builder to leave in the building, for the building owner at occupancy, maintenance information for all features, materials, components, and manufactured devices that require routine maintenance for efficient operation. Required routine maintenance actions shall be clearly stated and incorporated on a readily accessible label. The label may be limited to identifying, by title and/or publication number, the operation and maintenance manual for that particular model and type of feature, material, component or manufactured device. For low-rise residential buildings, this information shall include a schedule of all interior luminaires and lamps installed to comply with Section 150.0(k).

   For dwelling units, buildings or tenant spaces that are not individually owned and operated, or are centrally operated, such information shall be provided to the person(s) responsible for maintaining the feature, material, component or mechanical device installed in the building. This information shall be in paper or electronic format.

4. **Ventilation information.**

   A. For ~~low-rise~~ low-rise and high-rise residential buildings, the enforcement agency shall require the builder to leave the following information in the building, for the building owner at occupancy:

      i. ~~, a~~ A description of the quantities of outdoor air that the whole-dwelling unit ventilation system(s) are designed to provide to the building's conditioned space, and instructions for proper operation and maintenance of the ventilation system.

      ii. Instructions for proper operation and maintenance of local exhaust systems, including instructions for conditions for which any occupant-controlled systems such as kitchen range hoods and bathroom exhaust fans should be used.

      iii. For systems in buildings or tenant spaces that are not individually owned and operated by the dwelling unit occupants, the building's owner or their representative shall provide a copy of the ventilation system information to dwelling occupants at the beginning of their occupancy. For systems in buildings or tenant spaces that~~or~~ are centrally operated, ~~such~~ all applicable ventilation system information shall be provided to the person(s) responsible for operating and maintaining the feature, material, component or mechanical ventilation device installed in the building. This information shall be in paper or electronic format.

   B. For nonresidential buildings, ~~high-rise residential buildings and~~ hotels, and motels, the enforcement agency shall require the builder to provide the building owner at occupancy a description of the quantities of outdoor and recirculated air that the ventilation systems are designed to provide to each area. For buildings or tenant spaces that are not individually owned and operated, or are centrally operated, such information shall be provided to the person(s) responsible for operating and maintaining the feature, material, component or mechanical device installed in the building. This information shall be in paper or electronic format.

(c) **Equipment Information to be Provided by Manufacturer or Supplier.** The manufacturer or supplier of any manufactured device shall, upon request, provide to building designers and installers information about the device. The information shall include the efficiency (and other characteristics regulated by Part 6). This information shall be in paper or electronic format.

(d) **Enforcement Agency Requirements.**

1. **Permits.** An enforcement agency shall not issue a building permit for any construction unless the enforcement agency determines in writing that the construction is designed to comply with the requirements of Part 6 that are in effect on the date the building permit was applied for. The enforcement agency determination shall confirm that the documentation requirements of Sections 10-103(a)1 and 10-103(a)2 have been met.

If a building permit has been previously issued, there has been no construction under the permit, and the permit has expired, the enforcement agency shall not issue a new permit unless the enforcement agency determines in writing that the construction is designed to comply with the requirements of Part 6 in effect on the date the new permit is applied for. The enforcement agency determination shall confirm that the documentation requirements of Sections 10-103(a)1 and 10-103(a)2 have been met.

"Determines in writing" includes, but is not limited to, approval of a building permit with a stamp normally used by the enforcement agency.

2. **Inspection.** The enforcement agency shall inspect newly constructed buildings and additions, and alterations to existing buildings to determine whether the construction or installation is consistent with the agency's approved plans and specifications, and complies with Part 6. Final certificate of occupancy shall not be issued until such consistency and compliance is verified. For Occupancy Group R-3, final inspection shall not be complete until such consistency and compliance is verified.

   Such verification shall include determination that:

   A. All installed features, materials, components or manufactured devices, regulated by the Appliance Efficiency Regulations or Part 6 are indicated, when applicable, on the Certificate(s) of Installation, Certificate(s) of Acceptance and Certificate(s) of Verification, and are consistent with such features, materials, components or manufactured devices given in the plans and specifications and the Certificate(s) of Compliance approved by the local enforcement agency.

   B. All required Certificates of Installation are posted, or made available with the building permit(s) issued for the building, or made available for viewing on an approved data registry, and are made available to the enforcement agency for all applicable inspections, and that all required Certificates of Installation conform to the specifications of Section 10-103(a)3.

   C. All required Certificates of Acceptance are posted, or made available with the building permit(s) issued for the building, ~~or made available for viewing on an approved data registry,~~ and are made available to the enforcement agency for all applicable inspections, and that all required Certificates of Acceptance conform to the specifications of Section 10-103(a)4.

   D. All required Certificates of Verification are posted, or made available with the building permit(s) issued for the building, or made available for viewing on an approved data registry, and are made available to the enforcement agency for all applicable inspections, and that all required Certificates of Verification conform to the specifications of Section 10-103(a)5.

NOTE: Authority: Section 25402, 25402.1, Public Resources Code. Reference: Section 25402, Public Resources Code.

10-103.1 – NONRESIDENTIAL LIGHTING CONTROLS ACCEPTANCE TEST TRAINING AND CERTIFICATION

(a) **Scope.** The requirements of this section apply to Acceptance Test Technicians (ATTs), Acceptance Test Employers (ATEs), and Acceptance Test Technician Certification Providers (ATTCPs) that perform work relating to the acceptance testing of nonresidential lighting systems and controls.

(b) **Industry Certification Threshold.** ATT and ATE certification requirements shall take effect when the Energy Commission finds that each of the following conditions are met. Until such time that Sections 10-103.1(b)1 and 10-103.1(b)2 are met, or if, subsequent to being met, they cease to be maintained, Field Technicians may complete acceptance testing as specified in Part 6, Section 130.4 without meeting the certification requirements specified in Part 1, Section 10-103.1.

1. **Number of Certified ATTs.** There shall be no less than 300 ATTs certified to perform the lighting acceptance tests in Building Energy Efficiency Standards, Section 130.4. The number of certified ATTs shall be submitted to the Energy Commission in the annual reports prepared by ATTCPs, as specified in Section 10-103.1(d)1.

2. **Industry Coverage by ATTCPs.** ATTCPs approved by the Energy Commission, in their entirety, shall provide reasonable access to certification to the following industry groups: electrical contractors, certified general electricians, licensed architects, professional engineers, controls installation and startup contractors and certified commissioning professionals who have verifiable training, experience and expertise in lighting controls and electrical systems. The Energy Commission will determine whether reasonable access to certification is provided by considering factors such as certification costs commensurate with the complexity of the training being provided, certification marketing materials, prequalification criteria, class location and availability, and curriculum.

(c) **Qualifications and Approval of ATTCPs.** ATTCPs shall submit a written application to the Energy Commission with a summary and the related background documents to explain how the following criteria and procedures have been met:

1. **Organizational Structure.** ATTCPs shall provide written explanations of the organization type, by-laws, and ownership structure. ATTCPs shall explain in writing how their certification program meets the qualification requirements of Title 24, Part 1, Section 10-103.1(c). ATTCPs shall explain in their application to the Energy Commission their organizational structure and their procedures for independent oversight, quality assurance, supervision and support of the acceptance test training and certification processes.

2. **Certification of ATEs.** The ATTCPs shall provide written explanations of their certification and oversight of ATEs. This explanation shall document how the ATTCP ensures that ATEs are providing quality control and appropriate supervision and support for their ATTs.

   A. **Recertification.** The ATTCP shall recertify all ATEs prior to the implementation of each adopted update to the Building Energy Efficiency Standards as these updates affect the acceptance test requirements. Recertification requirements and procedures shall only apply to those specific elements that are new or modified in future updates to Building Energy Efficiency Standards.

3. **Training and Certification Procedures.** ATTCPs shall include with their application a complete copy of all training and testing procedures, manuals, handbooks and materials. ATTCPs shall explain in writing how their training and certification procedures include, but are not limited to, the following:

   A. **Training Scope.** The scope of the training shall include both hands-on experience and theoretical training to certify competency in the technologies and skills necessary to perform the acceptance tests.

   B. **ATT Training.**

i. **Curricula.** ATTCP training curricula for ATTs shall include, but not be limited to, the analysis, theory, and practical application of the following:

   a. Lamp and ballast systems;

   b. Line voltage switching controls;

   c. Low voltage switching controls;

   d. Dimming controls;

   e. Occupancy sensors;

   f. Photosensors;

   g. Demand responsive signal inputs to lighting control systems;

   h. Building Energy Efficiency Standards required lighting control systems;

   i. Building Energy Efficiency Standards required lighting control system-specific analytical/problem solving skills;

   j. Integration of mechanical and electrical systems for Building Energy Efficiency Standards required lighting control installation and commissioning;

   k. Safety procedures for low-voltage retrofits (<50 volts) to control line voltage systems (120 to 480 volts);

   l. Accurate and effective tuning, calibration, and programming of Building Energy Efficiency Standards required lighting control systems;

   m. Measurement of illuminance according to the Illuminating Engineering Society's measurement procedures as provided in the IES Lighting Handbook, 10th Edition, 2011;

   n. Building Energy Efficiency Standards lighting controls acceptance testing procedures; and

   o. Building Energy Efficiency Standard**s** acceptance testing compliance documentation for lighting controls.

ii. **Hands-on training.** The ATTCP shall describe in its application the design and technical specifications of the laboratory boards, equipment and other elements that will be used to meet the hands-on requirements of the training and certification.

iii. **Prequalification.** Participation in the certification program shall be limited to persons who have at least three years of professional experience and expertise in lighting controls and electrical systems as determined by the Lighting Controls ATTCPs.

   NOTE: ATTCPs may specify additional qualifications for participation in their programs, such as limiting participation to persons that are not currently listed as "decertified" by another ATTCP.

iv. **Instructor to Trainee Ratio.** The ATTCP shall document in its application to the Energy Commission why its instructor to trainee ratio is sufficient to ensure the integrity and efficacy of the curriculum and program based on industry standards and other relevant information.

v. **Tests.** The ATTCP shall describe the written and practical tests used to demonstrate each certification applicant's competence in all specified subjects. The ATTCPs shall retain all results of these tests for five years from the date of the test.

vi. **Recertification.** The ATTCP shall recertify all ATTs prior to the implementation of each adopted update to the Building Energy Efficiency Standards when these updates affect the acceptance test requirements. Recertification requirements and procedures shall

only apply to those specific elements that are new or modified in future updates to Building Energy Efficiency Standards. The ATTCP shall develop recertification training curricula for ATTs consistent with training requirements in Sections 10-103.1(c)3A and 10-103.1(c)3B, and shall submit the proposed recertification training curricula to the Energy Commission for review and approval in the update report required under Section 10-103.1(d)2.

C. **ATE Training.** Training for ATEs shall consist of a single class or webinar consisting of at least four hours of instruction that covers the scope and process of the acceptance tests in Building Energy Efficiency Standards, Section 130.4.

D. **Complaint Procedures.** The ATTCP shall describe in its applications to the Energy Commission procedures for accepting and addressing complaints regarding the performance of any ATT or ATE certified by the ATTCP, and explain how building departments and the public will be notified of these proceedings.

E. **Decertification Procedures.** The ATTCP shall describe in its applications to the Energy Commission procedures for revoking their certification of ATTs and ATEs based upon poor quality or ineffective work, failure to perform acceptance tests, falsification of documents, failure to comply with the documentation requirements of these regulations or other specified actions that justify decertification. The ATTCP shall also describe its general procedures for decertified ATTs or ATEs seeking to regain their certification status, including eligibility requirements for recertification (if any).

F. **Quality Assurance and Accountability.** The ATTCP shall describe in its application to the Energy Commission its procedures for conducting quality assurance and accountability activities, including but not limited to the following:

i. The ATTCP shall include quality assurance and accountability measures, including but not limited to independent oversight of the certification materials, processes and procedures, visits to building sites where certified technicians are completing acceptance tests, certification process evaluations, building department surveys to determine acceptance testing effectiveness, and expert review of the training curricula developed for Building Energy Efficiency Standards, Section 130.4.

ii. The ATTCP shall review a random sample of no less than 1 percent of each ATT's completed compliance forms, and shall perform randomly selected on-site audits of no less than 1 percent of each ATT's completed acceptance tests. Independent oversight may be demonstrated by accreditation under the ISO/IEC 17024 standard.

G. **Certification Identification Number and Verification of ATT and ATE Certification Status.** The ATTCP shall describe in its application to the Energy Commission its procedures for recording, tracking, and communicating certification status, including but not limited to the following:

i. Upon certification of an ATT or ATE, the ATTCP shall issue a unique certification identification number to the ATT or ATE.

ii. The ATTCP shall maintain an accurate public record of the certification status for all ATTs and ATEs that the ATTCP has certified, including any ATTs or ATEs who have been decertified as specified in Section 10-103.1(c)3E.

iii. The ATTCP shall provide verification of current ATT certification status upon request to authorized document Registration Provider personnel or enforcement agency personnel to determine the ATT's eligibility to sign Certificate of Acceptance documentation according to all applicable requirements in Sections 10-103.1, 10-102, 10-103(a)4, and the Reference Joint Appendix JA7.

H. **Electronic Database System**. The ATTCP shall maintain, or by suitable contractual requirements cause to be maintained, an electronic database system approved by the Energy Commission. The electronic database system shall be capable of all the following:

i. Support all activities for the ATTCP to comply with its quality assurance program as required by Section 10-103.1(c)3F.

ii. For no less than five years, record and preserve all certificates of acceptance offered for certification by the ATTCP and as performed by its own certified ATTs.

iii. Allow the transmission of electronic copies of each completed certificate of acceptance to the ATT that performed the test, the ATE associated with that ATT, or both.

a. Each page of each certificate of acceptance shall bear the logo of the ATTCP or other identifying insignia as approved by the Energy Commission.

b. The electronic copy shall be capable of being printed.

c. The ATTCP may apply to the Energy Commission for approval to use alternative compliance documents that differ from those approved for use by the Energy Commission but must demonstrate that these alternative compliance documents do not differ in format, informational order, or content from approved compliance documents.

iv. Provide a means of verifying any certificate of acceptance to the enforcement agency having jurisdiction as identified on the certificate of acceptance.

v. Provide the Energy Commission with any of the following project data or documents upon request: project address, permit numbers, acceptance test technician and acceptance test employee certification numbers, certificates of acceptance, compliance forms, installation forms, and record of quality assurance review. The Energy Commission may adopt an Application Programming Interface (API) for providing data electronically. Within one year of development of an API, the ATTCP's electronic database system shall have the ability to transfer project data to the Energy Commission through the API upon completion of the project or at established intervals no longer than monthly.

I. Compliance Document Recording and Repository Reporting Requirement:

i. The ATTCP shall record all certificates of compliance (Section 10-103(a)1), certificates of installation (Section 10-103(a)3), and certificates of acceptance (Section 10-103(a)4) associated with any acceptance test specified in Part 6, Section 130.4.

ii. Contingent upon Energy Commission approval of the threshold (Section 10-103.1(b) or 10-103.2(b)) and upon availability and approval of an electronic document repository by the Executive Director, the ATTCP shall submit monthly data transfer packets to the Energy Commission to an electronic document repository for retention consistent with Energy Commission instructions.

(d) **Requirements for ATTCPs to Provide Regular Reports.** The ATTCP shall provide the following regular reports to the Energy Commission:

1. **Annual Report.** The ATTCP shall provide an annual report to the Energy Commission that includes the following:

A. A summary of the certification services provided over the reporting period, including the total number of Acceptance Test Technicians and Employers certified by the ATTCP during the reporting period and to date.

B. A summary of all actions taken against any ATT or ATE as a result of the complaint or quality assurance procedures described by the ATTCP as required under Section 10-103.1(c)(3)(D) and 10-103.1(c)(3)(F).

C. A summary of the quality assurance and accountability activities conducted over the reporting period, including the compliance forms reviewed and the on-site audits performed as required under Section 10-103.1(c)3F(ii) during the reporting period and to date.

D. A summary of the number and type of acceptance tests performed in each local jurisdiction over the reporting period and to date.

E. A signed certification to the Energy Commission that the ATTCP continues to meet the requirements of Section 10-103.1.

2. **Update Report**. The ATTCP shall have no less than six months following the adoption of an update to the Building Energy Efficiency Standards to prepare an Update Report. The ATTCP shall submit an Update Report to the Energy Commission no less than six months prior to the effective date of any newly adopted update to the Building Energy Efficiency Standards. The ATTCP shall report to the Energy Commission what application amendments are proposed, to address changes to the Building Energy Efficiency Standards or to ensure training is reflective of the variety of lighting controls that are currently encountered in the field. All required update reports shall contain a signed certification that the ATTCP continues to meet the requirements of Section 10-103.1. Update reports shall be approved through the Amendment Process provided under Section 10-103.1(f).

All required reports shall contain a signed certification that the ATTCP has met all requirements for this program.

(e) **Application Review and Determination.** The Energy Commission shall review ATTCP applications according to the criteria and procedures in Section 10-103.1(c) to determine if such providers meet the specified requirements for providing acceptance testing certification services.

1. Energy Commission staff will review and validate all information received on ATTCP applications, and determine whether the application is complete and contains sufficient information to be evaluated by staff. Complete applications shall be evaluated by staff based on their contents.

2. The Executive Director may require that the applicant provide additional information as required by staff to fully evaluate the ATTCP application.

3. The Executive Director shall provide a copy of the staff evaluation to interested persons and provide a reasonable opportunity for public comment.

4. The Executive Director shall issue a written recommendation that the Energy Commission designate the applicant as an authorized ATTCP or deny the application.

5. The Energy Commission shall make a final decision on the application at a publicly noticed hearing.

(f) **Amendment Process.**

The ATTCP may amend a submitted or approved application, as follows:

1. **Amendment Scope.**

A. **Nonsubstantive Changes.** A nonsubstantive change is a change that does not substantively alter the requirements of the application materials for the ATTCP, ATT, or ATE. For amendments making only nonsubstantive changes, the ATTCP shall submit the following:

i. A letter describing the change to the Energy Commission as an addendum to the application;

ii. A replacement copy of the affected sections of the ATTCP application with the changes incorporated; and

iii. A copy of the affected sections of the ATTCP application showing the changes in underline and strikeout format.

B. **Substantive Changes.** A substantive change is a change that substantively alters the requirements of the application materials for the ATTCP, ATT, or ATE. For amendments making any substantive changes, the ATTCP shall submit the following:

i. A document describing the scope of the change to the application, the reason for the change and the potential impact to the ATTCP, ATT, and ATE as an addendum to the application;

ii. A replacement copy of the affected sections of the ATTCP application with the changes incorporated; and

iii. A copy of the affected sections of the ATTCP application showing the changes in underline and strikeout format.

2. **Amendment Review.** Amendments submitted prior to approval of an ATTCP application shall be included in the application's Application Review and Determination process specified in Section 10-103.1(e).

Amendments submitted after approval of an ATTCP's application that contain only nonsubstantive changes shall be reviewed by the Executive Director for consistency with Section 10-103.1. Amendments determined to be consistent with this Section shall be incorporated into the approval as errata.

Amendments submitted after approval of an ATTCP's application that contain any substantive changes shall be subject to the Application Review and Determination process specified in Section 10-103.1(e). If the Energy Commission finds that the amended application does not meet the requirements of Section 10-103.1, then the ATTCP shall either abide by the terms of their previously approved application or have their approval suspended.

(g) **Review by the Energy Commission.**

If the Energy Commission determines there is a violation of these regulations or that an ATTCP is no longer providing adequate certification services, the Energy Commission may revoke the authorization of the ATTCP pursuant to Section 1230 et seq. of Title 20 of the California Code of Regulations.

NOTE: Authority: Sections 25402, 25402.1, 25213, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8 and 25943, Public Resources Code.

10-103.2 – NONRESIDENTIAL MECHANICAL ACCEPTANCE TEST TRAINING AND CERTIFICATION

(a) **Scope.** The requirements of this section apply to Acceptance Test Technicians (ATTs), Acceptance Test Employers (ATEs), and Acceptance Test Technician Certification Providers (ATTCPs) that perform work relating to the acceptance testing of nonresidential mechanical systems and controls.

(b) **Industry Certification Threshold.** ATT and ATE certification requirements shall take effect when the Energy Commission finds that each of the following conditions are met. Until such time that Sections 10-103.2(b)1 and 10-103.2(b)2 are met, or if, subsequent to being met, they cease to be maintained, Field Technicians may complete acceptance testing as specified in Section 120.5 without completing certification requirements specified in Part 1, Section 10-103.2.

1. **Number of Certified ATTs.**

   A. There shall be no less than 300 ATTs certified to perform the complete set of mechanical acceptance tests in Building Energy Efficiency Standards, Section 120.5, except as provided in Subsection 10-103.2(b)1.B. The number of certified ATTs shall be submitted to the Energy Commission in the annual reports prepared by ATTCPs, as specified in Section 10-103.2(d)1.

   B. If there are less than 300 ATTs certified to perform all of the acceptance tests in Building Energy Efficiency Standards, Section 120.5, then there shall be at least 300 ATTs certified to complete the following tests:

      i. NA7.5.1 Outdoor Air Ventilation Systems
      ii. NA7.5.2 Constant Volume, Single Zone Unitary Air Conditioners and Heat Pumps
      iii. NA7.5.4 Air Economizer Controls
      iv. NA7.5.5 Demand Control Ventilation Systems
      v. NA 7.5.6 Supply Fan Variable Flow Controls
      vi. NA7.5.7, NA7.5.9 Hydronic System Variable Flow Controls
      vii. NA7.5.10 Automatic Demand Shed Controls

2. **Industry Coverage by ATTCPs.** ATTCPs approved by the Energy Commission, in their entirety, provide reasonable access to certification to the following industry groups: Professional engineers, licensed architects, HVAC installers, mechanical contractors, Testing and Balancing (TAB) certified technicians, controls installation and startup contractors and certified commissioning professionals who have verifiable training, experience and expertise in HVAC systems. The Energy Commission will determine reasonable access by considering factors such as certification costs commensurate with the complexity of the training being provided, certification marketing materials, prequalification criteria, class availability and curriculum.

(c) **Qualifications and Approval of ATTCPs.** ATTCPs shall submit a written application to the Energy Commission with a summary and the necessary background documents to explain how the following criteria and procedures have been met:

1. **Organizational Structure.** ATTCPs shall provide written explanations of the organization type, by-laws, and ownership structure. ATTCPs shall explain in writing how their certification program meets the qualifications of Building Energy Efficiency Standards, Section 10-103.2(c). ATTCPs shall explain in their application to the Energy Commission their organizational structure and their procedures for independent oversight, quality assurance, supervision and support of the acceptance test training and certification processes.

2. **Certification of ATEs.** The ATTCPs shall provide written explanations of their certification and oversight of ATEs. This explanation shall document how the ATTCP ensures that ATEs are providing quality control and appropriate supervision and support for their ATTs.

   A. **Recertification.** The ATTCP shall recertify all ATEs prior to the implementation of each adopted update to the Building Energy Efficiency Standards as these updates affect the acceptance test

requirements. Recertification requirements and procedures shall only apply to those specific elements that are new or modified in future updates to Building Energy Efficiency Standards.

3. **Requirements for Applicant ATTCPs to Document Training and Certification Procedures.** ATTCPs shall include with their application a complete copy of all training and testing procedures, manuals, handbooks and materials. ATTCPs shall explain in writing how their training and certification procedures include, but are not limited to, the following:

   A. **Training Scope.** The scope of the training shall include both hands-on experience and theoretical training to certify competency in the technologies and skills necessary to perform the acceptance tests.

   B. **ATT Training.**

      i. **Curricula**. ATTCP training curricula for ATTs shall include, but not be limited to, the analysis, theory, and practical application of the following:

         a. Constant volume system controls;

         b. Variable volume system controls;

         c. Air-side economizers;

         d. Air distribution system leakage;

         e. Demand controlled ventilation with CO_2 sensors;

         f. Demand controlled ventilation with occupancy sensors;

         g. Automatic demand shed controls;

         h. Hydronic valve leakage;

         i. Hydronic system variable flow controls;

         j. Supply air temperature reset controls;

         k. Condenser water temperature reset controls;

         l. Outdoor air ventilation systems;

         m. Supply fan variable flow controls;

         n. Boiler and chiller isolation controls;

         o. Fault detection and diagnostics for packaged direct-expansion units;

         p. Automatic fault detection and diagnostics for air handling units and zone terminal units;

         q. Distributed energy storage direct-expansion air conditioning systems;

         r. Thermal energy storage systems;

         s. Building Energy Efficiency Standards mechanical acceptance testing procedures; and

         t. Building Energy Efficiency Standards acceptance testing compliance documentation for mechanical systems.

      ii. **Hands-on training.** The ATTCP shall describe in its application the design and technical specifications of the laboratory boards, equipment and other elements that will be used to meet the hands-on requirements of the training and certification.

      iii. **Prequalification.** Participation in the certification program shall be limited to persons who have at least three years of professional experience and expertise in mechanical controls and systems as determined by the Mechanical ATTCPs.

NOTE: ATTCPs may specify additional qualifications for participation in their programs, such as limiting participation to persons that are not currently listed as "decertified" by another ATTCP.

iv. **Instructor to Trainee Ratio.** The ATTCP shall document in its application to the Energy Commission why its instructor to trainee ratio is sufficient to ensure the integrity and efficacy of the curriculum and program based on industry standards and other relevant information.

v. **Tests.** The ATTCP shall describe the written and practical tests used to demonstrate each certification applicant's competence in all specified subjects. The ATTCPs shall retain all results of these tests for five years from the date of the test.

vi. **Recertification.** The ATTCP shall recertify all ATTs prior to the implementation of each adopted update to the Building Energy Efficiency Standards as these updates affect the acceptance test requirements. Recertification requirements and procedures shall only apply to those specific elements that are new or modified in future updates to Building Energy Efficiency Standards.

C. **ATE Training.** Training for ATEs shall consist of a single class or webinar consisting of at least four hours of instruction that covers the scope and process of the acceptance tests in Building Energy Efficiency Standards, Section 120.5.

D. **Complaint Procedures.** Procedures described in writing for notifying building departments and the public that the ATTCP will accept complaints regarding the performance of any certified ATT or ATE, and procedures for how the ATTCP will address these complaints.

E**. Decertification Procedures.** The ATTCP shall describe in its application to the Energy Commission procedures for revoking their certification of ATTs and ATEs based upon poor quality or ineffective work, failure to perform acceptance tests, falsification of documents, failure to comply with the documentation requirements of these regulations or other specified actions that justify decertification. The ATTCP shall also describe its general procedures for decertified ATTs or ATEs seeking to regain their certification status, including eligibility requirements for recertification (if any).

F. **Quality Assurance and Accountability.** The ATTCP shall describe in its applications to the Energy Commission procedures for conducting quality assurance and accountability activities, including but not limited to the following:

i. The ATTCPs shall include quality assurance and accountability measures, including but not limited to independent oversight of the certification materials, processes and procedures, visits to building sites where certified technicians are completing acceptance tests, certification process evaluations, building department surveys to determine acceptance testing effectiveness, and expert review of the training curricula developed for Building Energy Efficiency Standards, Section 120.5.

ii. The ATTCP shall review a random sample of no less than 1 percent of each ATT's completed compliance forms. The ATTCP shall also randomly select and shadow audit no less than 1 percent of each ATE's overseen projects, following the assigned ATT and observing their performance on the job site. Independent oversight may be demonstrated by accreditation under the ISO/IEC 17024 standard.

G. **Certification Identification Number and Verification of ATT and ATE Certification Status.** The ATTCP shall describe in its applications to the Energy Commission procedures for recording, tracking, and communicating certification status, including but not limited to the following:

i. Upon certification of an ATT or ATE, the ATTCP shall issue a unique certification identification number to the ATT or ATE.

ii. The ATTCP shall maintain an accurate public record of the certification status for all ATTs and ATEs that the ATTCP has certified, including any ATTs or ATEs who have been decertified as specified in 10-103.2(c)3E.

iii. The ATTCP shall provide verification of current ATT certification status upon request to authorized document Registration Provider personnel or enforcement agency personnel to determine the ATT's eligibility to sign Certificate of Acceptance documentation according to all applicable requirements in Sections 10-103.2, 10-102, 10-103(a)4, and Reference Joint Appendix JA7.

H. **Electronic Database System**. The ATTCP shall maintain, or by suitable contractual requirements cause to be maintained, an electronic database system approved by the Energy Commission. The electronic database system shall be capable of all the following:

i. Support all activities for the ATTCP to comply with its quality assurance program as required by Section 10-103.2(c)3F.

ii. For no less than five years, record and preserve all certificates of acceptance offered for certification by the ATTCP and as performed by its own certified ATTs.

iii. Allow the transmission of electronic copies of each completed certificate of acceptance to the ATT that performed the test, the ATE associated with that ATT, or both.

a. Each page of each certificate of acceptance shall bear the logo of the ATTCP or other identifying insignia as approved by the Energy Commission.

b. The electronic copy shall be capable of being printed.

c. The ATTCP may apply to the Energy Commission for approval to use alternative compliance documents that differ from those approved for use by the Energy Commission but must demonstrate that these alternative compliance documents do not differ in format, informational order, or content from approved compliance documents.

iv. Provide a means of verifying any certificate of acceptance to the enforcement agency having jurisdiction as identified on the certificate of acceptance.

v. Provide the Energy Commission with any of the following project data or documents upon request: project address, permit numbers, acceptance test technician and acceptance test employee certification numbers, certificates of acceptance, compliance forms, installation forms, and record of quality assurance review. The Energy Commission may adopt an Application Programming Interface (API) for providing data electronically. Within one year of development of an API, the ATTCP's electronic database system shall have the ability to transfer project data to the Energy Commission through the API upon completion of the project or at established intervals no longer than monthly.

I. Compliance Document Recording and Repository Reporting Requirement:

i. The ATTCP shall record all certificates of compliance (Section 10-103(a)1), certificates of installation (Section 10-103(a)3), and certificates of acceptance (Section 10-103(a)4) associated with any acceptance test specified in Part 6, Section 120.5.

ii. Contingent upon Energy Commission approval of the threshold (Section 10-103.1(b) or 10-103.2(b)) and upon availability and approval of an electronic document repository by the Executive Director, the ATTCP shall submit monthly data transfer packets to the Energy Commission to an electronic document repository for retention consistent with Energy Commission instructions.

(d) **Requirements for ATTCPs to Provide Regular Reports.** The ATTCP shall provide the following regular reports to the Energy Commission:

1. **Annual Report.** The ATTCP shall provide an annual report to the Energy Commission that includes the following:

A. A summary of the certification services provided over the reporting period, including the total number of Acceptance Test Technicians and Employers certified by the agency during the reporting period and to date.

B. A summary of all actions taken against any ATT or ATE as a result of the complaint or quality assurance procedures described by the ATTCP as required under Section 10-103.2(c)(3)(D) and 10-103.2(c)(3)(F).

C. A summary of the quality assurance and accountability activities conducted over the reporting period, including the compliance forms reviewed and the on-site audits performed as required under Section 10-103.2(c)3F(ii) during the reporting period and to date.

D. A summary of the number and type of acceptance tests performed in each local jurisdiction over the reporting period and to date.

E. A signed certification to the Energy Commission that the ATTCP continues to meet the requirements of Section 10-103.2.

2. **Update Report.** The ATTCP shall have no less than six months following the adoption of an update to the Building Energy Efficiency Standards to prepare an Update Report. The ATTCP shall submit an Update Report to the Energy Commission no less than six months prior to the effective date of any newly adopted update to the Building Energy Efficiency Standards, The ATTCP shall report to the Energy Commission what application amendments are proposed to address changes to the Building Energy Efficiency Standards or to ensure training is reflective of the variety of mechanical equipment and systems currently encountered in the field. All required update reports shall contain a signed certification that the ATTCP continues to meet all the requirements of Section 10-103.2(c). Update reports shall be approved through the Amendment Process provided under Section 10-103.2(f).

All required reports shall contain a signed certification that the ATTCP has met all requirements for this program.

(e) **Application Review and Determination.** The Energy Commission shall review ATTCP applications according to the criteria and procedures in Section 10-103.2(c) to determine if such providers meet the specified requirements for providing acceptance testing certification services.

1. Energy Commission staff will review and validate all information received on ATTCP applications, and determine whether the application is complete and contains sufficient information to be evaluated by staff. Complete applications shall be evaluated by staff based on their contents.

2. The Executive Director may require that the applicant provide additional information as required by staff to fully evaluate the ATTCP application.

3. The Executive Director shall provide a copy of the staff evaluation to interested persons and provide an opportunity for public comment.

4. The Executive Director shall issue a written recommendation that the Energy Commission designate the applicant as an authorized ATTCP or deny the Provider application.

5. The Energy Commission shall make a final decision on the application at a publicly noticed hearing.

(f) **Amendment Process.**

The ATTCP may amend a submitted or approved application, as follows:

1. **Amendment Scope.**

A. **Nonsubstantive Changes.** A nonsubstantive change is a change that does not substantively alter the requirements of the application materials for the ATTCP, ATT, or ATE. For amendments making only nonsubstantive changes, the ATTCP shall submit the following:

i. a letter describing the change to the Energy Commission as an addendum to the application;

ii. A replacement copy of the affected sections of the ATTCP application with the changes incorporated; and

iii. A copy of the affected sections of the ATTCP application showing the changes in underline and strikeout format.

B. **Substantive Changes.** A substantive change is a change that substantively alters the requirements of the application materials for the ATTCP, ATT, or ATE. For amendments making any substantive changes, the ATTCP shall submit the following:

i. A document describing the scope of the change to the application, the reason for the change and the potential impact to the ATTCP, ATT, and ATE as an addendum to the application;

ii. A replacement copy of the affected sections of the ATTCP application with the changes incorporated; and

iii. A copy of the affected sections of the ATTCP application showing the changes in underline and strikeout format.

2. **Amendment Review.** Amendments submitted prior to approval of an ATTCP application shall be included in the application's Application Review and Determination process specified in Section 10-103.2(e).

Amendments submitted after approval of an ATTCP's application that contain only nonsubstantive changes shall be reviewed by the Executive Director for consistency with Section 10-103.2. Amendments determined to be consistent with this Section shall be incorporated into the approval as errata.

Amendments submitted after approval of an ATTCP's application that contain any substantive changes shall be subject to the Application Review and Determination process specified in Section 10-103.2(e). If the Energy Commission finds that the amended application does not meet the requirements of Section 10-103.2, then the ATTCP shall either abide by the terms of their previously approved application or have their approval suspended.

(g) **Review by the Energy Commission.**

If the Energy Commission determines there is a violation of these regulations or that an ATTCP is no longer providing adequate certification services, the Energy Commission may revoke the authorization of the ATTCP pursuant to Section 1230 et. seq. of Title 20 of the California Code of Regulations.

NOTE: Authority: Sections 25402, 25402.1, 25213, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8 and 25943, Public Resources Code.

10-104 – EXCEPTIONAL DESIGNS

NOTE: See Section 10-109 for approval of calculation methods and Alternative Component Packages.

(a) **Requirements.** If a building permit applicant proposes to use a performance compliance approach, and the building designs cannot be adequately modeled by an approved calculation method, an applicant shall be granted a building permit if the Commission finds:

1. That the design cannot be adequately modeled with an approved calculation method;
2. Using an alternative evaluation technique, that the design complies with Part 6; and
3. That the enforcement agency has determined that the design complies with all other legal requirements.

(b) **Applications.** The applicant shall submit four copies of a signed application with the following materials to the Executive Director:

1. A copy of the plans and documentation required by Section 10-103(a)2;
2. A statement explaining why meeting the energy budget cannot be demonstrated using an approved calculation method;
3. Documentation from the enforcement agency stating that:
   A. Meeting the energy budget requirements cannot be demonstrated using an approved calculation method; and
   B. The design complies with all other legal requirements; and
4. A detailed evaluation of the energy consumption of the proposed building and the building's materials, components, and manufactured devices proposed to be installed to meet the requirements of Part 6 using an alternative evaluation technique. The evaluation shall include a copy of the technique, instructions for its use, a list of all input data, and all other information required to replicate the results.

NOTE: Authority: Sections 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8 and 25943, Public Resources Code.

10-105 – ENFORCEMENT BY THE COMMISSION

(a) **Where there is No Local Enforcement Agency.** Before new construction may begin in an area where there is no local enforcement agency, the Executive Director shall determine in writing that the building design conforms to the requirements of Part 6. The person proposing to construct the building shall submit the information described in Sections 10-103(a)1 and 10-103(a)2 to the Executive Director when such a determination is sought.

(b) **Where building construction is under the jurisdiction of a State agency.** Pursuant to Public Resources Code Section 25402.1(g)(5), no construction of any State building shall commence until the Department of General Services or the State agency that otherwise has jurisdiction over the property determines that the construction is designed to comply with the requirements of Part 6, and confirms that the documentation requirements of Sections 10-103(a)1 and 10-103(a)2 have been met and that the plans indicate the features and performance specifications needed to comply with Part 6. The responsible state agency shall notify the Commission's Executive Director of its determination.

(c) **Where the Enforcement Agency Fails to Enforce.** If an enforcement agency fails to enforce the requirements of this article or of Part 6 the Commission, after furnishing 10 days written notice, may condition building permit issuance on submission of the information described in Sections 10-103(a)1 and 10-103(a)2 to the Executive Director and on his or her written determination that proposed construction conforms to the requirements of Part 6.

NOTE: Authority: Code Section 25402.1, Public Resources Code. Reference: Section 25402.1, Public Resources Code.

10-106 – LOCALLY ADOPTED ENERGY STANDARDS

(a) **Requirements.** Local governmental agencies may adopt and enforce energy standards for newly constructed buildings, additions, alterations, and repairs to existing buildings provided the following two requirements are met prior to any enforcement of the standards:

1. A determination that the standards are cost effective is adopted by the local agency at a public meeting and subsequently filed with the Energy Commission; and
2. The Energy Commission finds that the standards will require buildings to be designed to consume less energy than permitted by Title 24, Part 6.

(b) **Documentation Application.** Local governmental agencies wishing to enforce energy standards subject to Section10-106(a) shall submit an application with the following materials to the Executive Director:

1. The proposed energy standards;
2. The local governmental agency's findings and supporting analyses on the energy savings and cost effectiveness of the proposed energy standards;
3. A statement or finding by the local governmental agency that the proposed energy standards will require buildings to be designed to consume less energy than permitted by Part 6; and
4. Any findings, determinations, declarations or reports, including any negative declaration or environmental impact report, required pursuant to the California Environmental Quality Act, Pub. Resources Code Section 21000 et seq.

NOTE: Authority: Section 25402.1, Public Resources Code. Reference: Sections 25402.1, 21080.4, 21153, Public Resources Code.

10-107 – INTERPRETATIONS

(a) The Commission may make a written determination as to the applicability or interpretation of any provision of this article or of Part 6 upon written application, if a dispute concerning a provision arises between an applicant for a building permit and the enforcement agency, and the dispute has been heard by the local board of permit appeals or other highest local review body. Notice of any such appeal, including a summary of the dispute and the section of the regulations involved, shall if possible be sent to the Commission by the enforcing agency 15 days before the appeal is heard, and the result of the appeal shall be sent to the Commission within 15 days after the decision is made. Either party to the dispute may apply for a determination but shall concurrently deliver a copy of the application to the other party. The determinations are binding on the parties.

(b) The Executive Director may, upon request, give written advice concerning the meaning of any provision of this article or of Part 6. Such advice is not binding on any person.

NOTE: Authority: Section 25402.1, Public Resources Code. Reference: Section 25218.5 and 25402.1, Public Resources Code.

10-108 – EXEMPTION

(a) **Requirements.** The Commission may exempt any building from any provision of Part 6 if it finds that:

1. Substantial funds had been expended in good faith on planning, designing, architecture, or engineering of the building before the adoption date of the provision; and
2. Compliance with the requirements of the provision would be impossible without both substantial delays and substantial increases in costs of construction above the reasonable costs of the measures required to comply with the provision.

(b) **Application.** The applicant shall submit four copies of a signed application with the following materials to the Executive Director:

1. A summary of the claimant's contracts for the project;
2. A summary of internal financial reports on the project;
3. Dated schedules of design activities; and
4. A progress report on project completion.

NOTE: Authority: Section 25402.1, Public Resources Code. Reference: Section 25402.1, Public Resources Code.

10-109 – COMPLIANCE SOFTWARE, ALTERNATIVE COMPONENT PACKAGES, EXCEPTIONAL METHODS, DATA REGISTRIES AND RELATED EXTERNAL DIGITAL DATA SOURCES, ALTERNATIVE RESIDENTIAL FIELD VERIFICATION PROTOCOLS, ELECTRONIC DOCUMENT REPOSITORIES, AND PHOTOVOLTAIC SYSTEM REQUIREMENT DETERMINATIONS

(a) **Compliance software, alternative component packages, exceptional methods, data registries and related data input software, alternative residential field verification protocols or electronic document repositories** must be approved by the Commission in order to be used to demonstrate compliance with Part 6.

(b) **Application.** Applications for approval of compliance software, alternative component packages, exceptional methods, data registries and related data input software, and alternative field verification protocols must be made as follows:

1. An applicant shall submit four copies of a signed application form specified by the Executive Director.

2. The application shall include the following materials:

   A. A description of the functional or analytical capabilities of the compliance software, alternative component package, calculation method, exceptional method, data registry or related data input software, and alternative field verification protocol; and

   B. A demonstration that the criteria in Section 10-109 are met; and

   C. An initial fee of one thousand dollars ($1,000). The total fee shall cover the Commission's cost of reviewing and analyzing the application. Within 75 days of receipt of an application, the Commission will provide an estimate of the total maximum cost to review and analyze the application and make a determination as to the completeness of the application. Consideration of the application will be delayed until the applicant submits requested additional information. After the Commission determines the total cost, if the cost exceeds the initial fee, the Commission shall assess an additional fee to cover the total cost. If the actual cost is less than the initial, or any estimated maximum, fee the Commission shall refund the difference to the applicant.

(c) **Compliance Software.**

1. **Public Domain Computer Programs.** In addition to the public domain computer programs that are approved pursuant to Public Resources Code Section 25402.1, the Commission may, upon written application or its own motion, approve additional public domain computer programs that may be used to demonstrate that proposed building designs meet energy budgets.

   A. The Commission shall ensure that users' manuals or guides for each approved program are available.

   B. The Commission shall approve a program only if it predicts energy consumption substantially equivalent to that predicted by the above-referenced public domain computer program, when it models building designs or features.

2. **Alternative Calculation Methods (All Occupancies)**. The Commission may approve non-public domain computer programs as an alternative calculation method that building permit applicants may then use to demonstrate compliance with the performance standards (energy budgets) in Part 6. In addition to the application requirements of subdivision (b) above, an application for approval of compliance software must include documentation demonstrating that the compliance software meets the requirements, specifications, and criteria set forth in the Residential or Nonresidential ACM Approval Manual, as appropriate.

NOTE: Copies of the ACM Approval Manuals may be obtained from the Commission's website at: www.energy.ca.gov/title24.

(d) **Alternative Component Packages.** In addition to the application requirements of subdivision (b) above, an application for approval of an alternative component package must include documentation that demonstrates that the package:

1. Will meet the applicable energy budgets; and
2. Is likely to apply to a significant percentage of newly constructed buildings or to a significant segment of the building construction and design community.

(e) **Exceptional Methods.** The Commission may approve an exceptional method that analyzes a design, material, or device that cannot be adequately modeled using the public domain computer programs. Applications for approval of exceptional methods shall include all information needed to verify the method's accuracy.

(f) **Commission Action.** The Commission may take the following actions on an application submitted pursuant to this section:

1. Approve the application unconditionally;
2. Restrict approval to specified occupancies, designs, materials, or devices; or
3. Reject the application.

(g) **Resubmittal.** An applicant may resubmit a rejected application or may request modification of a restricted approval. Such application shall include the information required pursuant to this section, and, if applicable, shall indicate how the proposed compliance software, alternative component package, exceptional method, data registry or related data input software has been changed to enhance its accuracy or capabilities.

1. Modification. Whenever an approved compliance software, alternative component package, exceptional method, data registry or related data input software is changed in any way, it must be resubmitted under this section for approval.
2. The Commission may modify or withdraw approval of compliance software, an alternative component package, an exceptional method, or a data registry or related data input software based on its approval of other programs, methods, registries or data input software that are more suitable.

(h) **In addition to** the procedures and protocols identified in the Alternative Calculation Method Approval Manuals and the Reference Appendices, the Commission may authorize alternative procedures or protocols that demonstrate compliance with Part 6.

(i) **Data Registries And Related External Digital Data Sources, And Electronic Document Repositories.**

1. **Data Registries and Related External Digital Data Sources.**

Data registries and related external digital data sources shall conform to the requirements specified in Reference Joint Appendix JA7.

A. The Commission may approve residential data registries that provide for registration, when required by Part 6 of all residential compliance documentation and the nonresidential Certificates of Verification.

B. **Nonresidential Data Registry Approval Thresholds.**

i. The Commission may approve nonresidential data registries that provide for registration, when required by Part 6 of all nonresidential compliance documentation. However, nonresidential data registries may not provide for registration of nonresidential Certificates of Verification.

ii. As a prerequisite to reviewing and/or approving nonresidential data registries for use on or after January 1, 2023, the Commission shall first make all of the following findings:

a. The Commission has approved data schema capable of utilization in the development of any nonresidential data registry.
b. The Commission will not lose access to information necessary to support the enforcement and development of current and future building code cycles.

iii. The procedures for consideration and approval of applications enumerated in 10-110 shall not apply to applications for nonresidential data registries until the Commission makes the findings specified in 10-109(i)1Bii.
iv. Nothing in this or any other section, including 10-110, shall be construed as requiring the Commission to make the findings specified in 10-109(i)1Biia by any set date, regardless of pending applications.
v. The Registration Provider shall only use data schema approved by the Commission in a nonresidential data registry.

C. The Commission may approve external digital data sources used for data input to various data registries for registering, when required by Part 6 residential or nonresidential compliance documentation.

2. **Electronic Document Repositories.**

A. The Commission may approve electronic document repositories that retain for the Commission electronic compliance documentation generated by residential and nonresidential data registries when registration is required by Part 6.

(j) **Alternative Residential Field Verification Protocols.**

Alternative residential field verification protocols shall comply with the application requirements of Section 10-109(b) and any applicable requirements of Reference Residential Appendices RA1.

(k) **Photovoltaic System Requirement Determinations.**

The Commission may, upon written application or its own motion, determine that the photovoltaic requirements in Section 150.1(c)14 and Section 140.10 shall not apply, if the Commission finds that the implementation of public agency rules regarding utility system costs and revenue requirements, compensation for customer-owned generation, ~~or~~ interconnection fees, or other factors, causes the Commission's cost effectiveness conclusions, made pursuant to Public Resources Code 25402(b)(3), to not hold for particular buildings.

Applications shall include full information regarding the differences between public agency rules and Energy Commission cost effectiveness determinations, including all information requested by the Commission to enable full review of the application. Applications shall also include specific recommended limitations to the scope of the determination that is requested, and specific eligibility criteria to determine what buildings would qualify for the determination. Applications from public agencies shall be submitted to the Energy Commission only after public review within the jurisdiction of the public entity or service area of the utility.

NOTE: Authority: Sections 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8,25605, 25910, and 25943, Public Resources Code.

10-110 – PROCEDURES FOR CONSIDERATION OF APPLICATIONS UNDER SECTIONS 10-104, 10-106, 10-108, AND 10-109

(a) Within 75 days of receipt of an application, the Executive Director shall determine if the application is complete with all the supporting information required pursuant to Sections 10-104, 10-106, 10-108, or 10-109 (the complete application package).

(b) Once the application is determined to be complete, the Executive Director shall make the complete application package available to interested parties for review and comment. Comments from interested parties must be submitted within a time period set by the Executive Director, which shall be no less than 15 and no greater than 60 days after the complete application package is made available.

(c) Within 75 days of the date the application is determined to be complete, the Executive Director may request any additional information needed to evaluate the application. Consideration of the application will be delayed until the applicant submits the requested additional information.

(d) Within 75 days of the date the application is determined to be complete, the Executive Director may convene a workshop to gather additional information from the applicant and other interested parties. Interested parties will have 15 days after the workshop to submit additional comments or information regarding the application.

(e) Within 90 days of the date the application is determined to be complete, or within 30 days after receipt of complete additional information requested under Section 10-110(c), or within 60 days after the receipt of additional information submitted by interested parties under Section 10-110(d), whichever is later, the Executive Director shall submit to the Commission a written recommendation on the application.

(f) The complete application package, any additional information considered by the Executive Director, and the Executive Director's recommendation shall be placed on the consent calendar and considered at the next business meeting after submission of the recommendation. The matter may be removed from the consent calendar at the request of any person.

(g) The Executive Director may charge a fee to recover the costs of processing and reviewing applications, with the exception of Section 10-106 applications.

(h) All applicants have the burden of proof to establish that their applications should be granted.

NOTE: Authority: Section 25402.1, Public Resources Code. Reference: Section 25402.1, Public Resources Code.

10-111 – CERTIFICATION AND LABELING OF FENESTRATION PRODUCT AND EXTERIOR DOOR U-FACTORS, SOLAR HEAT GAIN COEFFICIENTS, VISIBLE TRANSMITTANCE AND AIR LEAKAGE

This section establishes rules for implementing labeling and certification requirements relating to U-factors, solar heat gain coefficients (SHGCs), visible transmittance (VT) and air leakage for fenestration products and exterior doors under Section 110.6(a) of Part 6. This section also provides for designation of the National Fenestration Rating Council (NFRC) as the supervisory entity responsible for administering the state's certification program for fenestration products and exterior doors, provided NFRC meets specified criteria.

(a) **Labeling Requirements.**

1. **Temporary labels.**

   A. Every manufactured fenestration product and exterior door shall have attached to it a clearly visible temporary label that lists the U-factor, the solar heat gain coefficient (SHGC) and Visible Transmittance (VT) and that certifies compliance with the air leakage requirements of Section 110.6(a)1. Temporary labels for manufactured fenestration products and exterior doors are to incorporate the values determined by Section 10-111(a)1B and shall comply with the labeling requirements of NFRC 700. No other values for U-factor, SHGC, VT and Air Leakage are allowed on the temporary label attached to the manufactured fenestration product or exterior door. Component Modeling Approach (CMA) and site-built fenestration products shall have an NFRC label certificate that lists the U-factor, the Solar Heat Gain Coefficient (SHGC), and the Visible Transmittance (VT) and shall comply with the labeling requirements of NFRC 705 for the Computer Modeling Approach or NFRC 700 for site-built fenestration products.

   B. U-factor, SHGC, VT and Air Leakage shall be determined by either:

      i. Fenestration products and exterior doors rated and certified using NFRC 100, NFRC 200, NFRC 202 NFRC 203 or NFRC 400 Rating Procedures. The manufacturer shall stipulate that the ratings were determined in accordance with applicable NFRC procedures. For manufactured fenestration products and exterior doors, a temporary label certificate approved by the supervisory entity (NFRC) meets the requirements of this section. For component modeling and site-built fenestration products, a label certificate approved by the supervisory entity (NFRC) meets the requirements of this section.

      ii. For manufactured or site-built fenestration products and exterior doors not rated by NFRC, a temporary label with the words “CEC Default U-factor,” followed by the appropriate default U-factor specified in Section 110.6(a)2 and with the words “CEC Default SHGC,” followed by the appropriate default SHGC specified in Section 110.6(a)3 and with the words "CEC Default VT," followed by the appropriate VT as specified in Section 110.6(a)4, meets the requirements of this Subsection B.

   C. Temporary labels shall also certify that the manufactured fenestration product or exterior door complies with the air leakage requirements of Section 110.6(a)1 of the Standards.

2. **Permanent labels.** Rated products shall have a permanent label consistent with their rating and certification that is either a stand-alone label, an extension or tab of an existing permanent certification label being used by the manufacturer/responsible party, or a series of marks or etchings on the product. The permanent label coupled with observable product characteristics, shall be usable to trace the product to certification information on file with the supervisory entity or to a directory of certified products, published by the supervisory entity. For CMA and site-built fenestration products, a label certificate approved by the supervisory entity meets the requirements of this section.

EXCEPTION to Section 10-111(a): Field-fabricated fenestration products.

(b) **Certification Requirements.**

1. **Certification to default ratings.** The manufacturer shall certify on the Default Label that the product's U-factor, SHGC and VT meets the default criteria in Sections 110.6(a)2, 110.6(a)3 and 110.6(a)4; and

   A. A temporary label, affixed to the product, that meets the requirements of Section 10-111(a)1B meets this requirement.

   B. If the product claims the default U-factor for a thermal break product, the manufacturer shall also certify on the label that the product meets the thermal break product criteria, specified on the default table, on which the default value is based. Placing the terms “Meets Thermal Break Default Criteria” on the default temporary label or default label certificate meets this requirement.

2. **Certification to NFRC rating procedure.** If a product's U-factor, SHGC or VT is based on the NFRC Rating Procedure, the U-factor, SHGC or VT shall be certified by the manufacturer according to the procedures of an independent certifying organization approved by the Commission.

   A. A temporary label, affixed to the product or label certificate for CMA and site-built fenestration, meeting the requirements of Section 10-111(a) certified by the independent certifying organization complies with this requirement.

   B. An “independent certifying organization approved by the Commission” means any organization authorized by the supervisory entity to certify U-factor ratings, Solar Heat Gain Coefficient and Visible Transmittance ratings in accordance with the NFRC Rating Procedure. If the Commission designates the NFRC as the supervisory entity, any independent certification and inspection agency (IA) licensed by NFRC shall be deemed to be an “independent certifying organization approved by the Commission.”

   C. The “supervisory entity” means the NFRC, except as provided in Section 10-111(c)1.

EXCEPTION to Section 10-111(b): Field-fabricated fenestration products.

(c) **Designation of Supervisory Entity.** The NFRC shall be the supervisory entity to administer the certification program relating to U-factors, SHGC, and VT ratings for fenestration products and exterior doors, provided the Commission determines that the NFRC meets the criteria in Section 10-111(d).

1. The Commission may consider designating a supervisory entity other than NFRC only if the Commission determines that the NFRC cannot meet the criteria in Section 10-111(d). Such other supervisory entity shall meet the criteria in Section 10-111(d) prior to being designated.

2. The Commission shall periodically review, at least annually, the structure and operations of the supervisory entity to ensure continuing compliance with the criteria in Section 10-111(d).

(d) **Criteria for Supervisory Entity.**

1. Membership in the entity shall be open on a nondiscriminatory basis to any person or organization that has an interest in uniform thermal performance ratings for fenestration products and exterior doors, including, but not limited to, members of the fenestration industry, glazing infill industry, building industry, design professionals, specifiers, utilities, government agencies, and public interest organizations. The membership shall be composed of a broad cross section of those interested in uniform thermal performance ratings for fenestration products.

2. The governing body of the entity shall reflect a reasonable cross section of the interests represented by the membership.

3. The entity shall maintain a program of oversight of product manufacturers, laboratories, and independent certifying organizations that ensures uniform application of the NFRC Rating Procedures, labeling and certification, and such other rating procedures for other factors affecting energy performance as the NFRC and the Commission may adopt.

4. The entity shall require manufacturers and independent certifying organizations within its program to use laboratories accredited by the supervisory entity to perform simulations and tests under the NFRC Rating

Procedure or by an NFRC Approved Calculation Entity (ACE) under the Component Modeling Approach (CMA) Product Certification Program (PCP).

5. The entity shall maintain appropriate guidelines for testing and simulation laboratories, manufacturers, and certifying agencies, including requirements for adequate:
   A. Possession and calibration of equipment;
   B. Education, competence, and training of personnel;
   C. Quality control;
   D. Record keeping and reporting;
   E. Periodic review (including, but not limited to, blind testing by laboratories; inspections of products; and inspections of laboratories, manufacturing facilities, and certifying agencies);
   F. Challenges to certified ratings; and
   G. Guidelines to maintain the integrity of the program, including, but not limited to, provisions to avoid conflicts of interest within the rating and certification process.
6. The entity shall be a nonprofit organization and shall maintain reasonable, nondiscriminatory fee schedules for the services it provides and shall make its fee schedules, the financial information on which fees are based, and financial statements available to its members for inspection.
7. The entity shall provide hearing processes that give laboratories, manufacturers, and certifying agencies a fair review of decisions that adversely affect them.
8. The entity shall maintain a certification policy committee whose procedures are designed to avoid conflicts of interest in deciding appeals, resolving disputes, and setting policy for the certifying organizations within its program.
9. The entity shall publish at least annually a directory of products certified and decertified within its program.
10. The entity itself shall be free from conflict-of-interest ties or to undue influence from any particular manufacturing interest(s), testing or simulation lab(s), or independent certifying organization(s).
11. The entity shall provide or authorize the use of labels and label certificates for Component Modeling Approach and site-built fenestration products that can be used to meet the requirements of Sections 110.6(a)2, 110.6(a)3 and 110.6(a)4, and this section.
12. The entity's certification program shall allow for multiple participants in each aspect of the program to provide for competition between manufacturers, testing labs, simulation labs, and independent certifying organizations.

(e) **Certification for Other Factors.** Nothing in this section shall preclude any entity, whether associated with a U-factor, SHGC or VT certification program or not, from providing certification services relating to factors other than U-factors, SHGCs and VTs for fenestration products and exterior doors.

NOTE: Authority: Section 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, Public Resources Code.

10-112 – CRITERIA FOR DEFAULT TABLES

(a) The Commission shall maintain tables of default U-factors and SHGCs for use as an alternative to U-factors and SHGCs derived based on the NFRC Rating Procedure. The default values shall meet the following criteria:

1. The values shall be derived from simulations of products using the same computer simulation program(s) used in the NFRC Rating Procedure.
2. The default values shall be set so that they do not provide to any significant number of products a lower U-factor or SHGC than those products would obtain if they were rated using the full NFRC Rating Procedure.

(b) The Commission shall periodically review and revise the default tables as necessary to ensure that the criteria are met.

NOTE: Authority: Sections 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, 25910 and 25943, Public Resources Code.

10-113 – RATING AND LABELING OF ROOFING PRODUCT REFLECTANCE AND EMITTANCE

This section establishes rules for implementing labeling and rating requirements relating to reflectance and emittance for roofing products for showing compliance with Sections 140.1, 140.2, 140.3(a)1, 141.0(b)2B, 150.1(c)11, 150.2(b)1H, and 150.2(b)2 of Title 24, California Code of Regulations, Part 6. This section also provides for designation of the Cool Roof Rating Council (CRRC) as the supervisory entity responsible for administering the state's rating program for roofing products, provided CRRC meets specified criteria.

(a) **Labeling Requirements.**

Every roofing product installed in construction to take compliance credit or meet the prescriptive requirements for reflectance and emittance under Sections 140.1, 140.2, 140.3(a)1, 141.0(b)2B, 150.1(c)11, 150.2(b)1H or 150.2(b)2 shall have a clearly visible packaging label that lists the emittance and the initial and aged solar reflectance, or a CRRC Rapid Rating for solar reflectance, tested in accordance with CRRC-1.

Packaging for liquid-applied roof coatings shall state the product meets the requirements specified in Section 110.8(i)4.

(b) **Certification Requirements.**

Every roofing product installed in construction to take compliance credit or meet the prescriptive requirements for reflectance and emittance under Sections 140.1, 140.2, 140.3(a)1, 141.0(b)2B, 150.1(c)11, 150.2(b)1H or 150.2(b)2 shall be rated by CRRC or another supervisory entity approved by the Commission pursuant to Section 10-113(c).

(c) **Designation of Supervisory Entity.** The CRRC shall be the supervisory entity to administer the rating program relating to reflectance and emittance ratings for roofing products, provided the Commission determines that the CRRC meets the criteria in Section 10-113(d).

1. The Commission may consider designating a supervisory entity other than CRRC if the Commission determines that the CRRC is not meeting the criteria in Section 10-113(d). Such other supervisory entity shall meet the criteria in Section 10-113(d) prior to being designated.
2. The Commission shall periodically review, at least annually, the structure and operations of the supervisory entity to ensure continuing compliance with the criteria in Section 10-113(d). The supervisory entity shall provide an annual report to the Commission explaining all of the measures it has taken to comply with the criteria in Section 10-113(d).

(d) **Criteria for Supervisory Entity.**

1. Membership in the entity shall be open on a nondiscriminatory basis to any person or organization that has an interest in uniform performance ratings for roofing products, including, but not limited to, members of the roofing industry, building industry, design professionals, specifiers, utilities, government agencies, and public interest organizations. The membership shall be composed of a broad cross section of those interested in uniform thermal performance ratings for roofing products.
2. The governing body of the entity shall reflect a reasonable cross-section of the interests represented by the membership.
3. The entity shall maintain a program of oversight of product manufacturers, laboratories, and independent certifying organizations that ensures uniform application of the CRRC testing and rating procedures, labeling and rating, and such other rating procedures for other factors that improves the accuracy of properties of roofing products affecting energy performance as the CRRC and the Commission may adopt.
4. The entity shall require manufacturers and independent certifying organizations within its program to use only laboratories accredited by the supervisory entity to perform tests in accordance with CRRC-1.

5. The entity shall maintain appropriate guidelines for testing laboratories and manufacturers, including requirements for adequate:
   A. Possession and calibration of equipment;
   B. Education, competence, and training of personnel;
   C. Quality control;
   D. Record keeping and reporting;
   E. Periodic review including but not limited to, blind testing by laboratories; inspections of products; and inspections of laboratories and manufacturing facilities;
   F. Challenges to ratings; and
   G. Guidelines to maintain the integrity of the program, including, but not limited to, provisions to avoid conflicts of interest within the rating process.
6. The entity shall be a nonprofit organization and shall maintain reasonable, nondiscriminatory fee schedules for the services it provides, and shall make its fee schedules, the financial information on which fees are based, and financial statements available to its members for inspection.
7. The entity shall provide hearing processes that give laboratories, manufacturers and certifying agencies a fair review of decisions that adversely affect them.
8. The entity shall maintain a policy committee or similar body whose procedures are designed to avoid conflicts of interest in deciding appeals, resolving disputes and setting policy for the certifying organizations in its program.
9. The entity shall publish at least annually a directory of rated products and products that are no longer rated by the CRRC.
10. The entity itself shall be free from conflict-of-interest ties or to undue influence from any particular roofing product manufacturing interest(s), testing or independent certifying organization(s).
11. The entity shall provide or authorize the use of labels that can be used to meet the requirements for showing compliance with the requirements of Sections 140.1, 140.2, 140.3(a)1, 141.0(b)2B, 150.1(c)11, 150.2(b)1H and 150.2(b)2, and this section.
12. The entity's rating program shall allow for multiple participants in each aspect of the program to provide for competition between manufacturers and between testing labs.

NOTE: Authority: Sections 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, 25910 and 25943, Public Resources Code.

10-114 – DETERMINATION OF OUTDOOR LIGHTING ZONES AND ADMINISTRATIVE RULES FOR USE

This section establishes rules for implementing outdoor lighting zones to show compliance with Section 140.7 of Title 24, California Code of Regulations, Part 6.

(a) **Lighting Zones.** Exterior lighting allowances in California vary by Lighting Zones (LZ).

(b) **Lighting Zone Characteristics.** TABLE 10-114-A specifies the relative ambient illumination level and the statewide default location for each lighting zone.

(c) **Amending the Lighting Zone Designation.** A local jurisdiction may officially adopt changes to the lighting zone designation of an area by following a public process that allows for formal public notification, review, and comment about the proposed change. The local jurisdiction may determine areas where Lighting Zone 4 is applicable and may increase or decrease the lighting zones for areas that are in State Default Lighting Zones 1, 2 and 3, as specified in TABLE 10-114-A.

~~(d) **Commission Notification, Amended Outdoor Lighting Zone Designation.** Local jurisdictions who adopt changes to the State Default Lighting Zones shall notify the Commission by providing the following materials to the Executive Director:~~

~~1. A detailed specification of the boundaries of the adopted Lighting Zones, consisting of the county name, the city name if any, the zip code(s) of the redesignated areas, and a description of the physical boundaries within each zip code;~~

~~2. A description of the public process that was conducted in adopting the Lighting Zone changes; and~~

~~3. An explanation of how the adopted Lighting Zone changes are consistent with the specifications of Section 10-114.~~

~~(e) The Commission shall have the authority to not allow Lighting Zone changes which the Commission finds to be inconsistent with the specifications of Section 10-114.~~

TABLE 10-114-A LIGHTING ZONE CHARACTERISTICS AND RULES FOR AMENDMENTS BY LOCAL JURISDICTIONS

Zone	Ambient Illumination	State wide Default Location	Moving Up to Higher Zones	Moving Down to Lower Zones
LZ0	Very Low	Undeveloped areas of government designated parks, recreation areas, and wildlife preserves.	Undeveloped areas of government designated parks, recreation areas, and wildlife preserves can be designated as LZ1 or LZ2 if they are contained within such a zone.	Not applicable
LZ1	Low	Rural areas, as defined by the 2010 U.S. Census. These areas include: single or dual family residential areas, parks, and agricultural zone districts, ~~Developed~~ developed portion of government designated parks, recreation areas, and wildlife preserves. Those that are wholly contained within a higher lighting zone may be considered by the local government as part of that lighting zone.	Developed portion of a government designated park, recreation area, or wildlife preserve, can be designated as LZ2 or LZ3 if they are contained within such a zone. Retail stores, located in a residential neighborhood, and rural town centers, as defined by the 2010 U.S. Census, can be designated as LZ2 if the business operates during hours of darkness.	Not applicable.
LZ2	Moderate	~~Rural areas~~Urban clusters, as defined by the 2010 U.S. Census. The following building types may occur here: multifamily housing, mixed use residential neighborhoods, religious facilities, schools, and light commercial business districts or industrial zoning districts.	Special districts within a default LZ2 zone may be designated as LZ3 or LZ4 by a local jurisdiction. Examples include special commercial districts or areas with special security considerations located within a ~~rural~~ mixed-use residential area or city center.	Special districts ~~and government designated parks within a default LZ2 zone~~ may be designated as LZ1 by the local jurisdiction, ~~for lower illumination standards,~~ without any size limits.
LZ3	Moderately High	Urban areas, as defined by the 2010 U.S. Census. The following building types may occur here: high intensity commercial corridors, entertainment centers, and heavy industrial or manufacturing zone districts.	Special districts within a default LZ3 may be designated as a LZ4 by local jurisdiction for high intensity nighttime use, such as entertainment or commercial districts or areas with special security considerations requiring very high light levels.	Special districts ~~and government designated parks within a default LZ3 zone~~ may be designated as LZ1 or LZ2 by the local jurisdiction, without any size limits.
LZ4	High	None.	Not applicable.	Not applicable.

NOTE: Authority: Sections 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

10-115 – COMMUNITY SHARED SOLAR ELECTRIC GENERATION SYSTEM OR COMMUNITY SHARED BATTERY STORAGE SYSTEM COMPLIANCE OPTION FOR ON-SITE SOLAR ELECTRIC GENERATION OR BATTERY STORAGE REQUIREMENTS

(a) Community Shared Solar Electric Generation System or Battery Storage System Offset. If approved by the commission, ~~A~~a community shared solar system, other community shared renewable system, community shared battery storage system, or combination of the aforementioned systems (hereinafter referred to as a community shared solar or battery storage system) may be ~~approved by the Commission~~ used as a compliance option to partially or totally meet the on-site solar electric generation system and/or battery storage system that is otherwise required by Section 140.1(b), 150.1(b)1, or 170.1(b) of Title 24, California Code of Regulations, Part 6. To be approved, the community shared solar electric generation or community shared battery storage system ~~shall~~ must ~~meet~~ demonstrate, to the Commission's satisfaction, that all the following requirements will be met:~~.~~

1. **Enforcement Agency.** The community shared solar electric generation system and/or community shared battery storage system shall be installed and available for enforcement agency site inspection~~,~~ no later than the point in time the enforcement agency must physically verify compliance of the building~~,~~ which would otherwise be required to have an on-site solar electric generation and/or battery storage system, and shall not cause delay in the process of enforcement agency review and approval of that building. The enforcement agency shall have jurisdiction and facilitated access to make site inspections. All documentation for the community solar electric generation system and/or community solar battery storage system that is required to demonstrate compliance for the building shall be completed prior to building permit application.

2. **Energy Performance.** The community shared solar electric generation system and/or community shared battery storage system shall be demonstrated to provide the same or better energy performance equal to the partial or total compliance with the energy performance of the on-site solar electric generation and/or battery storage system that would otherwise have been required for the building, computed by compliance software certified for use by the Commission.

3. ~~**Dedicated**~~ **Participating Building Energy Savings Benefits.** The community shared solar electric generation system and/or community shared battery storage system shall provide energy saving benefits directly to the building ~~that would otherwise have been required to have an on-site solar electric generation system and/or battery storage system~~. ~~The energy savings benefits shall be allocated from the total resource of the community shared solar electric generation system and/or community shared battery storage system in a manner demonstrated to be equivalent to the reductions in energy consumption that would have resulted from the on-site solar electric generation system and/or battery storage system that is otherwise required by Section 150.1 of Title 24.~~ The energy savings benefits allocated to the building shall be in the form of:

   A. actual reductions in the energy consumption of the ~~dedicated~~ participating building;

   B. ~~utility~~ energy reduction credits that will result in virtual reductions in the building's energy consumption that is subject to energy bill payments; or

   C. payments to the building that will have an equivalent effect as energy bill reductions.

   The reduction in the building's energy bill resulting from A, B, or C above shall be greater than the added cost to the building resulting from the building's share in the community shared solar and/or battery storage system.

4. **Durability and Building Opt-out.** The community shared solar electric generation system and/or community shared battery storage system shall be designed and installed to provide the energy savings benefits to the ~~dedicated~~ participating building specified in Section 10-115(a)3 for a period of no less than twenty (20) years. At any time during this period, the building owner shall have the option to discontinue the participation of the building in the community shared solar and/or battery storage system if and only if the building owner causes an on-site solar electric generation system to be installed, which meets the

requirements of Section 150.1(b)(1) or successor requirements, which were in effect at the time the building was permitted. At the time of interconnection of that on-site solar electric generation system, all costs associated with participation in the community shared solar and/or battery storage system shall cease.

5. **Additionality.** The community shared solar electric generation system and/or community shared battery storage system shall provide the energy savings benefits specified in Section 10-115(a)3 exclusively to the ~~dedicated~~ participating building(s). Those energy savings benefits shall in no way be attributed to other purposes or transferred to other buildings or property.

    A. The participating building(s) shall be served primarily by renewable resources developed specifically for the community solar electric generation system.

    B. Other renewable resources may be used when participating buildings are permitted before the renewable resources developed for the program start operating or after they cease operating. During these times, other renewable resources may be used to meet the requirements of Section 10-115(a)4 for each participating building.

    C. The renewable resources, including those developed primarily to serve participating buildings and those utilized to fill before and after time gaps for the purpose of meeting the requirements of Section 10-115(a)4, shall meet the following requirement:

        i. For each renewable resource used to serve participating buildings, bundled (Product Content Category 1) Renewable Energy Credits (RECs) shall be retired and tracked in the Western Renewable Energy Generation Information System (WREGIS) on the behalf of program participants, to ensure that they will not be allocated to or used for any other purpose, including Renewable Performance Standard (RPS) compliance, resale of RECs or renewable generation to any other person or entity, or any other mandatory or voluntary renewable electricity program requirement or claim.

6. **Location.** The community shared solar electric generation system and/or community shared battery storage system shall be located on a distribution system of the load serving entity providing service to the participating buildings.

7. **Size.** The community shared solar electric generation system and/or community shared battery storage system shall not be served by any individual source larger than 20 MW.

8. **Original Building Purchaser Choice.** Whenever a newly constructed building is offered for sale as being eligible to be a participating building in a community shared solar electric generation system and/or community shared battery storage system, the potential original building-purchaser shall also be offered the option instead to comply with the requirements of Section 150.1(b)1 through installation of an on-site solar electric generation system.

9~~6~~. **Accountability and Recordkeeping.** Applicants for Commission approval of community shared solar electric generation systems and/or community shared battery storage systems shall be accountable to all parties who relied on these systems for partial or total compliance with the on-site solar electric generation and/or battery storage system that would otherwise be required, including but not limited to builders of the buildings, owners of the buildings, enforcement agencies, and the Commission. Annual reports demonstrating compliance with the requirements of each Section within 10-115 shall be provided to the Commission. -Recordkeeping regarding compliance with the requirements in Sections 10-115(a)1-6 shall be maintained over the period of time specified in Section 10-115(a)4 for each building for which the community shared solar electric generation or battery storage system is used to demonstrate partial or total compliance. Access to these records shall be provided to any entity approved by the Commission for auditing compliance with these requirements.

(b) Application for Commission Approval. Any entity may apply to the Commission for approval to administer a community shared solar electric generation or community shared battery storage system to provide partial or total compliance with the on-site solar electric generation system and/or battery storage system required by Section 150.1 of Title 24, California Code of Regulations, Part 6.

1. The application shall demonstrate to the Commission's satisfaction that each of the requirements specified in Section 10-115(a)1-~~9~~6 will be met and shall include detailed explanation of the actions that will be taken by the applicant to ensure that each requirement is met over the period of time specified in Section 10-115(a)4 for each building for which a partial or total offset is used to demonstrate compliance.
2. All applicants have the burden of proof to establish that their application should be granted.
3. Applications from public agencies shall be submitted to the Energy Commission only after public review through at least one public meeting within the jurisdiction of the public entity or service area of the load-serving entity and adoption by the public agency. The Commission shall have the authority to not approve any application that the Commission determines to be inconsistent with the requirements of Section 10-115.

~~**(c)Commission Approval.** Community shared solar electric generation systems and/or community shared battery storage systems, which demonstrate to the Commission's satisfaction that all of the requirements specified in Section 10-115 will be met, shall be approved.~~**(c)Executive Director Approval of Revised Applications.** The administrator of an approved community shared solar electric generation system and/or community shared battery storage system shall submit a revised application demonstrating compliance with the Section 10-115 requirements to the Executive Director for approval, when:

1. A new renewable resource is proposed to be added to a community shared solar electric generation system and/or community shared battery storage system, and/or
2. The Commission modifies the requirements of Section 10-115 in a building standards rulemaking.

The Executive Director may either: approve the revised application by letter if the Executive Director concludes that the requirements of Section 10-115 will be met, request the administrator resubmit their revised application with changes, or refer the revised application to the Commission.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402, 25402.1, and 25605, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, 25605, and 25943, Public Resources Code.

Building Energy Efficiency Standards

CALIFORNIA CODE OF REGULATIONS
TITLE 24, PART 6

SUBCHAPTER 1
ALL OCCUPANCIES—GENERAL PROVISIONS

SECTION 100.0 – SCOPE

(a) **Buildings Covered.** The provisions of Part 6 apply to all buildings:

1. That are of Occupancy Group A, B, E, F, H, I, M, R, S, or U; and
2. For which an application for a building permit or renewal of an existing permit is filed (or is required by law to be filed) on or after the effective date of the provisions, or which are constructed by a governmental agency; and
3. That are:
   A. Unconditioned; or
   B. Indirectly or directly conditioned, or process spaces.

EXCEPTION 1 to Section 100.0(a): Qualified historic buildings, as regulated by the California Historic Building Code (Title 24, Part 8). Lighting in qualified historic buildings shall comply with the applicable requirements in Section 140.6(a)3Q.

EXCEPTION 2 to Section 100.0(a): Building departments, at their discretion, may exempt temporary buildings, temporary outdoor lighting or temporary lighting in an unconditioned building, or structures erected in response to a natural disaster. Temporary buildings or structures shall be completely removed upon the expiration of the time limit stated in the permit.

EXCEPTION 3 to Section 100.0(a): Buildings in Occupancy Group I-3 and I-4.

(b) **Parts of Buildings Regulated.** The provisions of Part 6 apply to the building envelope, space-conditioning systems, water-heating systems, pool and spas, solar ready buildings, indoor lighting systems of buildings, outdoor lighting systems, electrical power distribution systems, and signs located either indoors or outdoors, in buildings that are:

1. Covered by Section 100.0(a); and
2. Set forth in TABLE 100.0-A.

(c) **Habitable Stories.**

1. All conditioned space in a story shall comply with Part 6 whether or not the story is a habitable space.
2. All unconditioned space in a story shall comply with the lighting requirements of Part 6 whether or not the story is a habitable space.

(d) **Outdoor Lighting and Indoor and Outdoor Signs.** The provisions of Part 6 apply to outdoor lighting systems and to signs located either indoors or outdoors as set forth in TABLE 100.0-A.

(e) **Sections Applicable to Particular Buildings.** TABLE 100.0-A and this subsection list the provisions of Part 6 that are applicable to different types of buildings covered by Section 100.0(a).

1. **All buildings.** Sections 100.0 through 110.12 apply to all buildings.

   EXCEPTION to Section 100.0(e)1: Spaces or requirements not listed in TABLE 100.0-A.

2. **Newly constructed buildings.**
   A. **All newly constructed buildings.** Sections 110.0 through 110.12 apply to all newly constructed buildings within the scope of Section 100.0(a). In addition, newly constructed buildings shall meet the requirements of Subsections B, C, D or E, as applicable.

B. **Nonresidential~~, high-rise residential,~~ and hotel/motel buildings** that are mechanically heated or mechanically cooled.

i. Sections applicable. Sections 120.0 through 140.8 apply to newly constructed nonresidential buildings~~, high-rise residential buildings,~~ and hotels/motels that are mechanically heated or mechanically cooled.

ii. Compliance approaches. In order to comply with Part 6, newly constructed nonresidential buildings~~, high-rise residential buildings,~~ and hotels/motels that are mechanically heated or mechanically cooled must meet the requirements of:

a. Mandatory measures: The applicable provisions of Sections 120.0 through 130.5; and

b. Either:

(i) Performance approach: Section 140.1; or

(ii) Prescriptive approach: Sections 140.2 through 140.9.

C. **Unconditioned nonresidential buildings and process space.** Sections 110.9, 110.10, 120.6, 130.0 through 130.5, 140.3(c), 140.6, 140.7, and 140.8 apply to all newly constructed unconditioned buildings and 140.1, and 140.3(c), for process spaces within the scope of Section 100.0(a).

D. ~~**Low-rise residential**~~**Single-family buildings.**

i. Sections applicable. Sections 150.0 through 150.1 apply to newly constructed ~~low-rise residential~~single-family buildings.

ii. Compliance approaches. In order to comply with Part 6 newly constructed single-family~~low-rise residential~~ buildings must meet the requirements of:

a. Mandatory measures: The applicable provisions of Sections 110.0 through 110.10, and 150.0; and

b. Either:

(i) Performance approach: Sections 150.1(a) and (b); or

(ii) Prescriptive approach: Sections 150.1(a) and (c).

EXCEPTION to Section 100.0(e)2Diib: Seasonally occupied agricultural housing limited by state or federal agency contract to occupancy not more than 180 days in any calendar year.

E. **Multifamily Buildings**.

i. Sections applicable. Sections 160.0 through 170.2 apply to newly constructed multifamily buildings.

ii. Compliance approaches. In order to comply with Part 6 newly constructed multifamily buildings must meet the requirements of:

a. Mandatory measures: The applicable provisions of Sections 110.0 through 110.10, and 160.0; and

b. Either:

(i) Performance approach: Section 170.1; or

(ii) Prescriptive approach: Section 170.2(a) through (f).

F~~E~~. **Covered Processes.**

i. Sections applicable. Sections 110.2, 120.6 and 140.9 apply to covered processes.

ii. Compliance approaches. In order to comply with Part 6, covered processes must meet the requirements of:

a. The applicable mandatory measures in Section 120.6; and

b. Either:

(i) The Performance approach requirements of Section 140.1; or

(ii) The Prescriptive approach requirements of Section 140.9.

Note: If covered processes do not have prescriptive requirements, then only the applicable mandatory measures in Section 120.6 must be met.

3. **New construction in existing buildings (additions, alterations and repairs).**

A. **Nonresidential ~~, high-rise residential,~~ and hotel/motel buildings.** Section 141.0 applies to new construction in existing nonresidential, high-rise residential, and hotel/motel buildings. New construction in existing buildings includes additions, alterations and repairs. Section 141.0 specifies requirements that uniquely apply to additions, alterations or repairs to existing buildings, and specify which requirements in other sections also apply. For alterations that change the occupancy classification of the building, the requirements specified in Section 141.0 apply to the occupancy after the alterations.

B. **~~Low-rise residential~~Single-family buildings.** Section 150.2 applies to new construction in existing ~~low-rise residential~~single-family buildings. New construction in existing buildings includes additions, alterations and repairs. Section 150.2 specifies requirements that uniquely apply to additions, alterations or repairs to existing buildings, and specify which requirements in other sections also apply. For alterations that change the occupancy classification of the building, the requirements specified in Section 150.2 apply to the occupancy after the alterations.

C. **Multifamily buildings.** Section 180.0 applies to new construction in existing multifamily buildings. New construction in existing buildings includes additions, alterations and repairs. Section 180.0 specifies requirements that uniquely apply to additions, alterations or repairs to existing buildings, and specify which requirements in other sections also apply. For alterations that change the occupancy classification of the building, the requirements specified in Section 180.0 apply to the occupancy after the alterations.

4. **Installation of insulation in existing buildings.** Section 110.8(d) applies to buildings in which insulation is being installed in existing attics, or on existing water heaters, or existing space conditioning ducts.

5. **Outdoor Lighting.** Sections 110.9, 130.0, 130.2, 130.4, 140.7, and 150.0 apply to newly constructed outdoor lighting systems, and Section 141.0 applies to outdoor lighting that is either added or altered.

6. **Signs.** Sections 130.0, 130.3 and 140.8 apply to newly constructed signs located either indoors or outdoors and Section 141.0 applies to sign alterations located either indoors or outdoors.

(f) **Mixed Occupancy.** When a building is designed and constructed for more than one type of occupancy (residential and nonresidential), the space for each occupancy shall meet the provisions of Part 6 applicable to that occupancy.

EXCEPTION 1 to Section 100.0(f): If one occupancy constitutes at least 80 percent of the conditioned floor area of the building, the entire building envelope, HVAC, and water heating may be designed to comply with the provisions of Part 6 applicable to that occupancy, provided that the applicable lighting requirements in Sections 140.6 through 140.8, ~~or~~ 150.0(k), or 160.5 and 170.2(e) are met for each occupancy and space, and mandatory measures in Sections 110.0 through 130.5, ~~and~~ 150.0, and 160.0 through 160.9 are met for each occupancy and space.

EXCEPTION 2 to Section 100.0(f): If one occupancy constitutes at least 90 percent of the combined conditioned plus unconditioned floor area of the building, the entire building indoor lighting may be designed to comply with only the lighting provisions of Part 6 applicable to that occupancy.

(g) **Administrative Requirements.** Administrative requirements relating to permit requirements, enforcement by the Commission, locally adopted energy standards, interpretations, claims of exemption, approved calculation methods, rights of appeal, and certification and labeling requirements of fenestration products and roofing products are specified in California Code of Regulations, Title 24, Part 1, Sections 10-101 to 10-114.

(h) **Certification Requirements for Manufactured Equipment, Products, and Devices.** Part 6 limits the installation of manufactured equipment, products, and devices to those that have been certified as specified by sections 110.0 and 110.1. Requirements for manufactured equipment, products, and devices, when not specified in Title 24 Part 6, are specified in California Code of Regulations, Title 20, Sections 1601-1609.

TABLE 100.0-A APPLICATION OF STANDARDS ***(This TABLE will be updated for the 15-Day language)***

Occupancies	Application	Mandatory	Prescriptive	Performance	Additions/Alterations
General Provisions for All Buildings		100.0, 100.1, 100.2, 110.0			
Nonresidential, ~~High-Rise Residential,~~ And Hotels/Motels	General	120.0	140.0, 140.2	140.0, 140.1	141.0
	Envelope (conditioned)	110.6, 110.7, 110.8,120.7	140.3		
	Envelope (unconditioned process spaces)	N.A.	140.3(c)		
	HVAC (conditioned)	110.2, 110.5, 120.1, 120.2, 120.3, 120.4, 120.5, 120.8	140.4		
	Water Heating	110.3, 120.3, 120.8, 120.9	140.5		
	Indoor Lighting (conditioned, process spaces)	110.9, 120.8, 130.0, 130.1, 130.4	140.3(c), 140.6		
	Indoor Lighting (unconditioned and parking garages)	110.9, 120.8, 130.0, 130.1, 130.4	140.3(c), 140.6	N.A.	
	Outdoor Lighting	110.9, 130.0, 130.2, 130.4	140.7		
	Electrical Power Distribution	110.11, 130.5	N.A.		
	Pool and Spa Systems	110.4, 110.5, 150.0(p)	N. A.		141.0
	Solar Ready Buildings	110.10	N.A.		141.0(a)
	<u>Solar PV and Battery Storage Systems</u>	<u>N.A.</u>	<u>141.10</u>	<u>140.0, 140.1</u>	<u>N.A.</u>
Covered Processes[1]	Envelope, Ventilation, Process Loads	110.2, 120.6	140.9	140.1	120.6, 140.9, 141.1
Signs	Indoor and Outdoor	110.9, 130.0, 130.3	140.8	N.A.	141.0, 141.0(b)2H
~~Low-Rise Residential~~<u>Single-Family</u>	General	150.0	150.1(a, c)	150.1(a), 150.1(b)	150.2(a), 150.2(b)
	Envelope (conditioned)	110.6, 110.7, 110.8, 150(a), 150.0(b), 150.0(c), 150.0(d), 150.0(e), 150.0(g), 150.0(q)			
	HVAC (conditioned)	110.2, 110.5, 150.0(h), 150.0(i), 150.0(j), 150.0(m), 150.0(o)			
	Water Heating	110.3, 150.0(j, n)			
	Indoor Lighting (conditioned, unconditioned and parking garages)	110.9, 130.0, 150.0(k)			
	Outdoor Lighting	110.9, 130.0,150.0(k)			
	Pool and Spa Systems	110.4, 150.0(p)	N. A.	N.A.	150.2(a), 150.2(b)

	Solar Ready Buildings	110.10	N. A.	N.A.	N.A.
	Solar PV Systems	N.A.	150.1(c)14	150.1(a), 150.1(b)	N.A.
Multifamily	General	160.0	170.2	170.1	180.0
	Envelope (conditioned)	160.1	170.1(a)		
	Ventilation and Indoor Air Quality	160.2	N.A.		
	HVAC (conditioned)	160.3	170.2(c)		
	Water Heating	160.4	170.2(d)		
	Indoor Lighting	160.5	170.2(e)		
	Outdoor Lighting	160.5	170.2(e)		
	Electrical Power Distribution	160.6	N.A.	N.A.	
	Pool and Spa Systems	110.4	N.A.	N.A.	
	Solar Ready Buildings	110.10	N.A.	N.A.	
	Solar PV and Battery Storage Systems	N.A.	170.2(f), (g), (h)	170.1	N.A.

[1] Nonresidential~~, high-rise~~ and hotel/motel buildings that contain covered processes may conform to the applicable requirements of both occupancy types listed in this table.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 100.1 – DEFINITIONS AND RULES OF CONSTRUCTION

(a) **Rules of Construction.**

1. Where the context requires, the singular includes the plural and the plural includes the singular.
2. The use of "and" in a conjunctive provision means that all elements in the provision must be complied with, or must exist to make the provision applicable. Where compliance with one or more elements suffices, or where existence of one or more elements makes the provision applicable, "or" (rather than "and/or") is used.
3. "Shall" is mandatory and "may" is permissive.

(b) **Definitions.** Terms, phrases, words and their derivatives in Part 6 shall be defined as specified in Section 100.1. Terms, phrases, words and their derivatives not found in Section 100.1 shall be defined as specified in the "Definitions" chapters of Title 24, Parts 1 through 5 of the California Code of Regulations. Where terms, phrases, words and their derivatives are not defined in any of the references above, they shall be defined as specified in *Webster's Third New International Dictionary of the English Language, Unabridged* (1961 edition, through the 2002 addenda), unless the context requires otherwise.

AAMA/WDMA/CSA 101/ I.S.2/A440-~~11~~17 are the American Architectural Manufacturers Association/ Window and Door Manufacturers Association/ Canadian Standards Association document titled "North American Fenestration Standard/Specification for windows, doors, and skylights" (~~2011~~2017)

ACCA is the Air Conditioning Contractors of America.

ACCA MANUAL J is the Air Conditioning Contractors of America document titled "Manual J - Residential Load Calculation" (ANSI/ACCA 2 Manual J – 2016).

ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE is a description of test procedures in the Reference Nonresidential Appendices that includes equipment and systems to be tested, functions to be tested, conditions under which the test shall be performed, the scope of the tests, results to be obtained, and measurable criteria for acceptable performance.

ACCESSIBLE is having access thereto, but which first may require removal or opening of access panels, doors, or similar obstructions.

ADDITION is any change to a building that increases conditioned floor area and conditioned volume. See also "newly conditioned space." Addition is also any change that increases the floor area and volume of an unconditioned building of an occupancy group or type regulated by Part 6. Addition is also any change that increases the illuminated area of an outdoor lighting application regulated by Part 6.

ADIABATIC PAD is a material located before the heat transfer surface of an adiabatic condenser, which precools the ambient air by becoming fully wetted during precool mode operation.

AGRICULTURAL BUILDING is a structure designed and constructed to house farm implements, hay, grain, poultry, livestock or other horticultural products. It is not a structure that is a place of human habitation, a place of employment where agricultural products are processed, treated or packaged, or a place used by the public.

AIR BARRIER is a combination of interconnected materials and assemblies joined and sealed together to provide a continuous barrier to air leakage through the building envelope that separates conditioned from unconditioned space, or that separates adjoining conditioned spaces of different occupancies or uses.

AIR CONDITIONER is an appliance that supplies cooled and dehumidified air to a space for the purpose of cooling objects within the space.

AIR-COOLED AIR CONDITIONER is an air conditioner using an air-cooled condenser.

AIR CURTAIN UNIT means equipment providing a directionally-controlled stream of air moving across the entire height and width of an opening that reduces the infiltration or transfer of air from one side of the opening.

AIR-HANDLING UNIT or AIR HANDLER is a blower or fan that distributes supply air to a room, space, or area.

AIR FILTER, AIR FILTER EQUIPMENT, or AIR FILTER DEVICE is air-cleaning equipment used for removing particulate matter from the air.

AIR FILTER MEDIA is the part of the air filter equipment which is the actual particulate removing agent.

AIR-TO-AIR HEAT EXCHANGER is a device which will reduce the heat losses or gains that occur when a building is mechanically ventilated, by transferring heat between the conditioned air being exhausted and outside air being supplied.

AIR-SOURCE HEAT PUMP is an appliance that consists of one or more factory-made assemblies, that includes an indoor conditioning coil, a compressor, and a refrigerant-to-air heat exchanger, and that provides heating and cooling functions.

ALTERATION is any change to a building's water-heating system, space-conditioning system, lighting system, electrical power distribution system, or envelope that is not an addition. Alteration is also any change that is regulated by Part 6 to an outdoor lighting system that is not an addition. Alteration is also any change that is regulated by Part 6 to signs located either indoors or outdoors. Alteration is also any change that is regulated by Part 6 to a covered process that is not an addition. (See also “fenestration alteration”.)

ALTERED COMPONENT is a component that has undergone an alteration.

ALTERNATIVE CALCULATION METHODS (ACM) are compliance softwares, or alternative component packages, or exceptional methods approved by the Commission under Section 10-109. ACMs are also referred to as Compliance Software.

ALTERNATIVE CALCULATION METHODS (ACM) APPROVAL MANUAL are the documents establishing the requirements for Energy Commission approval of Compliance Software used to demonstrate compliance with the Building Energy Efficiency Standards for Residential and Nonresidential Buildings currently adopted by the Energy Commission.

ALTERNATING CURRENT-OUTPUT UNINTERRUPTIBLE POWER SUPPLY (AC-OUTPUT UPS) is a combination of convertors switches, and energy storage devices, such as batteries, constituting a power system for maintaining continuity of load power in case of input power failure. Input power failure occurs when voltage and frequency are outside rated steady-state and transient tolerance bands or when distortion or interruptions are outside the limits specified for the uninterruptible power supply. An AC-output UPS is an uninterruptible power supply that supplies power with a continuous flow of electric charge that periodically reverses direction.

AMCA Is the Air Movement and Control Association.

ANNUAL FUEL UTILIZATION EFFICIENCY (AFUE) is a measure of the percentage of heat from the combustion of gas or oil which is transferred to the space being heated during a year, as determined using the applicable test method in the Appliance Efficiency Regulations or Section 110.2.

ANNUNCIATED is a type of visual signaling device that indicates the on, off, or other status of a load **ANSI** is the American National Standards Institute.

~~**ANSI C82.6-2015** is the American National Standards Institute document titled “Ballasts for High-Intensity Discharge Lamps – Methods of Measurement.” (ANSI C82.6-2015)~~

ANSI/AMCA STANDARD 500-D is the American National Standards Institute / Air Movement and Control Association document titled “Laboratory Methods of Testing Dampers For Rating”.2018 (ANSI/AMCA 500-D-~~2012~~18)

ANSI/ASABE S640 is the American National Standards Institute/American Society of Agricultural and Biological Engineers document titled “Quantities and Units of Electromagnetic Radiation for Plants (Photosynthetic Organisms)” 2017 (ANSI/ASABE S640 JUL2017).

~~**ANSI/IES RP-16-17** is the document coauthored by the American National Standards Institute and the Illuminating Engineering Society of North America, Recommended Practice titled "Nomenclature and Definitions for Illuminating Engineering".~~ **ANSI Z9.5** is the American National Standards Institute document titled “Laboratory Ventilation,” 2012 (ANSI/ASSE Z9.5-2012).

ANSI/NEMA WD 6 is the National Electrical Manufacturers Association Document titled, “Wiring Devices – Dimensional Specification,” 2016 (ANSI/NEMA WD 6-2016).

ANSI C82.6- Is The American National Standards Institute Document Titled "Ballasts For High-Intensity Discharge Lamps – Methods Of Measurement." 2020 (ANSI C82.6-2020).

ANSI/CTA-2045-A is the American National Standards Institute document titled "Modular Communications Interface for Energy Management" 2018 (ANSI/CTA-2045-A-2018).

ANSI Z21.10.3 is the American National Standards Institute document titled "Gas Water Heaters - Volume III, Storage Water Heaters With Input Ratings Above 75,000 Btu Per Hour," ~~2011~~2019 (ANSI Z21.10.3~~-2017~~2019/CSA 4.3~~-2017~~2019).

ANSI Z21.13 is the American National Standards Institute document titled "Gas-Fired Low Pressure Steam and Hot Water Boilers," 2017 (ANSI Z21.13-2017/CSA 4.9-2017).

ANSI Z21.40.4~~A~~ is the American National Standards Institute document titled "Addenda 1 to ANSI Z21.40.4-1996/CGA 2.94-M96, Performance Testing and Rating of Gas-Fired, Air Conditioning and Heat Pump Appliances," 2017~~1998~~ (ANSI Z21.40.4-1998 (R2017)/CGA 2.94~~A~~-M98(R2017)).

ANSI Z21.47 is the American National Standards Institute document titled "Gas-Fired Central Furnaces," 2016 (ANSI Z21.47-2016/CSA 2.3-2016).

ANSI Z83.8 is the American National Standards Institute document titled "~~American National Standard/CSA Standard For~~ Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters and Gas-Fired Duct Furnaces," 2016 (ANSI Z83.8 -2016/CSA 2.6-2016).

~~**ANSI Z9.5** is the American National Standards Institute document titled "Laboratory Ventilation," 2012 (ANSI/ASSE Z9.5-2012).~~

APPLIANCE EFFICIENCY REGULATIONS are the regulations in Title 20, Sections 1601 et seq. of the California Code of Regulations.

APPROVED CALCULATION METHOD (See "alternative calculation methods")

AHRI is the Air-Conditioning, Heating, and Refrigeration Institute.

AHRI 210/240 is the Air-Conditioning, Heating, and Refrigeration Institute document titled "Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment," ~~2008~~2017 (ANSI/AHRI Standard 210/240~~-2008~~2017 with Addenda 1~~ and 2~~).

ANSI/ASHRAE 84 is the American National Standards Institute / American Society of Heating, Refrigeration, and Air-conditioning Engineers document titled "Method of Testing Air-to-Air Heat/Energy Exchanger". 2020 (ANSI/ASHRAE 84-2020)

ANSI/AMCA 208 is the Air Movement and Control Association document titled "Calculation of the Fan Energy Index". 2018 (ANSI/AMCA 208-18)

ANSI/AMCA 210 is the Air Movement and Control Association document titled "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating". 2016 (ANSI/AMCA 210-16)

~~**ANSI/**~~**AHRI~~**/CSA**~~ **310/380** is the Air-Conditioning, Heating, and Refrigeration Institute document titled "~~Standard for~~ Packaged Terminal Air-Conditioners and Heat Pumps (CSA-C744-17)," 2004 (~~ANSI/~~AHRI~~/CSA Standard~~ 310/380-2017).

~~**AHRI 320** is the Air-Conditioning, Heating, and Refrigeration Institute document titled "Water-Source Heat Pumps," 1998 (AHRI Standard 320-1998).~~

~~**AHRI 325** is the Air-Conditioning, Heating, and Refrigeration Institute document titled "Ground Water-Source Heat Pumps," 1998 (ARI Standard 325-1998).~~

~~**ANSI/**~~**AHRI 340/360** is the Air-Conditioning, Heating, and Refrigeration Institute document titled "Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment," ~~2015~~2019 (~~ANSI/~~AHRI Standard 340/360-(I-P)~~-2015~~2019).

ANSI/AHRI 365 is the Air-Conditioning, Heating, and Refrigeration Institute document titled " Performance Rating of Commercial and Industrial Unitary Air-Conditioning Condensing Units," 2009 (ANSI/AHRI Standard 365 (I-P)-2009).

ANSI/AHRI 390 is the Air-Conditioning, Heating, and Refrigeration Institute document titled "Performance Rating of Single Package Vertical Air-Conditioners and Heat Pumps," 2003 (ANSI/AHRI Standard 390 ~~(I-P)~~ 2003).

ANSI/AHRI 400 is the Air-Conditioning, Heating, and Refrigeration Institute document titled " Performance Rating of Liquid to Liquid Heat Exchangers," 2015 (ANSI/AHRI Standard 400 (I-P)-2015).

AHAM is the Association of Home Appliance Manufacturers.

AHAM HRH-2 is the Association of Home Appliance Manufacturers document titled "Residential Kitchen Range Hood Performance Test Procedures," 2020 (AHAM HRH-2).

AHAM RKRH-CPPG is the Association of Home Appliance Manufacturers document titled "Residential Kitchen Range Hood Certification Program Procedural Guide" 2020 (version 3).

AHRI 430 is the Air-conditioning, Heating and Refrigeration Institute document titled “Performance Rating of Central Station Air-handling Unit Supply Fans”. 2020 (AHRI Standard 430 (I-P)-2020)

AHRI 440 is the Air-conditioning, Heating and Refrigeration Institute document titled “Performance Rating of Fan-coil Units”. 2019 (AHRI Standard 440 (I-P)-2019)

ANSI/AHRI 460 is the Air-Conditioning, Heating, and Refrigeration Institute document titled “Performance Rating of Remote Mechanical-Draft Air-Cooled Refrigerant Condensers,” 2005 (ANSI/AHRI Standard 460-2005).

AHRI 550/590 is the Air-Conditioning, Heating, and Refrigeration Institute document titled “Performance Rating of Water Chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle,” 2020~~15~~ (AHRI Standard 550/590 (I-P)-2020~~15~~) ~~with Addendum 1~~.

~~**ANSI/**~~**AHRI 560** is the Air-Conditioning, Heating, and Refrigeration Institute document titled “Absorption Water Chilling and Water Heating Packages,” 2000 (~~ANSI/~~AHRI Standard 560-2000).

AHRI 680 is the Air-Conditioning, Heating, and Refrigeration Institute document titled “Performance Rating of Residential Air Filter Equipment,” 2017 (~~ANSI/~~AHRI Standard 680-2017).

AHRI 920 is the Air-Conditioning, Heating, and Refrigeration Institute document titled “Performance Rating of DX-Dedicated Outdoor Air System Units” 2020 (ANSI/AHRI Standard 920 (I-P)-2020).

AHRI 1060 is the Air-Conditioning, Heating, and Refrigeration Institute document titled “Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment,” 2018 (AHRI Standard 1060 (I-P)-2018).

AHRI 1230 is the Air-Conditioning, Heating, and Refrigeration Institute document titled “Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment,” 2014 (AHRI Standard 1230-2014) with Addendum 1.

AHRI 1360 is the Air-Conditioning, Heating, and Refrigeration Institute document titled “Performance Rating of Computer and Data Processing Room Air Conditioners,” 2017 (AHRI Standard 1360 (I-P)-2017).

AIR, AVAILABLE TRANSFER is that portion of total outdoor ventilation air that is not required to satisfy other exhaust needs or to maintain pressurization of other spaces and that is transferable according to Section 120.1(g).

AIR, INFILTRATION is outdoor air that enters a building or space through openings in the building or space envelope due to negative pressure in the space or building relative to the exterior of the building envelope.

AIR, MAKEUP, or Compensating Outdoor Air is outdoor air that is intentionally conveyed by openings or ducts into the building from the outside; is supplied to the vicinity of an exhaust hood; and replaces air, vapor and contaminants being exhausted by the exhaust hood. Makeup air is generally filtered and fan-forced, and it may be heated or cooled. Makeup air may be delivered through openings or ducts integral to the exhaust hood.

AIR, REPLACEMENT is air that is used to replace air removed from a building through an exhaust system. Replacement air may be derived from one or more of the following: makeup air, portions of supply air, transfer air, or infiltration air.

AIR, SUPPLY is air entering a space from an air-conditioning, heating, or ventilating system for the purpose of comfort conditioning. Supply air is generally filtered, fan-forced, and heated, cooled, humidified or dehumidified as necessary to maintain specified temperature and humidity conditions.

AIR, TRANSFER is air transferred, whether actively by fans or passively by pressure differentials, from one room to another within a building through openings in the room envelope.

ASCE 7-16 Is the American Society of Civil Engineers Standard 7-16,

ASHRAE is the American Society of Heating, Refrigerating, and Air-conditioning Engineers.

ASHRAE CLIMATIC DATA FOR REGION × is the American Society of Heating, Refrigerating and Air-Conditioning Engineers document titled "ASHRAE Climatic Data for Region X, Arizona, California, Hawaii and Nevada," Publication SPCDX, 1982 and "Supplement," 1994.

ASHRAE HANDBOOK, APPLICATIONS VOLUME is the American Society of Heating, Refrigerating and Air-Conditioning Engineers document titled "ASHRAE Handbook: Heating, Ventilating, and Air-Conditioning Applications" (~~2015~~2019).

ASHRAE HANDBOOK, SYSTEMS AND EQUIPMENT VOLUME is the American Society of Heating, Refrigerating and Air-Conditioning Engineers document titled "ASHRAE Handbook: Heating, Ventilating, and Air-Conditioning Systems and Equipment" (~~2016~~2020).

ASHRAE HANDBOOK, FUNDAMENTALS VOLUME is the American Society of Heating, Refrigerating and Air-Conditioning Engineers document titled "ASHRAE Handbook: Fundamentals" (2017).

ASHRAE STANDARD 52.2 is the American Society of Heating, Refrigerating and Air-Conditioning Engineers document titled "Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size," 2017 (ANSI/ASHRAE Standard 52.2-2017).

ASHRAE STANDARD 55 is the American Society of Heating, Refrigerating and Air-Conditioning Engineers document titled " Thermal Environmental Conditions for Human Occupancy," ~~2017~~2020 (ANSI/ASHRAE Standard 55-~~2017~~2020).

ASHRAE STANDARD 62.1 is the American Society of Heating, Refrigerating and Air-Conditioning Engineers document titled **"**Ventilation for Acceptable Indoor Air Quality", ~~2016~~2019 (ANSI/ASHRAE Standard 62.1-~~2016~~2019, including Addenda ~~k~~y, ao, P, B).

ASHRAE STANDARD 62.2 is the American Society of Heating, Refrigerating and Air-Conditioning Engineers document titled "Ventilation and Acceptable Indoor Air Quality in Residential Buildings," ~~2016~~ 2019 (ANSI/ASHRAE Standard 62.2-~~2016~~ 2019 including ANSI/ASHRAE ~~Addenda b, d, l, q, and s~~Addendum v to ANSI/ASHRAE 62.2-~~2016~~ 2019.~~published in the 2017 supplement).~~

ANSI/ASHRAE STANDARD 154 is the American Society of Heating, Refrigerating and Air-Conditioning Engineers document titled "Ventilation For Commercial Cooking Operations," 2016 (ANSI/ASHRAE Standard 154-2016)

ASHRAE STANDARD 193 is the American Society of Heating, Refrigerating and Air-Conditioning Engineers document titled "Method of Test for Determining the Airtightness of HVAC Equipment," RA2014 (ANSI/ASHRAE Standard 193-RA2014).

ASME is the American Society of Mechanical Engineers.

ASME A17.1/CSA B44 is the American Society of Mechanical Engineers document titled "~~Handbook on~~ Safety Code for Elevators and Escalators" ~~2016~~2019 (ASME ~~Standard~~ A17.1/CSAB44-~~2016~~2019).

ASME A112.18.1/CSA B125.1 is the American Society of Mechanical Engineers document titled "Plumbing Fixture Fittings" ~~2012~~2018 (ASME ~~Standard~~ A112.18.1-~~2012~~2018/CSA B125.1-~~12~~18).

ASTM is the American Society for Testing and Materials International.

ASTM C55 is the American Society for Testing and Materials document titled "Standard Specification for Concrete Brick," 2017 (ASTM C55-17).

ASTM C177 is the American Society for Testing and Materials document titled "Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus," ~~2013~~2019 (ASTM C177-~~13~~19).

ASTM C272 is the American Society for Testing and Materials document titled "Standard Test Method for Water Absorption of Core Materials for ~~Structural~~ Sandwich Constructions," ~~2016~~2018 (ASTM C272/C272M-~~16~~18).

ASTM C335/C335M is the American Society for Testing and Materials document titled "Standard Test Method for Steady-State Heat Transfer Properties of Pipe Insulation," 2017 (ASTM C335/C335M-17).

ASTM C518 is the American Society for Testing and Materials document titled "Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus," 2017 (ASTM C518-17).

ASTM C731 is the American Society for Testing and Materials document titled "Standard Test Method for Extrudability, After Package Aging of Latex Sealants," 2015 (ASTM C731-15).

ASTM C732 is the American Society for Testing and Materials document titled "Standard Test Method for Aging Effects of Artificial Weathering on Latex Sealants," 2017 (ASTM C732-17) ~~(2017)~~.

ASTM C836 is the American Society of Testing and Materials document titled, "Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course," ~~2015~~2018 (ASTM C836/C836M-~~15~~18).

ASTM C1167 is the American Society for Testing and Materials document titled "Standard Specification for Clay Roof Tiles," ~~2011~~2017 (ASTM C1167-11(2017)).

ASTM C1371 is the American Society for Testing and Materials document titled "Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers," 2015 (ASTM C1371-15~~(2015)~~.

ASTM C1492 is the American Society for Testing and Materials document entitled "Standard Specification for Concrete Roof Tile," 2016 (ASTM C1492-03(2016)).

ASTM C1549 is the American Society for Testing and Materials document entitled, "Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer,"2016 (ASTM C1549-~~-~~16. ~~(2016)~~.

ASTM C1583 is the American Society of Testing and Materials document titled, "Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)," ~~2013~~2020 (ASTM C1583/c1583M-~~13~~20).

ASTM D448 is the American Society for Testing and Materials document titled, "Standard Classification for Sizes of Aggregate for Road and Bridge Construction,"2017 (ASTM D448-12(2017)).

ASTM D522 is the American Society of Testing and Materials document titled, "Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings," 2017 (ASTM D522/D522M-17).

ASTM D822 is the American Society of Testing and Materials document titled, "Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings," ~~2013~~2018 (ASTM D822/D822M-~~13~~13(2018)).

ASTM D1003 is the American Society for Testing and Materials document titled "Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics," 2013 (ANSI/ASTM D1003-13).

ASTM D1653 is the American Society of Testing and Materials document titled, "Standard Test Methods for Water Vapor Transmission of Organic Coating Films," 2013 (ASTM D1653-13).

ASTM D1863 is the American Society for Testing and Materials document titled, "Standard Specification for Mineral Aggregate Used on Built-Up Roofs,"~~2011~~2018 (ASTM D1863/D1863M-05 (~~2011~~2018)).

ASTM D2202 is the American Society of Testing and Materials document titled, "Standard Test Method for Slump of Sealants," 2019 (ASTM D2202 - 00(2019))

ASTM D2370 is the American Society of Testing and Materials document titled, "Standard Test Method for Tensile Properties of Organic Coatings," 2016 (ASTM D2370-~~98 (20~~16~~)~~).

ASTM D2824 is the American Society of Testing and Materials document titled "Standard Specification for Aluminum-Pigmented Asphalt Roof Coatings, Nonfibered, ~~Asbestos Fibered,~~ and Fibered without Asbestos," ~~2013~~2018 (ASTM D2824/D2824M-~~13~~18).

ASTM D3468 is the American Society of Testing and Materials document titled, "Standard Specification for Liquid-Applied Neoprene and Chlorosulfonated Polyethylene Used in Roofing and Waterproofing," ~~2013~~2020 (ASTM D3468/D3468M-99 (~~2013~~2020)).

ASTM D3805 is the American Society of Testing and Materials document titled "Standard Guide for Application of Aluminum-Pigmented Asphalt Roof Coatings," 2016 (ASTM D3805/D3805M-16~~ (2016)~~).

ASTM D4798 is the American Society for Testing and Materials document titled "Standard Test Method for Accelerated Weathering Test Conditions and Procedures for Bituminous Materials (Xenon-Arc Method)," ~~2016~~2021 (ASTM D4798/D4798M-~~16~~11(2021)).

ASTM D5870 is the American Society of Testing and Materials document titled, "Standard Practice for Calculating Property Retention Index of Plastics," 2016 (ASTM D5870-16).

ASTM D6083 is the American Society of Testing and Materials document title, "Standard Specification for Liquid Applied Acrylic Coatings Used in Roofing," 2021 (ASTM D6083/D6083M-21).

ASTM D6694 is the American Society of Testing and Materials document titled, "Standard Specification for Liquid-Applied Silicone Coating Used in Spray Polyurethane Foam Roofing," 2015 (ASTM D6694/D6694M-15~~ (2015~~).

ASTM E96 is the American Society for Testing and Materials document titled "Standard Test Methods for Water Vapor Transmission of Materials," 2016 (ASTM E96/E96M-16).

ASTM E283 is the American Society for Testing and Materials document titled "Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Skylight, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen," ~~2012~~2019 (ASTM E283/E238~~-04(2012)~~-19).

ASTM E408 is the American Society for Testing and Materials document titled, "Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques," ~~2013~~2019 (ASTM E408-~~13~~13(2019)).

ASTM E779 is the American Society for Testing and Materials document titled, "Standard Test Method for Determining Air Leakage Rate by Fan Pressurization," ~~2010~~2019 (ASTM E779-~~10~~19).

ASTM E903 is the American Society for Testing and Materials document titled, "Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres,"~~2012~~2020 (ASTM E903-~~12(2012)~~20).

ASTM E972 is the American Society for Testing and Materials document titled, "Standard Test Method for Solar Photometric Transmittance of Sheet Materials Using Sunlight,"~~1996~~2021 (ASTM E972-96(~~2013~~2021)).

ASTM E1175 is the American Society for Testing and Materials document titled, "Standard Test Method for Determining Solar or Photopic Reflectance, Transmittance, and Absorptance of Materials Using a Large Diameter Integrating Sphere," 2015 (ASTM E1175-87(2015)).

ASTM E1677 is the American Society for Testing and Materials document titled, "Standard Specification for ~~an~~ Air ~~Retarder (AR)~~ Barrier (AB) Material or ~~System~~ Assemblies for Low-Rise Framed Building Walls," ~~2011~~2019 (ASTM E1677-~~11~~19).

ASTM E1680 is the American Society for Testing and Materials document titled, " Standard Test Method for Rate of Air Leakage through Exterior Metal Roof Panel Systems," 2016 (ASTM E1680-16).

ASTM E1918 is the American Society for Testing and Materials document entitled, "Standard Test Method for Measuring Solar reflectance of Horizontal and Low-Sloped Surfaces in the Field,"2016 (ASTM E1918-16~~(2016)~~).

ASTM E1980 is the American Society for Testing and Materials document titled, "Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surface," ~~2011~~2019 (ASTM E1980-~~11~~11(2019)).

ASTM E2178 is the American Society for Testing and Materials document titled, "Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials," ~~2013~~2021 (ASTM E21778-~~13~~21).

ASTM E2357 is the American Society for Testing and Materials document titled, "Standard Test Method for determining air leakage of air barrier assemblies" ~~2017~~2018 (ASTM E2357-~~17~~18).

ASTM E3087 is the American Society of Testing and Materials document titled "Standard Test Method for Measuring Capture Efficiency of Domestic Range Hoods", 2018 (ASTM E3087-18)

ATTIC is an enclosed space directly below the roof deck and above the ceiling beams.

AUTOMATIC is capable of operating without human intervention.

AUTOMATED TELLER MACHINE (ATM) is any electronic information processing device which accepts or dispenses currency in connection with a credit, deposit, or convenience account without involvement by a clerk.

AZIMUTH is the degrees of clockwise rotation from true north.

BACK-UP COMPRESSORS are those compressors not used to meet peak compressed air loads. Back-up compressors are physically connected to the compressed air piping system and can be automatically controlled to turn on if one of the online compressors fails. Back-up compressors do not normally operate.

BATTERY SYSTEM, STATIONARY STORAGE. A rechargeable energy storage system consisting of electrochemical storage batteries, battery chargers, controls, and associated electrical equipment designed to provide electrical power to a building. The system is typically used to provide standby or emergency power, and uninterruptable power supply, load shedding, load sharing or similar capabilities.

BELOW-GRADE WALL is the portion of a wall, enclosing conditioned space that is below the grade line.

BOILER SYSTEM is one or more boilers and their piping and controls that work together to supply steam or hot water to heat output devices remote from the boiler.

BUBBLE POINT is the liquid saturation temperature of a refrigerant at a specified pressure.

BUILDING is any structure or space covered by Section 100.0 of the Building Energy Efficiency Standards.

BUILDING COMMISSIONING is a systematic quality assurance process that spans the entire design and construction process, including verifying and documenting that building systems and components are planned, designed, installed, tested, operated and maintained to meet the owner's project requirements.

BUILDING ENVELOPE is the ensemble of exterior and demising partitions of a building that enclose conditioned space.

CALL CENTER is a phone center that handles large number of phone calls including but not limited to help desk, customer and sales support, technical support, emergency response, telephone answering service, and inbound and outbound telemarketing.

CARBON DIOXIDE ENRICHMENT is injection of additional carbon dioxide into the CEH spaces for the purpose of stimulating plant growth.

CASCADE REFRIGERATION SYSTEM is a type of refrigeration system that uses a low-stage refrigeration system where the heat rejected from condensing the low-stage refrigerant is absorbed using a heat-exchanger by a separate high-stage refrigeration system, and the ultimate heat rejection to ambient air is accomplished by the high-stage refrigeration system.

CEILING FAN means a nonportable device that is suspended from a ceiling or overhead structure for circulating air via the rotation of fan blades as defined in 10 cfr 430.2.

Central Fan Ventilation Cooling System, or CFVCS is a ducting arrangement including outside air ducts, motorized dampers, and an automatic control system that allows a residential space conditioning system central fan and ducts to distribute outside air throughout a residential dwelling unit, intending to reduce or eliminate the need for mechanical cooling.

CERTIFIED TO THE ENERGY COMMISSION means, when used in association with appliances, certified under Section 1606 of Title 20 of the California Code of Regulations; and otherwise means certified by the manufacturer in a declaration, executed under penalty of perjury under the laws of the State of California, that all the information provided pursuant to the certification is true, complete, accurate and in compliance with all applicable provisions of Part 6; and if applicable that the equipment, product, or device was tested under the applicable test method specified in Part 6.

CERTIFYING ORGANIZATION is an independent organization recognized by the Commission to certify manufactured devices for performance values in accordance with procedures adopted by the Commission.

CIE 13.3 is the International Commission on Illumination (Commission Internationale de l'Eclairage) document titled "Method of Measuring and Specifying Colour Rendering Properties of Light Sources," 1995 (CIE 13.3-1995).

CIE 15 is the International Commission on Illumination (Commission Internationale de l'Eclairage) document titled "Technical Report: Colorimetry," ~~2004~~2018 (CIE 15:~~2004~~2018).

CIRCULATING FAN means a fan that is not a ceiling fan, but that is used to move air within a space that has no provision for connection to ducting or separation of the fan inlet from its outlet, and designed to be used for the general circulation of air.

CLIMATE ZONES are the 16 geographic areas of California for which the Commission has established typical weather data, prescriptive packages and energy budgets. Climate zones are defined by ZIP code and listed in Reference Joint Appendix JA2. FIGURE 100.1-A is an approximate map of the 16 Climate Zones.

CLOSED-CIRCUIT COOLING TOWER is a cooling tower that utilizes indirect contact between a heated fluid, typically water or glycol, and the cooling atmosphere to transfer the source heat load through sensible heat, latent heat, and mass transfer indirectly to the air, essentially combining a heat exchanger and cooling tower into an integrated and relatively compact device.

CODES, CALIFORNIA HISTORICAL BUILDING CODE is the California Historical Building Code, California Code of Regulations, Title 24, Part 8 and Part 2 (Chapter 34).

CODES, CBC is the ~~2016~~ 2022 *California Building Code*.

CODES, CEC is the ~~2016~~ 2022 *California Electrical Code*.

CODES, CMC is the 2022~~16~~ *California Mechanical Code*.

CODES, CPC is the ~~2016~~ 2022*California Plumbing Code*.

COEFFICIENT OF PERFORMANCE (COP), COOLING is the ratio of the rate of net heat removal to the rate of total energy input, calculated under designated operating conditions and expressed in consistent units, as determined using the applicable test method in the Appliance Efficiency Regulations or Section 110.2.

COEFFICIENT OF PERFORMANCE (COP), HEATING is the ratio of the rate of net heat output to the rate of total energy input, calculated under designated operating conditions and expressed in consistent units, as determined using the applicable test method in the Appliance Efficiency Regulations or Section 110.2.

COEFFICIENT OF PERFORMANCE (COP), HEAT PUMP is the ratio of the rate of useful heat output delivered by the complete heat pump unit (exclusive of supplementary heating) to the corresponding rate of energy input, in consistent units and as determined using the applicable test method in Appliance Efficiency Regulations or Section 110.2.

COMBUSTION AIR POSITIVE SHUT-OFF is a means of restricting airflow through a boiler combustion chamber during standby periods, used to reduce standby heat loss. A flue damper and a vent damper are two examples of combustion air positive shut-off devices.

COMBUSTION EFFICIENCY is a measure of the percentage of heat from the combustion of gas or oil that is transferred to the medium being heated or lost as jacket loss.

COMMERCIAL BOILER is a type of boiler with a capacity (rated maximum input) of 300,000 Btus per hour (Btu/h) or more and serving a space heating or water heating load in a commercial building.

COMMISSION is the California State Energy Resources Conservation and Development Commission, which is also referred to as the California Energy Commission.

COMMON LIVING AREAS are habitable common use areas in multifamily buildings intended for use by residents in the same manner as dwelling spaces. Common living areas do not include nonhabitable common use areas; see common service areas.

COMMON SERVICE AREAS are nonhabitable common use areas in multifamily buildings used to provide amenities or services to residents and their guests, including but not limited to shared laundry facilities, gyms and workout areas, guest services areas, pool or spa areas, recreational areas, and office areas or conference rooms available for use by

residents. Common service areas also include office and maintenance spaces necessary for the operation of the multifamily building. Common service areas do not include habitable common use areas; see common living areas.

COMMON USE AREAS are private use areas within multifamily residential facilities where the use of these areas is limited exclusively to owners, residents, and their guests. The areas may be defined as rooms or spaces or elements inside or outside of a building.

COMPLEX MECHANICAL SYSTEMS are systems that include 1) fan systems each serving multiple thermostatically controlled zones; or 2) built-up air handler systems (nonunitary or nonpackaged HVAC equipment); or 3) hydronic or steam heating systems; or 4) hydronic cooling systems. Complex mechanical systems are NOT the following: 1) unitary or packaged equipment listed in Table 110.2-A, 110.2-B, 110.2-C, or 110.2-E that each serves one zone, or 2) two-pipe, heating only systems serving one or more zones.

COMPLIANCE SOFTWARE is software that has been approved pursuant to Section 10-109 of Part 1 of Title 24 of the California Code of Regulations, to demonstrate compliance with the performance approach of Part 6.

COMPRESSED AIR SYSTEM is a system of at least one compressor providing compressed air at 40 psig or higher.

COMPUTER ROOM is a room within a building whose primary function is to house electronic equipment and that has a design information technology equipment (ITE) equipment power density exceeding 20 watts/ft^2 (215 watts/m^2) of conditioned floor area.

CONDENSER is a refrigeration component that condenses refrigerant vapor by rejecting heat to air mechanically circulated over its heat transfer surface.

CONDENSER, ADIABATIC is a condenser that has the ability to use two heat transfer processes in series as accomplished by a single factory-made unit. The first heat transfer process is the precooling of the entering air by lowering the entering air drybulb temperature. The second heat transfer process is forced-air circulation cooling over the heat transfer surface of the condenser.

DRY MODE is an operating condition of an adiabatic condenser wherein the only means of heat transfer is accomplished through forced-air circulation over the heat transfer surface of the condenser without any precooling of the entering air.

PRECOOL MODE is an operating condition of an adiabatic condenser wherein the entering air is precooled.

CONDENSER SPECIFIC EFFICIENCY is the full load condenser Total Heat of Rejection (THR) capacity at standardized conditions divided by the fan input electric power (including but not limited to spray pump electric input power for evaporative condensers) at 100 percent rated fan speed.

CONDITIONED FLOOR AREA (CFA) is the floor area (in square feet) of enclosed conditioned space on all floors of a building, as measured at the floor level of the exterior surfaces of exterior walls enclosing the conditioned space.

CONDITIONED SPACE is an enclosed space within a building that is directly conditioned or indirectly conditioned.

CONDITIONED SPACE, DIRECTLY is an enclosed space that is provided with wood heating, mechanical heating that has a capacity exceeding 10 Btu/hr-ft^2, or mechanical cooling that has a capacity exceeding 5 Btu/hr-ft^2, . Directly conditioned space does not include process space. (See “process space.”)

CONDITIONED SPACE, INDIRECTLY is enclosed space that (1) is not directly conditioned space; and (2) either (a) has a thermal transmittance area product (UA) to directly conditioned space exceeding that to the outdoors or to unconditioned space and does not have fixed vents or openings to the outdoors or to unconditioned space, or (b) is a space through which air from directly conditioned spaces is transferred at a rate exceeding three air changes per hour.

CONDITIONED VOLUME is the total volume (in cubic feet) of the conditioned space within a building.

CONTINUOUS INSULATION (c.i.) is insulation that is continuous across all assemblies that separate conditioned from unconditioned space. It is installed on the exterior or interior or is integral to any opaque surface of the building envelope and has no thermal bridges other than fasteners and necessary service openings.

CONTROLLED ATMOSPHERE is an airtight space maintained at reduced oxygen levels for the purpose of reducing respiration of perishable product in long term storage.

CONTROLLED ENVIRONMENT HORTICULTURE (CEH) SPACE is a building space dedicated to plant production by manipulating indoor environmental conditions, such as through electric lighting, irrigation, mechanical heating, mechanical cooling, or dehumidification. CEH space does not include building space where plants are grown solely to decorate that same space. Greenhouse and indoor growing are types of CEH spaces (see "greenhouse" and "indoor growing").

COOLER is a space to be capable of operation at a temperature greater than or equal to 28°F but less than 55°F.

COOL ROOF is a roofing material with high thermal emittance and high solar reflectance, or low thermal emittance and exceptionally high solar reflectance as specified in Part 6 that reduces heat gain through the roof.

COOLING EQUIPMENT is equipment used to provide mechanical cooling for a room or rooms in a building.

CRAWL SPACE is a space immediately under the first floor of a building adjacent to grade.

CRRC-1 is the Cool Roof Rating Council document titled "Product Rating Program Manual."(2021)

CTI is the Cooling Technology Institute.

CTI ATC-105 is the Cooling Technology Institute document titled "Acceptance Test Code for Water Cooling Towers," ~~2000~~2019 (CTI ATC-105-~~00~~19).

CTI ATC-105S(11) is the Cooling Technology Institute document titled "Acceptance Test Code for Closed-Circuit Cooling Towers," 2011 (CTI ATC-105-(11)).

CTI ATC-106 is the Cooling Technology Institute document titled "Acceptance Test Code for Mechanical Draft Evaporative Vapor Condensers", 2011 (CTI ATC-106 (11)).

CTI STD-201 is the Cooling Technology Institute document titled "Standard for ~~Thermal Performance~~ the Certification of Water Cooling Thermal Performance ~~Evaporative Heat Rejection Equipment~~," ~~2015~~2017 (CTI STD-201-~~15~~RS(17)).

CURRENT AIR DEMAND is the actual cubic feet per minute (acfm) of total airflow necessary for end uses in a compressed air system.

C-VALUE (also known as C-factor) is the time rate of heat flow through unit area of a body induced by a unit temperature difference between the body surfaces, in Btu (hr × ft² × °F). It is not the same as K-value or K-factor.

CYCLES OF CONCENTRATION is the number of times the concentration of total dissolved solids (TDS) in cooling tower water is multiplied relative to the TDS in the makeup water. Because evaporation of pure water leaves dissolved solids behind in the system water, TDS increases over time as the tower operates. The number of times the dissolved minerals are concentrated is relative to the TDS in the makeup water. For example, five cycles of concentration represents five times the concentration of solids in the cooling tower system water relative to the TDS in the makeup water entering the tower.

DATA CENTER is a building whose primary function is to house computer room(s).

DAYLIT ZONE is the floor area under skylights or next to windows. Types of Daylit Zones include Primary Sidelit Daylit Zone, Secondary Sidelit Daylit Zone, and Skylit Daylit Zone.

DEADBAND is the temperature range within which the HVAC system is neither calling for heating or cooling.

DECORATIVE GAS APPLIANCE is a gas appliance that is designed or installed for visual effect only, cannot burn solid wood, and simulates a fire in a fireplace.

DEDICATED OUTDOOR AIR SYSTEM (DOAS) – A ventilation system which delivers 100 percent outdoor air and delivers ventilation supply air to each space, either directly or in conjunction with local or central space-conditioning systems serving those same spaces such as a DX-DOAS, HRV, ERV, or custom ventilation only unit.~~/s~~

DEGREE DAY, HEATING, is a unit, based upon temperature difference and time, used in estimating fuel consumption and specifying nominal annual heating load of a building. For any one day, when the mean temperature is less than 65°F, there exist as many degree days as there are Fahrenheit degrees difference in temperature between the mean temperature for the day and 65°F. The number of degree days for specific geographical locations are those listed in the

Reference Joint Appendix JA2. For those localities not listed in the Reference Joint Appendix JA2, the number of degree days is as determined by the applicable enforcing agency.

DEMAND FLEXIBILITY MEASURE is a measure that reduces TDV energy consumption using communication and control technology to shift electricity use across hours of the day to decrease energy use onpeak or increase energy use offpeak, including but not limited to battery storage, or HVAC or water heating load shifting.

DEMAND RESPONSE is short-term changes in electricity usage by end-use customers from their normal consumption patterns. Demand response may be in response to:

a. changes in the price of electricity; or

b. participation in programs or services designed to modify electricity use: _____

   i. in response to wholesale market prices; or

   ii. when system reliability is jeopardized.

DEMAND RESPONSE PERIOD is a period of time during which electricity loads are modified in response to a demand response signal.

DEMAND RESPONSE SIGNAL is a signal that indicates a price or a request to modify electricity consumption for a limited time period.

DEMAND RESPONSIVE CONTROL is an automatic control that is capable of receiving and automatically responding to a demand response signal.

DEMISING PARTITION is a wall, fenestration, floor, or ceiling that separates conditioned space from enclosed unconditioned space.

DESIGN CONDITIONS are the parameters and conditions used to determine the performance requirements of space-conditioning systems. Design conditions for determining design heating and cooling loads are specified in Section 140.4(b) for nonresidential~~, high-rise residential,~~ and hotel/motel buildings~~, and~~ in Section 150.0(h) for ~~low-rise~~ single-family residential buildings, and in Sections 160.3(b) and 170.2(c) for multifamily buildings.

DESIGN HEAT GAIN RATE is the total calculated heat gain through the building envelope under design conditions.

DESIGN HEAT LOSS RATE is the total calculated heat loss through the building envelope under design conditions.

DESIGN REVIEW is an additional review of the construction documents (drawings and specifications) that seeks to improve compliance with existing Title 24 regulations, to encourage adoption of best practices in design, and to encourage designs that are constructible and maintainable. It is an opportunity for an experienced design engineer or architect to look at a project with a fresh perspective in an effort to catch missing or unclear design information and to suggest design enhancements.

DESICCANT DEHUMIDIFICATION SYSTEM is a mechanical dehumidification technology that uses a solid or liquid desiccant to remove moisture from the air.

DEW POINT TEMPERATURE is the vapor saturation temperature at a specified pressure for a substance undergoing phase change from vapor to liquid.

DIRECT DIGITAL CONTROL (DDC) is a type of control where controlled and monitored analog or binary data, such as temperature and contact closures, are converted to digital format for manipulation and calculations by a digital computer or microprocessor, then converted back to analog or binary form to control mechanical devices.

DIRECT-VENT APPLIANCE or “sealed combustion” appliance is an appliance that is constructed and installed so that air from combustion is derived directly from the outdoors and flue gases are discharged to the outdoors.

DISPLAY PERIMETER is the length of an exterior wall in a Group B; Group F, Division 1; or Group M, Occupancy that immediately abuts a public sidewalk, measured at the sidewalk level for each story that abuts a public sidewalk.

DOMESTIC WATER HEATING SYSTEMS (see “service water heating”)

DOOR is an operable opening in the building envelope, including swinging and roll-up doors, fire doors, pet doors and access hatches with less than 25 percent glazed area. When that operable opening has 25 percent or more glazed area it is a glazed door. See Fenestration: Glazed Door.

DOOR AREA is the total rough opening area which includes the door, and when present, the fenestration, and the fenestration frame components in the door frame assembly.

DRAIN WATER HEAT RECOVERY (DWHR) is a system that recovers heat from effluent in waste piping and uses it to preheat water in a domestic or service water heating system in order to reduce water heating energy usage.

~~**DUAL-GLAZED GREENHOUSE WINDOWS** are a type of dual-glazed fenestration product which adds conditioned volume but not conditioned floor area to a building.~~

DUCT SEALING is a procedure for installing a space-conditioning distribution system that minimizes leakage of air from or to the distribution system. Minimum specifications for installation procedures, materials, diagnostic testing and field verification are contained in the Reference Residential Appendix RA3 and Reference Nonresidential Appendix NA1.

DUCT SYSTEM is all the ducts, duct fittings, plenums and fans when assembled to form a continuous passageway for the distribution of air.

DUCT WALL PENETRATIONS are openings to the duct wall made by pipes, holes, conduit, tie rods, or wires.

DUCTED SYSTEM is an air conditioner or heat pump, either a split system or single-packaged unit, that is designed to be permanently installed equipment and delivers conditioned air to an indoor space through a duct.

DWELLING is a building that contains one or two dwelling units used, intended or designed to be used, rented, leased, let or hired out to be occupied for living purposes.

DWELLING UNIT is a single unit providing complete, independent living facilities for one or more persons including access, permanent provisions for living, sleeping, eating, cooking and sanitation.

DWELLING UNIT, ATTACHED is a dwelling unit that shares a common wall or common floor/ceiling with another dwelling unit.

DWELLING UNIT, JUNIOR ACCESSORY, or JADU is a dwelling unit that is no more than 500 square feet in size and contained entirely within an existing single family building. A JADU includes a kitchen, a separate entrance from the main entrance to the building, and an interior entry to the main living area. A JADU may include separate sanitation facilities, or may share sanitation facilities with the existing single family building.

DX-DEDICATED OUTDOOR AIR SYSTEM UNITS (DX-DOAS)- a type of air-cooled, water-cooled, or water-source DOAS unit that dehumidifies 100 percent outdoor air and includes reheat that is capable of controlling the supply dry-bulb temperature of the dehumidified air to the designed supply air temperature. This conditioned outdoor air is then delivered directly or indirectly to the conditioned spaces. It may precondition outdoor air by containing an enthalpy wheel, sensible wheel, desiccant wheel, plate heat exchanger, heat pipes, or other heat or mass transfer apparatus.

EAST-FACING (See “orientation.”)

ECONOMIZER, AIR, is a ducting arrangement, including dampers, linkages, and an automatic control system that allows a cooling supply fan system to supply outside air to reduce or eliminate the need for mechanical cooling.

ECONOMIZER, PUMPED REFRIGERANT, is a system by which the supply air of a cooling system is cooled directly by refrigerant pumped between indoor and outdoor units during cooler ambient temperatures in order to reduce or eliminate the need for mechanical cooling.

ECONOMIZER, WATER, is a system by which the supply air of a cooling system is cooled directly or indirectly by evaporation of water, or other appropriate fluid, in order to reduce or eliminate the need for mechanical cooling.

ELECTRICAL POWER DISTRIBUTION SYSTEMS. The following definitions are intended to apply to Section 130.5 only:

EQUIPMENT. A general term, including devices, luminaires, apparatus, machinery, and the like used as a part of, or in connection with, an electrical installation.

PLUG LOAD is the energy consumed by any appliances or electronic device that is plugged into a receptacle or receptacle outlet. Plug loads are not related to general lighting, heating, ventilation, cooling, and water heating,

domestic and service water system, renewable power, information technology equipment, computer room electronic equipment, and electric vehicle charging.

ELECTRICAL METERING is a device or system for measuring the electrical power and energy supplied to a customer or premise(s).

LOW VOLTAGE DRY-TYPE DISTRIBUTION TRANSFORMER is a distribution transformer that has an input voltage of 600 volts or less, that is air-cooled, and that does not use oil as a coolant.

SERVICE is the conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premise served.

SERVICE EQUIPMENT is the necessary equipment, usually consisting of a circuit breaker(s) or switch(es) and fuse(s) and their accessories, connected to the load end of service conductors to a building or other structure, or an otherwise designated area, and intended to constitute the main control and cutoff of the supply.

ELECTRONICALLY-COMMUTATED MOTOR is a brushless DC motor with a permanent magnet rotor that is surrounded by stationary motor windings, and an electronic controller that varies rotor speed and direction by sequentially supplying DC current to the windings.

EMITTANCE, THERMAL is the ratio of the radiant heat flux emitted by a sample to that emitted by a blackbody radiator at the same temperature.

ENCLOSED SPACE is space that is substantially surrounded by solid surfaces, including walls, ceilings or roofs, doors, fenestration areas, and floors or ground.

ENERGY BUDGET is the maximum energy consumption, based on Time Dependent Valuation (TDV) energy, that a proposed building, or portion of a building, can be designed to consume, calculated using Commission-approved compliance software as specified by the Alternative Calculation Method Approval Manual. The Energy Budget for newly constructed, low-rise residential buildings is expressed in terms of the Energy Design Rating.

ENERGY COMMISSION (CEC) is the California State Energy Resources Conservation and Development Commission.

ENERGY DESIGN RATING (EDR) is a way to express the energy consumption of a building as a rating score index where a score of 100 represents the energy consumption of the building built to the specifications of the Residential Energy Services (RESNET) reference home characterization of the 2006 International Energy Conservation Code (IECC) with Title 24, Part 6 modeling assumptions, and a score of 0 (zero) represents a building that has zero net energy consumption. The EDR is calculated using Commission-approved compliance software as specified by the Alternative Calculation Method Approval Manual.

ENERGY DESIGN RATING, ENERGY EFFICIENCY is an Energy Design Rating based on the TDV energy consumption of a building that results from the building's energy efficiency characteristics, calculated using Commission-approved compliance software as specified by the Alternative Calculation Methods Approval Manual.

ENERGY DESIGN RATING, SOLAR ELECTRIC GENERATION AND DEMAND FLEXIBILITY is the reduction in TDV energy consumption of a building expressed in terms of an Energy Design Rating reduction that results from the combination of the building's solar electric generation system and demand flexibility measures.

ENERGY DESIGN RATING, TOTAL is the total Energy Design Rating for the building that is determined by subtracting the Solar Electric Generation System and Demand Flexibility Energy Design Rating from the Energy Efficiency Energy Design Rating.

ENERGY EFFICIENCY RATIO (EER) is the ratio of net cooling capacity (in Btu/hr) to total rate of electrical energy input (in watts), of a cooling system under designated operating conditions, as determined using the applicable test method in the Appliance Efficiency Regulations or Section 110.2.

~~**ENERGY FACTOR (EF)** of a water heater is a measure of overall water heater efficiency, as determined using the applicable test method in the Appliance Efficiency Regulations.~~

ENERGY MANAGEMENT CONTROL SYSTEM (EMCS) is an automated control system that regulates the energy consumption of a building by controlling the operation of energy consuming systems, and is capable of monitoring loads and adjusting operations in order to optimize energy usage and respond to demand response signals.

ENERGY OBTAINED FROM DEPLETABLE SOURCES is electricity purchased from a public utility, or any energy obtained from coal, oil, natural gas, or liquefied petroleum gases.

ENERGY OBTAINED FROM NONDEPLETABLE SOURCES is energy that is not energy obtained from depletable sources.

ENERGY STORAGE SYSTEM (ESS) is one or more devices, assembled together, that are capable of storing energy used for safely supplying electrical energy to selected loads at a future time.

ESS READY INTERCONNECTION EQUIPMENT is equipment, including but not limited to an ESS ready panelboard, that can accommodate the connection of a distributed energy resource or an ESS capable of either automatic or manual isolation from the utility power source.

ESS READY PANELBOARD is a panelboard that can accommodate either automatic or manual switching between a utility power source to a distributed energy resource or an energy storage system, such as a split bus panelboard.

ENFORCEMENT AGENCY is the city, county, or state agency responsible for issuing a building permit.

ENTHALPY RECOVERY RATIO (ERR) is a ratio of the change in enthalpy of the outdoor air supply to the difference in enthalpy between the entering supply airflow and the entering exhaust airflow, with no adjustment to account for that portion of the psychometric change in the leaving supply airflow that is the result of leakage of entering exhaust airflow rather than exchange of heat or moisture between the airstreams.

ENTIRE BUILDING is the ensemble of all enclosed space in a building, including the space for which a permit is sought, plus all existing conditioned and unconditioned space within the structure.

ENVELOPE (See “building envelope”.)

EXFILTRATION is uncontrolled outward air leakage from inside a building, including leakage through cracks and interstices, around windows and doors, and through any other exterior partition or duct penetration.

EXTERIOR FLOOR/SOFFIT is a horizontal exterior partition, or a horizontal demising partition, under conditioned space. For low-rise residential occupancies, exterior floors also include those on grade.

EXTERIOR PARTITION is an opaque, translucent, or transparent solid barrier that separates conditioned space from ambient air or space. For low-rise residential occupancies, exterior partitions also include barriers that separate conditioned space from unconditioned space, or the ground.

EXTERIOR ROOF/CEILING is an exterior partition, or a demising partition, that has a slope less than 60° from horizontal, that has conditioned space below, and that is not an exterior door or skylight.

EXTERIOR ROOF/CEILING AREA is the area of the exterior surface of exterior roof/ceilings.

EXTERIOR WALL is any wall or element of a wall, or any member or group of members, which defines the exterior boundaries or courts of a building and which has a slope of 60° or greater with the horizontal plane. An exterior wall or partition is not an exterior floor/soffit, exterior door, exterior roof/ceiling, window, skylight, or demising wall.

EXTERIOR WALL AREA is the area of the opaque exterior surface of exterior walls.

FAÇADE is the contiguous exterior of a building surface, but not limited to fenestration products.

FACTORY is build, structure or space designated as Factory Group F that is used for assembling, disassembling, fabricating, finishing, manufacturing, packaging, repair or processing operations.

FACTORY ASSEMBLED COOLING TOWERS are cooling towers constructed from factory-assembled modules either shipped to the site in one piece or put together in the field.

FAN ARRAYS are multiple fans in parallel and in a single enclosure between two plenum sections in an air distribution system, where plenum means a compartment or chamber that forms a part of the air distribution system, and that is not used for occupancy or storage.

FAN, EMBEDDED is a fan that is part of a manufactured assembly where the assembly includes functions other than air movement.

FAN ENERGY INDEX (FEI) is the ratio of the electric input power of a reference fan to the electric input power of the actual fan as calculated per ANSI/AMCA 208-18 at fan system design conditions.

FAN ELECTRICAL INPUT POWER (FAN kWdesign) is the electrical input power in kilowatts required to operate an individual fan or fan array at design conditions. It includes the power consumption of motor controllers, if present.

FAN NAMEPLATE ELECTRICAL INPUT POWER (kW) is the nominal electrical input power rating stamped on a fan assembly nameplate.

FAN SYSTEM includes all the fans that contribute to the movement of air through a point of a common duct, plenum, or cabinet.

FAN SYSTEM, COMPLEX means a fan system that combines a single-cabinet fan system with other supply fans, exhaust fans, or both.

FAN SYSTEM, EXHAUST is a fan system dedicated to the removal of air from interior spaces to the outdoors that may operate at times other than economizer operation.

FAN SYSTEM, MULTI-ZONE VARIABLE AIR VOLUME (VAV) is a fan system that serves three or more space-conditioning zones where airflow to each zone is individually controlled based on heating, cooling and/or ventilation requirements, indoor fan airflow varies as a function of load, and the sum of the minimum airflows for each zone is 40% or less of the fan system design conditions.

FAN SYSTEM, RELIEF is a fan system dedicated to the removal of air from interior spaces to the outdoors that operates only during economizer operation.

FAN SYSTEM, RETURN is a fan system dedicated to removing air from interior where some or all the air is to be recirculated except during economizer operation.

FAN SYSTEM, SUPPLY-ONLY is a fan system that provides supply air to interior spaces and does not recirculate the air.

FAN SYSTEM, SINGLE-CABINET is a fan system where a single fan, single fan array, a single set of fans operating in parallel, or fans or fan arrays in series and embedded in the same cabinet, that both supplies air to a space and recirculates the air.

FAN SYSTEM, TRANSFER is a fan system that exclusively moves air from one occupied space to another.

FAN SYSTEM AIRFLOW (cfm) is the sum of the airflow of all fans with fan electrical input power greater than 1 kW at fan system design conditions, excluding the airflow that passes through downstream fans with fan input power less than 1 kW.

FAN SYSTEM DESIGN CONDITIONS are operating conditions that can be expected to occur during normal system operation that result in the highest supply airflow rate to or from the conditioned spaces served by the fan system.

FAN SYSTEM ELECTRICAL INPUT POWER (Fan kWdesign, system) the sum of the fan electrical input power (Fan kWdesign) in kilowatts of all fans that are required to operate at fan system design conditions to supply air from the heating or cooling source to the conditioned spaces, return it to the source, exhaust it to the outdoors, or transfer it to another space.

FENESTRATION: Includes the following:

ACE is an NFRC-Approved Calculation Entity that conducts calculations of fenestration product ratings for certification authorization using the NFRC Component Modeling approach and issues label certificates to Specifying Authorities for product certification authorization in accordance with NFRC requirements.

ALTERED COMPONENT is a new fenestration component that has undergone an alteration other than a repair and is subject to all applicable Standards requirements.

BAY WINDOW is a combination assembly which is composed of three or more individual windows either joined side by side or installed within opaque assemblies and which projects away from the wall on which it is installed. Center

windows, if used are parallel to the wall on which the bay is installed, the end panels or two side windows are angled with respect to the center window. Common angles are 30° and 45°, although other angles may be employed.

CLERESTORY FENESTRATION is fenestration installed above a roofline greater than or equal to 60° from the horizontal, or any portion of exterior vertical glazing greater than eight feet per floor above the finished floor of a space.

CMA (component modeling approach) is a fenestration product certification program from the National Fenestration Rating Council (NFRC) that enables energy-related performance ratings for nonresidential fenestration products, including the thermal performance U-factor, Solar Heat Gain Coefficient, and Visible Transmittance.

CMAST (Component Modeling Approach Software Tool) is an NFRC approved software that allows a user to create a fenestration product "virtually," and generate its energy-related performance ratings, including the thermal performance U-factor, Solar Heat Gain Coefficient, and Visible Transmittance.

CURTAIN WALL/STOREFRONT is an external non-bearing wall intended to separate the exterior nonconditioned and interior conditioned spaces. It also consists of any combination of framing materials, fixed glazing, opaque glazing, operable windows, or other in-fill materials**. Note:** Window wall is also included as part of the curtain wall/storefront fenestration category.

DUAL-GLAZED GREENHOUSE WINDOWS is a double glass pane separated by an air or other gas space that adds conditioned volume but not conditioned floor area to a building.

DYNAMIC GLAZING SYSTEMS are glazing systems that have the ability to reversibly change their performance properties, including U-factor, Solar Heat Gain Coefficient (SHGC), and/or Visible Transmittance (VT) between well-defined end points. These may include, but are not limited to chromogenic glazing systems and integrated shading systems (defined below). Dynamic Glazing systems do not include internally mounted or externally mounted shading devices that attach to the window framing/glazing that may or may not be removable.

CHROMOGENIC GLAZING is a class of switchable glazing that includes active materials (e.g. electrochromic) and passive materials (e.g. photochromic and thermochromic) permanently integrated into the glazing assembly. Their primary function is to switch reversibly from a high transmission state to a low transmission state with associated changes in VT and SHGC.

INTEGRATED SHADING SYSTEM is a class of fenestration products including an active layer: e.g. shades, louvers, blinds or other materials permanently integrated between two or more glazing layers. The U-factor and/or SHGC and VT of the insulating glass assembly can be altered by reversibly changing the enclosed active layer.

FENESTRATION ALTERATION is any change to an existing building's exterior fenestration product that is not a repair (see "fenestration repair") that:

i. Replaces existing fenestration in an existing wall or roof with no net area added; or

ii. Replaces existing fenestration and adds new net area in the existing wall or roof; or

iii. Adds a new window that increases the net fenestration area to an existing wall or roof.

FENESTRATION AREA is the rough opening area of any fenestration product.

FENESTRATION PRODUCT is any transparent or translucent material plus any sash, frame, mullions and dividers, in the facade of a building, including, but not limited to, windows, glazed doors, skylights, curtain walls, dynamic glazing, garden windows ~~and,~~ glass block, and glazing used in greenhouses.

FENESTRATION REPAIR is the reconstruction or renewal for the purpose of maintenance of any fenestration product, component or system and shall not increase the preexisting energy consumption of the repaired fenestration product, component, system, or equipment. Replacement of any component, system, or equipment for which there are requirements in the Standards are considered an alteration (see "fenestration", "alteration") and not a repair and is subject to the requirements of Part 6 of the Standards.

FIELD-FABRICATED is a fenestration product whose frame is made at the construction site of standard dimensional lumber or other materials that were not previously cut, or otherwise formed with the specific intention of being used to fabricate a fenestration product. Field fabricated does not include site-built fenestration.

FIN is an opaque surface, oriented vertically and projecting outward horizontally from an exterior vertical surface.

FIN OFFSET is the horizontal distance from the edge of exposed exterior glazing at the jamb of a window to the fin.

FIN PROJECTION is the horizontal distance, measured outward horizontally, from the surface of exposed exterior glazing at the jamb of a window to the outward edge of a fin.

FIXED is fenestration that is not designed to be opened or closed.

GLAZED DOOR is an exterior door having a glazed area of 25 percent or greater of the area of the door. Glazed doors shall meet fenestration product requirements. See "door".

GREENHOUSE or GARDEN WINDOW is a window unit that consists of a three-dimensional, five-sided structure generally protruding from the wall in which it is installed. Operating sash may or may not be included.

HORIZONTAL SLATS, when referring to a daylighting device, is a set of adjacent surfaces located directly adjacent to vertical fenestration, oriented horizontally and projecting horizontally from its interior or exterior vertical surface.

LIGHT SHELF is an adjacent, opaque surfaced daylighting device located at the sill of clerestory glazing, oriented horizontally and projecting horizontally from an interior or exterior vertical surface.

MANUFACTURED or **KNOCKED DOWN PRODUCT** is a fenestration product constructed of materials which are factory cut or otherwise factory formed with the specific intention of being used to fabricate a fenestration product. Knocked down or partially assembled products may be sold as a fenestration product when provided with temporary and permanent labels as described in Section 10-111; or as a site-built fenestration product when not provided with temporary and permanent labels as described in Section 10-111.

NFRC 100 is the National Fenestration Rating Council document titled "~~NFRC 100:~~ Procedure for Determining Fenestration Product U-factors." ~~(2017~~2020~~)~~ (ANSI/NFRC 100-2020).

NFRC 200 is the National Fenestration Rating Council document titled "~~NFRC 200:~~ Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence." ~~(2017~~2020~~).~~ (ANSI/NFRC 200-2020).

NFRC 202 is the National Fenestration Rating Council document titled "~~NFRC 202:~~ Procedures for Determining Translucent Fenestration Product Visible Transmittance at Normal Incidence." ~~(2017~~2020~~).~~(ANSI/NFRC 202-2020).

NFRC 203 is the National Fenestration Rating Council document titled "~~NFRC 203:~~ Procedure for Determining Visible Transmittance of Tubular Daylighting Devices." ~~(2017~~2020~~).~~(ANSI/NFRC 203-2020).

NFRC 400 is the National Fenestration Rating Council document titled "~~NFRC 400:~~ Procedure for Determining Fenestration Product Air Leakage." ~~(2017~~2020~~).~~(ANSI/NFRC 400-2020).

OPERABLE SHADING DEVICE is a device at the interior or exterior of a building or integral with a fenestration product, which is capable of being operated, either manually or automatically, to adjust the amount of solar radiation admitted to the interior of the building.

RELATIVE SOLAR HEAT GAIN COEFFICIENT (RSHGC) is the ratio of solar heat gain through a fenestration product (corrected for external shading) to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted, or convected into the space.

SITE-BUILT is fenestration designed to be field-glazed or field assembled units using specific factory cut or otherwise factory formed framing and glazing units, that are manufactured with the intention of being assembled at the construction site. These include storefront systems, curtain walls, and atrium roof systems.

SKYLIGHT ROOF RATIO (SRR) is the ratio of the skylight area to the gross exterior roof area.

SOLAR HEAT GAIN COEFFICIENT (SHGC) is the ratio of the solar heat gain entering the space through the fenestration area to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted, or convected into the space.

SPANDRAL is opaque glazing material most often used to conceal building elements between floors of a building so they cannot be seen from the exterior, also known as "opaque in-fill systems".

TINTED GLASS is colored glass by incorporation of a mineral admixture resulting in a degree of tinting. Any tinting reduces both visible and radiant transmittance.

VERTICAL FENESTRATION is all fenestration other than skylights and doors.

VISIBLE REFLECTANCE is the reflectance of light at wavelengths from 410 to 722 namometers.

VISIBLE TRANSMITTANCE (VT) is the ratio (expressed as a decimal) of visible light that is transmitted through a glazing fenestration. The higher the VT rating, the more light is allowed through a window.

WINDOW is fenestration that is not a skylight and that is an assembled unit consisting of a frame and sash component holding one or more pieces of glazing.

WINDOW AREA is the area of the surface of a window, plus the area of the frame, sash, and mullions.

WINDOW HEAD HEIGHT is the height from the floor to the top of the vertical fenestration.

WINDOW WALL RATIO (WWR) is the ratio of the window area to the gross exterior wall area.

FIELD ERECTED COOLING TOWERS are cooling towers which are custom designed for a specific application and which cannot be delivered to a project site in the form of factory assembled modules due to their size, configuration, or materials of construction.

FIREPLACE is a hearth and fire chamber, or similar prepared place, in which a fire may be made and which is built in conjunction with a flue or chimney, including but not limited to factory-built fireplaces, masonry fireplaces, and masonry heaters as further clarified in the CBC.

FLOOR/SOFFIT TYPE is a type of floor/soffit assembly having a specific heat capacity, framing type, and U-factor.

FLUID COOLER is a fan-powered heat rejection device that includes a water or glycol circuit connected by a closed circulation loop to a liquid-cooled refrigerant condenser, and may be either evaporative-cooled, air-cooled, or a combination of the two.

FLUX is the rate of energy flow per unit area.

FOOD PREPARATION EQUIPMENT is cooking equipment intended for commercial use, including coffee machines, espresso coffee makers, conductive cookers, food warmers including heated food servers, fryers, griddles, nut warmers, ovens, popcorn makers, steam kettles, ranges, and cooking appliances for use in commercial kitchens, restaurants, or other business establishments where food is dispensed.

FREEZER is a space designed to be capable of operation at less than 28°F.

GAS COOLER is a refrigeration component that reduces the temperature of a refrigerant vapor by rejecting heat to air mechanically circulated over its heat transfer surface. Used by a CO2 refrigeration system in transcitical mode, and normally also capable of operating in subcritical mode.

GAS COOLING EQUIPMENT is cooling equipment that produces chilled water or cold air using natural gas or liquefied petroleum gas as the primary energy source.

GAS HEATING SYSTEM is a system that uses natural gas or liquefied petroleum gas as a fuel to heat a conditioned space.

GAS LOG is a self-contained, free-standing, open-flame, gas-burning appliance consisting of a metal frame or base supporting simulated logs, and designed for installation only in a vented fireplace.

GLAZING (See “fenestration product”)

GLOBAL WARMING POTENTIAL (GWP) is the radiative forcing impact of one mass-based unit of a given greenhouse gas relative to an equivalent unit of carbon dioxide over a given period of time.

GLOBAL WARMING POTENTIAL VALUE (GWP Value) is the 100-year GWP value published by the Intergovernmental Panel on Climate Change (IPCC) in either its Second Assessment Report (SAR) (IPCC, 1995), or its Fourth Assessment A-3 Report (AR4) (IPCC, 2007). Both the 1995 IPCC SAR values and the 2007 IPCC AR4 values are published in table 2.14 of the 2007 IPCC AR4. The SAR GWP values are found in column “SAR (100-yr)” of Table 2.14.; the AR4 GWP values are found in column “100 yr” of Table 2.14.”

GOVERNMENTAL AGENCY is any public agency or subdivision thereof, including, but not limited to, any agency of the state, a county, a city, a district, an association of governments, or a joint power agency.

GROSS EXTERIOR ROOF AREA is the sum of the skylight area and the exterior roof/ceiling area.

GROSS EXTERIOR WALL AREA is the sum of the window area, door area, and exterior wall area.

HABITABLE SPACE is space in a building for living, sleeping, eating or cooking, excluding bathrooms, toilets, hallways, storage areas, closets, utility rooms and similar areas. (See also "occupiable space".)

HABITABLE STORY is a story that contains habitable space and that has at least 50 percent of its volume above grade.

HEALTHCARE FACILITY is any building or portion thereof licensed pursuant to California Health and Safety Code Division 2, Chapter 1, §1204 or Chapter 2, §1250.

HEAT CAPACITY (HC) is the measurable physical quantity that characterizes the amount of heat required to change a substance's temperature by a given amount.

HEAT PUMP is an appliance, that consists of one or more assemblies; that uses an indoor conditioning coil, a compressor, and a refrigerant-to-outdoor air heat exchanger to provide air heating; and that may also provide air cooling, dehumidifying, humidifying, circulating, or air cleaning.

HEAT PUMP WATER HEATER (HPWH) is a water heater that transfer thermal energy from one temperature level to a higher temperature level for the purpose of heating water, including all ancillary equipment such as fans, storage tanks, pumps, or controls necessary for the device to perform its function.

> **SINGLE-PASS HEAT PUMP WATER HEATER** is a HPWH which the cold water passes through the heat pump(s) once and is heated to the intended storage temperature.
>
> **MULTI-PASS HEAT PUMP WATER HEATER** is a HPWH which the cold water passes through the heat pump(s) multiple times, each time gaining a temperature increase, until the tank reaches the intended storage temperature.

HEATED SLAB FLOOR is a concrete floor either, on-grade, raised, or a lightweight concrete slab topping. Heating is provided by a system placed within or under the slab, and is sometimes referred to as a radiant slab floor.

HEATING EQUIPMENT is equipment used to provide mechanical heating for a room or rooms in a building.

HEATING SEASONAL PERFORMANCE FACTOR (HSPF) is the total heating output of a central air-conditioning heat pump (in Btu) during its normal use period for heating divided by the total electrical energy input (in watt-hours) during the same period, as determined using the applicable test method in the Appliance Efficiency Regulations.

HIGH-RISE RESIDENTIAL BUILDING is a building, other than a hotel/motel, of Occupancy Group R-2 or R-4 with four or more habitable stories.

HORTICULTURAL LIGHTING consists of luminaires used for plant growth and maintenance. Horticultural luminaires may have either plug-in or hard-wired connections for electric power.

HOTEL/MOTEL is a building or buildings that has six or more guest rooms or a lobby serving six or more guest rooms, where the guest rooms are intended or designed to be used, or which are used, rented, or hired out to be occupied, or which are occupied for sleeping purposes by guests, and all conditioned spaces within the same building envelope. Hotel/motel ~~also~~ includes all conditioned spaces which are (1) on the same property as the hotel/motel, (2) served by the same central heating, ventilation, and air-conditioning system as the hotel/motel, and (3) integrally related to the functioning of the hotel/motel as such, including, but not limited to, exhibition facilities, meeting and conference facilities, food service facilities, lobbies, and laundries. Hotel/motel also includes the following:

A building of Occupancy Group R-1,

Vacation timeshare properties and hotel or motel buildings of Occupancy Group R-2, and

The following types of Occupancy Group R-3:

Congregate residences for transient use,

Boarding houses of more than 6 guests, and

Alcohol or drug abuse recovery homes of more than 6 guests.

HVAC SYSTEM is a space-conditioning system or a ventilation system.

HVI 915 is the Home Ventilating Institute document titled "~~Home Ventilating Institute~~ HVI Loudness Testing and Rating Procedure," ~~2015~~2020 (HVI Publication 915~~-2015~~2020).

HVI 916 is the Home Ventilating Institute document titled "~~Home Ventilating Institute~~ HVI Airflow Test Procedure," ~~2015~~2020 (HVI Publication 916~~-2015~~2020).

HVI 920 is the Home Ventilating Institute document titled "~~Home Ventilating Institute~~HVI Product Performance Certification Procedure Including Verification And Challenge," ~~2015~~2020 (HVI Publication 920~~-2015~~2020).

IES HB (See IES Lighting ~~Handbook~~Library)

IES LIGHTING ~~HANDBOOK~~ LIBRARY Formerly called the **"**IES Lighting Handbook (IES HB)" is the Illuminating Engineering Society document titled "The IES Lighting ~~Handbook: Reference and Applications, Tenth Edition" (2011)~~Library™~~.~~."

INTEGRATED SEASONAL COEFFICIENT OF PERFORMANCE (ISCOP) A seasonal efficiency number that is a combined value based on the formula listed in AHRI Standard 920 of the two COP values for the heating season of a DX-DOAS unit water or air source heat pump, expressed in W/W.

INTEGRATED SEASONAL MOISTURE REMOVAL EFFICIENCY (ISMRE) A seasonal efficiency number that is a combined value based on the formula listed in AHRI Standard 920 of the four dehumidification moisture removal efficiency (MRE) ratings required for DX-DOAS units, expressed in lb. of moisture/kWh.

IES LM-79~~-08~~ is ~~the~~an American National Standards authored by the Illuminating Engineering Society ~~document~~and titled, "Approved Method: Optical and Electrical Measurements of Solid State Lighting Products~~IES Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products~~" (20~~0~~19~~8~~) (ANSI/IES LM-79-19).

IES LS-1-20 is the American National Standard authored by the Illuminating Engineering Society and titled "Lighting Science: Nomenclature and Definitions for Illuminating Engineering" 2020 (ANSI/IES LS-1-20)

IES TM-15~~-11~~ is an American National Standards authored by the Illuminating Engineering Society ~~document~~ and titled, "Technical Memorandum: Luminaire Classification System~~s~~ for Outdoor Luminaires" (~~2011~~2020) (ANSI/IES TM-15-20).

INDOOR GROWING is a type of CEH space in a building with a Skylight Roof Ratio less than 50 percent. Growing plants in a warehouse with or without skylights is an example of indoor growing.

INFILTRATION is uncontrolled inward air leakage from outside a building or unconditioned space, including leakage through cracks and interstices, around windows and doors, and through any other exterior or demising partition or pipe or duct penetration. See AIR BARRIER.

INFORMATION TECHNOLOGY EQUIPMENT (ITE) includes computers, data storage, servers, and network/communication equipment located in a computer room.

INTEGRATED ENERGY EFFICIENCY RATIO (IEER) is a single-number cooling part load efficiency figure of merit calculated as specified by the method described in ANSI/AHRI Standard 340/360/1230 . This metric replaces the IPLV for ducted and non-ducted units.

INTEGRATED HVAC SYSTEM is an HVAC system designed to handle both sensible and latent heat removal. Integrated HVAC systems may include, but are not limited to: HVAC systems with a sensible heat ratio of 0.65 or less and the capability of providing cooling, dedicated outdoor air systems, single package air conditioners with at least one refrigerant circuit providing hot gas reheat, and stand-alone dehumidifiers modified to allow external heat rejection.

INTEGRATED PART LOAD VALUE (IPLV) is a single-number cooling part-load efficiency figure of merit calculated as specified by the method described in ANSI/AHRI Standard 550/590 for use with chillers.

ISO 5801 is the International Standards Organization document titled "Fans- Performance testing using standardized airways". 2017 (ISO 5801:2017)

ISO ~~STANDARD~~ 17025 is the International Organization for Standardization document titled "General Criteria for the Competence of Testing and Calibration Laboratories", 2005 (~~ANSI/~~ISO/IEC ~~Standard~~ 17025:2005).

ISO 13256-1 is the International Organization for Standardization document titled "Water-source heat pumps -- Testing and rating for performance -- Part 1: Water-to-air and brine-to-air heat pumps," 2012~~1998~~ (ASHRAE 13256-1:1998 (RA 2012).

ISO 13256-2 is the International Organization for Standardization document titled "Water-source heat pumps -- Testing and rating for performance -- Part 1: Water-to-water and brine-to-water heat pumps," 2020~~1998~~ (CAN/CSA C13256-2-01 (R2020)).

ITE DESIGN LOAD is the combined power of all the ITE loads for which the ITE cooling system is designed.

LANGELIER SATURATION INDEX (LSI) is expressed as the difference between the actual system pH and the saturation pH. LSI indicates whether water will precipitate, dissolve, or be in equilibrium with calcium carbonate, and is a function of hardness, alkalinity, conductivity, pH and temperature.

LARGEST NET CAPACITY INCREMENT is the largest increase in capacity when switching between combinations of base compressors that is expected to occur under the compressed air system control scheme.

LIGHTING definitions:

Accent Lighting is directional lighting ~~designed~~ to emphasize ~~highlight or spotlight objects~~a particular object or surface feature, or to draw attention to a part of the field of view. It can be recessed, surface mounted, or mounted to a pendant, stem, or track, and can be display lighting. It shall not provide general lighting.

Astronomical Time-Switch Control is a lighting control that controls lighting based on the time of day and astronomical events such as sunset and sunrise, accounting for geographic location and calendar date.

Automatic Daylight Control adjusts the luminous flux of the electric lighting system in either a series of steps or by continuous dimming in response to available daylight. This kind of control uses one or more photosensors to detect changes in daylight illumination and then automatically adjusts the electric lighting levels in response.

Automatic Scheduling Control is a time-based lighting control that is capable of being programmed to reduce or turn off lighting power for a portion of the night and to turn off lighting power for the day.

Automatic Time Switch Control controls lighting based on the time of day.

Captive-Key Override is a type of lighting control in which the key that activates the override cannot be released when the lights are in the on position.

Chandelier is a ceiling-mounted, close-to-ceiling, or suspended decorative luminaire that uses glass, crystal, ornamental metals, or other decorative material.

Color Rendering Index (CRI) is a measure of the degree of color shift that objects undergo when illuminated by the lighting source as compared with the color of the same objects when illuminated by a reference source of comparable color temperature.~~the ability of a light source to reflect the color of illuminated objects with fidelity relative to ideal or natural light sources of the same color temperature.~~ CRI is calculated according to CIE 13.3.

Correlated Color Temperature (CCT) is the absolute temperature of a blackbody whose chromaticity most nearly resembles that of the light source. ~~a description of color of light relative to the chromaticity of the radiative emission of heated black body and reported in temperature units of Kelvin according to CIE 15~~

Colored light source is a light source designed and marketed as a colored light source and not designed or marketed for general lighting applications with either of the following characteristics maintained throughout all modes of operation including color changing operation:

(1) A Color Rendering Index (CRI) less than 40, as determined according to the method set forth in CIE Publication 13.3; or

(2) A Correlated Color Temperature ~~less than 2,200 K or greater than 7,000 K as determined according to the method set forth in~~as measured with ANSI/IES LM-66-20 or ANSI/IES LM-79-19~~,~~ (as appropriate) and calculated with CIE 15, which does not have a corresponding nominal CCT designation in ANSI C78.377-2017.

Compact Fluorescent Lamp is a fluorescent lamp with a small diameter glass tube (T5 or smaller) that is~~a single-ended fluorescent lamp with a T5 or smaller diameter glass tube that is~~ folded, bent, or bridged to create a long discharge path in a small volume. The lamp designs generally include an amalgam and a cold chamber, or a cold spot, to control the mercury vapor pressure and light output.

Countdown Timer Switch turns lighting or other loads ON when activated using one or more selectable countdown time periods and then automatically turns lighting or other loads OFF when the selected time period had elapsed.

Daylight Continuous Dimming Controls is a continuous dimming controls that vary the luminous flux in response to available daylight.

Decorative (Lighting/Luminaires) is lighting or luminaires installed only for aesthetic purposes and that does not serve as display lighting or general lighting. Decorative luminaires are chandeliers, sconces, lanterns, neon or cold cathode, light emitting diodes, theatrical projectors, moving lights, and light color panels, not providing general lighting or task lighting.

Dimmer is a device used to control the intensity of light emitted by a luminaire by controlling the voltage or current available to it.

Dimmer, Continuous means a dimmer that varies the luminous flux of the electric lighting system over a continuous range from the device's maximum light output to the device's minimum light output without visually apparent abrupt changes in light level between the various steps.

Dimmer, Forward Phase Cut, varies the luminous flux of the electric lighting system in which a portion of the alternating current voltage waveform supplying to the light source is removed.

Dimmer, Stepped varies the luminous flux of the electric lighting system in one or more predetermined discrete steps between maximum light output and OFF with changes in light level between adjacent steps being visually apparent.

Display Lighting ~~is lighting that provides a higher level of illuminance to a specific area than the level of surrounding ambient illuminance. Types of display lighting include:~~

Display Lighting, Floor~~:~~ is supplementary lighting that provides a higher level of illuminance to a specific area than the level of surrounding ambient illuminance required to highlight features, such as merchandise on a clothing rack or sculpture or free standing of artwork, which is not displayed against a wall.

Display Lighting, Wall~~:~~ is supplementary lighting that provides a higher level of illuminance to a specific area than the level of surrounding ambient illuminance required to highlight features, such as merchandise on a shelf or wall-mounted artwork, which is displayed on perimeter walls.

Display Lighting, Window~~:~~ is lighting that provides a higher level of illuminance to a specific area than the level of surrounding ambient illuminance of objects such as merchandise, goods, and artifacts, in a show window, to be viewed from the outside of a space through a window.

Display Lighting, Case~~:~~ is lighting that provides a higher level of illuminance to a specific area than the level of surrounding ambient illuminance of small art objects, artifacts, or valuable collections which involves customer inspection of very fine detail from outside of a glass enclosed display case.

Enclosed Luminaires are luminaires which contain enclosed lamp compartments where ventilation openings are less than 3 square inches per lamp in the lamp compartment as defined by UL 1598.

General Lighting is installed electric lighting that provides a uniform level of illumination throughout an area, exclusive of any provision for special visual tasks or decorative effect, exclusive of daylighting, and also known as ambient lighting.

GU-24 is the designation of a lamp holder and socket configuration, based on a coding system by the International Energy Consortium, where “G” indicates the broad type of two or more projecting contacts, such as pins or posts, “U” distinguishes between lamp and holder designs of similar type but that are not interchangeable due to electrical or mechanical requirements, and “24” indicates 24 millimeters center to center spacing of the electrical contact posts.

Illuminance is the area density of the luminous flux incident at a point on a surface.

Illumination is commonly used in a qualitative sense to designate the act of illuminating or the state of being illuminated.~~light incident on a surface of body, or the general condition of being illuminated.~~

Inseparable Solid State Lighting (SSL) Luminaire is a luminaire featuring solid state lighting components such as LEDs, light engines, and/or driver components which cannot be easily removed or replaced by the end user, thus requiring replacement of the entire luminaire. Removal of solid state lighting components may require the cutting of wires, use of a soldering iron, or damage to or destruction of the luminaire. If solid state lighting components are not removable without destruction to the luminaire, the luminaire is deemed inseparable.

Institutional Tuning is the process of adjusting the maximum light output of lighting systems to support visual needs or save energy. Institutional tuning differs from personal tuning in that the control strategy is implemented at the institutional rather than the individual user level, and maximum light level adjustments are available only to authorized personnel.

Lamp is an electrical appliance that produces optical radiation for the purpose of visual illumination, designed with a base to provide an electrical connection between the lamp and a luminaire, and designed to be installed into a luminaire. A lamp is not a luminaire and is not an LED retrofit kit.

Landscape Lighting is a type of outdoor lighting that is recessed into or mounted on the ground, paving, or raised deck, which is mounted less than 42 inches above grade or mounted onto trees or trellises, and that is intended to be aimed only at landscape features.

Lantern is an outdoor luminaire that uses an electric lamp to replicate the appearance of a pre-electric lantern, which used a flame to generate light.

Light is ~~the luminous equivalent of power and is properly called luminous flux.~~a form of radiant energy that is capable of exciting the retina and producing a visual sensation. The visible portion of the electromagnetic spectrum extends from about 380 to about 770 nanometers.

Lighting, or illumination, is ~~the application of light to achieve some practical or aesthetic effect~~commonly used in a qualitative or general sense to designate the act of illuminating or the state of being illuminated.

Lighting Control, Self-Contained is a unitary lighting control module that requires no additional components to be a fully functional lighting control.

Lighting Control System requires two or more components to be installed in the building to provide all of the functionality required to make up a fully functional and compliant lighting control.

Light Emitting Diode (LED) is a p-n junction semiconductor device that emits incoherent optical radiation when forward-biased. The optical emission may be in the ultraviolet, visible, or infrared wavelength regions.

LED Driver is a device composed of a power source and light emitting diode (LED) control circuitry designed to operate an LED package (component), an LED array (module), or an LED lamp.~~solid-state diode whose radiated output is a function of its physical construction, material used and exciting current. The output may be in the near ultraviolet, the visible or in the infrared regions of the spectrum.~~LED Driver is a power source that adjusts the voltage or current to LEDs, ranging in complexity from a resistor to a constant voltage or constant current power supply. LED Driver is also known and referred to as Lamp Control Gear.

LED Light Engine is an integrated assembly composed~~comprised~~ of light emitting diode (LED) packages ~~, LED~~ (components)~~,~~ or LED arrays~~, LED~~ (modules), ~~or~~as well as an LED driver~~,~~ and other optical, thermal, mechanical and electrical components. The device is intended to connect directly to the branch circuit through a custom connector compatible with the LED luminaire for which it was designed. ~~and~~It does not use an ANSI standard base. ~~(IES RP-16-17).~~

LED Retrofit Kit is a solid state lighting product intended to replace existing light sources and systems, including incandescent and fluorescent light sources, in previously installed luminaires that already comply with safety standards. These kits replace the existing light source and related electrical components, and are classified or certified to UL 1598C. They may employ an ANSI standard lamp base, either integral or connected to the retrofit by wire leads. LED retrofit kit does not include self-ballasted lamps.

Non-integrated LED lamp is an assembly composed of a light emitting diode (LED) array (module) or LED packages (components), and an ANSI standard base. The device is intended to connect to the LED driver of an LED luminaire through an ANSI standard lamp-holder (socket). The device cannot be connected directly to the branch circuit. (ANSI/IES LS-1-20~~RP-16-17~~).

Integrated LED lamp is an integrated assembly composed of light emitting diode (LED) packages (components) or LED arrays (modules), as well as an LED driver, an ANSI standard base, and other optical, thermal, mechanical and electrical components. The device is intended to connect directly to the branch circuit through a corresponding ANSI standard lamp-holder (socket). (ANSI/IES ~~RP-16~~LS-1-20~~-17~~).

Low Voltage is less than 90 volts.

~~**Lumen**~~ **Luminous Maintenance** (often referred to as "lumen flux maintenance" or "lumen maintenance") is the remaining luminous flux output, typically expressed as a percentage of initial luminous flux output, at any selected elapsed operating time. Luminous maintenance is the converse of luminous flux depreciation (or "lumen depreciation").~~is a strategy used to provide a precise, constant level of lighting from a lighting system regardless of the age of the lamps or the maintenance of the luminaires.~~

Luminaire is a complete lighting unit consisting of a light source such as a lamp or lamps, together with the parts that distribute the light, to position and protect the light source, and to connect ~~it~~the light source to the power supply.

Luminance is the luminous intensity of the source or surface divided by the area of the source or surface seen by the observer.

Luminous Efficacy is a measure of the luminous efficiency of a light source. It is the quotient of the total luminous flux emitted by the total light source power input, expressed in lm/W.

Luminous Flux is ~~visually evaluated radiant flux and defines "light" for purposes of lighting design and illuminating engineering~~the time rate of flow of radiant energy, evaluated in terms of a standardized visual response..

Marquee Lighting is a permanent lighting system consisting of one or more rows of many small lamps, including light emitting diodes (LEDs) lamps, tungsten lamps, low pressure discharge lamps or fiber optic lighting, attached to a canopy.

Multilevel Astronomical Time Switch is an Astronomical Time Switch Control that reduces lighting power in multiple steps.

Multilevel Lighting Control reduces power going to a lighting system in multiple steps.

Multiscene Programmable Control allows for two or more predefined lighting settings, in addition to all-OFF, for two or more groups of luminaires to suit multiple activities in the space.

Narrow Band Spectrum is a limited range of wavelengths (nm) concentric to a dominant peak wavelength in the visible spectrum. The limited range of wavelength shall be within 20 nm on either side of the peak wavelength at 50 percent of the peak wavelength's relative spectral power, and within 75 nm on either side of the peak wavelength at 10 percent of the peak wavelength's relative spectral power.

NEMA LSD 57 is the National Electrical Manufacturers Association document titled "Polyurethane Foam Application: Lighting Equipment," 2018 (NEMA LSD 57-2018).

NEMA SSL 7A is the National Electrical Manufacturers Association document titled "Phase Cut Dimming for Solid State Lighting: Basic Compatibility," 2015 (NEMA SSL 7A-2015).

Occupant Sensing Controls automatically control levels of illumination, allow for manual operation, and consist of the following types:

Motion Sensing Control is used outdoors, automatically reduces lighting power or turns lights OFF after an area is vacated of occupants, and automatically turns the lights ON when the area is occupied.

Occupant Sensing Control is used indoors, automatically reduces lighting power or turns lights OFF after an area is vacated of occupants and is capable of automatically turning the lighting load ON when an area is occupied.

Partial-ON Occupant or Motion Sensing Control automatically turns lights OFF after an area is vacated of occupants and is capable of automatically or manually turning ON part of the lighting load when an area is occupied.

Partial-OFF Occupant or Motion Sensing Control automatically dims the lighting or turns OFF part of the lighting load after an area is vacated of occupants, and is capable of automatically turning ON the lighting load or restoring it to full when an area is occupied.

Vacancy Sensing Control automatically turns lights OFF after an area is vacated of occupants but requires lights to be turned ON manually.

~~**Ornamental Lighting** for compliance with Part 6 is the following:~~

Ornamental (Lighting/Luminaires) is lighting or luminaires installed outdoor which are rated for 50 watts or less ~~which are rated for 30 watts or less th~~that ~~at~~ are post-top luminaires, lanterns, pendant luminaires, chandeliers, and marquee lighting, not providing general lighting or task lighting.

~~**Decorative Luminaires** installed indoor that are chandeliers, sconces, lanterns, neon and cold cathode, light emitting diodes, theatrical projectors, moving lights, and light color panels, not providing general lighting or task lighting.~~

Pendant Luminaire (Suspended Luminaire) is a luminaire that is hung from a ceiling by supports.

Permanently Installed lighting consists of luminaires that are affixed to land, within the meaning of Civil Code Sections 658 and 660, except as provided below. Permanently installed luminaires may be mounted inside or outside of a building or site. Permanently installed luminaires may have either plug-in or hardwired connections for electric power. Examples include track and flexible lighting systems; lighting attached to walls, ceilings, columns, inside or outside of permanently installed cabinets, internally illuminated cabinets, mounted on poles, in trees, or in the ground; attached to ceiling fans and integral to exhaust fans. Permanently installed lighting does not include portable lighting or lighting that is installed by the manufacturer in exhaust hoods for cooking equipment, refrigerated cases, food preparation equipment, and scientific and industrial equipment.

Photo Control automatically turns lights ON and OFF, or automatically adjusts lighting levels, in response to the amount of daylight that is available. A Photo Control may also be one component of a field assembled lighting system, the component having the capability to provide a signal proportional to the amount of daylight to a Lighting Control System to dim or brighten the electric lights in response.

Portable Lighting is lighting equipment designed for manual portability, with plug-in connections for electric power, that is: table and freestanding floor lamps; attached to modular furniture; workstation task luminaires; luminaires attached to workstation panels; attached to movable displays; or attached to other personal property.

Post Top Luminaire is an outdoor luminaire that is mounted directly on top of a lamp-post.

Precision Lighting is task lighting for commercial or industrial work that illuminates low contrast, finely detailed, or fast moving objects.

Radiant Power is the time- rate- of flow of radiant energy. It is expressed preferably in watts.

Radiant Energy is energy travelling in the form of electromagnetic waves. It is measured in units of energy such as joules or kilowatt hours.

Recessed Luminaire is a luminaire that is mounted in the ceiling or behind a wall or other surface with the opening of the luminaire flush with the surface.

Sconce is a wall mounted decorative accent luminaire.

Security Cameras are any operational camera used to enhance the safety and security within a general hardscape area.

Shut-off Controls is any lighting control capable of automatically shutting OFF the lighting in a space when the space is typically unoccupied.

Solid State Lighting (SSL) is a family of light sources that includes: semiconductor light emitting diodes (LEDs); and organic light emitting diodes (OLEDs).

Driver, when used in relation to solid state lighting, is a device that uses semiconductors to control and supply dc power for LED starting and operation.

Source (light) is the general term used to reference a source of light. It can refer variously to an electric lamp, a light emitting diode (LED), an entire luminaire with lamp and optical control, or fenestration for daylighting.

Special Effects Lighting is lighting installed to give off luminance instead of providing illuminance, which does not serve as general, task, or display lighting.

Task Lighting is lighting directed to a specific surface or area, providing illumination for visual tasks. Task lighting is not general lighting.~~that is not general lighting and that specifically illuminates a location where a task is performed.~~

Temporary Lighting is a lighting installation, with plug-in connections, that does not persist beyond 60 consecutive days or more than 120 days per year.

Track Lighting is a lighting equipment system consisting of an electrified power channel (track) and removable luminaires (lamp holders; track heads) that can be mechanically attached anywhere along the power channel. The luminaires can be repositioned and re-aimed as desired.~~that includes luminaires and a track, rails, or cables that both mount the system, and deliver electric power.~~ Track lighting includes the following types:

Line-Voltage Track Lighting is equipped with luminaires that, use line-voltage lamps or that are equipped with integral transformers at each luminaire.

Low-Voltage Track Lighting is equipped with remote transformers for use with low-voltage equipment along the entire length of track.

Track Lighting Integral Current Limiter consists of a current limiter integral to the end-feed housing of a manufactured line-voltage track lighting system.

Track Lighting Supplementary Overcurrent Protection Panel is a panelboard containing Supplementary Overcurrent Protection Devices as defined in Article 100 of the California Electrical Code, and used only with line voltage track lighting.

Track Mounted Luminaires are luminaires designed to be attached at any point along a track lighting system. Track mounted luminaires may be line-voltage or low-voltage.

Tunable Lighting are light sources with the ability to alter their luminous flux and/or spectral power distribution. Tunable lighting includes the following types:

Dim-to-warm (also known as warm dim) light source is capable of simultaneously decreasing its correlated color temperature as its light output decreases, typically resembling the change in color temperature of an incandescent lamp as it dims.

Tunable white light source is capable of adjusting its correlated color temperature while maintaining its relative light output and capable of adjusting its light output while maintaining its correlated color temperature.

Color tunable light source is capable of emitting highly saturated light of varying hues, as well as white light, for example by varying the relative intensity of individual emitters within the light source.

~~**Tuning** is the ability to set maximum light levels at a lower level than full lighting power.~~

~~**LIGHTING CONTROLS** consist of the following:~~

~~**Astronomical Time-Switch Control** is a lighting control that controls lighting based on the time of day and astronomical events such as sunset and sunrise, accounting for geographic location and calendar date.~~

~~**Automatic Daylight Control** uses one or more photosensors to detect changes in daylight illumination and then automatically adjusts the luminous flux of the electric lighting system in response.~~

Automatic Multilevel Daylight Control adjusts the luminous flux of the electric lighting system in either a series of steps or by continuous dimming in response to available daylight. This kind of control uses one or more photosensors to detect changes in daylight illumination and then automatically adjusts the electric lighting levels in response.

Automatic Scheduling Control is a time-based lighting control that is capable of being programmed to reduce or turn off lighting power for a portion of the night and to turn off lighting power for the day.

Automatic Time Switch Control controls lighting based on the time of day.

Captive-Key Override is a type of lighting control in which the key that activates the override cannot be released when the lights are in the on position.

Countdown Timer Switch turns lighting or other loads ON when activated using one or more selectable countdown time periods and then automatically turns lighting or other loads OFF when the selected time period had elapsed.

Dimmer is a lighting control that varies the luminous flux of the electric lighting system by changing the power used by or delivered to that lighting system.

Dimmer, Full-Range, or Continuous Dimmer, means a dimmer that varies the luminous flux of the electric lighting system over a continuous range from the device's maximum light output to the device's minimum light output without visually apparent abrupt changes in light level between the various steps.

Dimmer, Stepped varies the luminous flux of the electric lighting system in one or more predetermined discrete steps between maximum light output and OFF with changes in light level between adjacent steps being visually apparent.

Dimmer, Forward Phase Cut, varies the luminous flux of the electric lighting system in which a portion of the alternating current voltage waveform supplying to the light source is removed.

Lighting Control, Self-Contained is a unitary lighting control module that requires no additional components to be a fully functional lighting control.

Lighting Control System requires two or more components to be installed in the building to provide all of the functionality required to make up a fully functional and compliant lighting control.

Multilevel Astronomical Time Switch is an Astronomical Time Switch Control that reduces lighting power in multiple steps.

Multilevel Lighting Control reduces power going to a lighting system in multiple steps.

Multiscene Programmable Control allows for two or more predefined lighting settings, in addition to all-OFF, for two or more groups of luminaires to suit multiple activities in the space.

NEMA SSL 7A is the National Electrical Manufacturers Association document titled "Phase Cut Dimming for Solid State Lighting: Basic Compatibility," 2015 (NEMA SSL 7A-2015).

Occupant Sensing Controls automatically control levels of illumination, allow for manual operation, and consist of the following types:

Motion Sensor is used outdoors, automatically reduces lighting power or turns lights OFF after an area is vacated of occupants, and automatically turns the lights ON when the area is occupied.

Occupant Sensor is used indoors, automatically reduces lighting power or turns lights OFF after an area is vacated of occupants and is capable of automatically turning the lighting load ON when an area is occupied.

Partial-ON Occupant or Motion Sensor automatically turns lights OFF after an area is vacated of occupants and is capable of automatically or manually turning ON part of the lighting load when an area is occupied.

Partial-OFF Occupant or Motion Sensor automatically dims the lighting or turns OFF part of the lighting load after an area is vacated of occupants, and is capable of automatically turning ON the lighting load or restoring it to full when an area is occupied.

~~**Vacancy Sensor** automatically turns lights OFF after an area is vacated of occupants but requires lights to be turned ON manually.~~

~~**Part-Night Outdoor Lighting Control** is a light sensing and time-based lighting control device or system that is programmed to reduce or turn off the lighting power to an outdoor luminaire for a portion of the night.~~

~~**Photo Control** automatically turns lights ON and OFF, or automatically adjusts lighting levels, in response to the amount of daylight that is available. A Photo Control may also be one component of a field assembled lighting system, the component having the capability to provide a signal proportional to the amount of daylight to a Lighting Control System to dim or brighten the electric lights in response.~~

~~**Shut-off Controls** is any lighting control capable of automatically shutting OFF the lighting in a space when the space is typically unoccupied.~~

LISTED is in accordance with Article 100 of the California Electrical Code.

LOW-GWP REFRIGERANT is a compound used as a heat transfer fluid or gas that is: (A) any compound or blend of compounds, with a GWP Value less than 150; and (B) U.S. EPA Significant New Alternatives Policy (SNAP)-approved; and (C) not an ozone depleting substance as defined in Title 40 of the Code of Federal Regulations, Part 82, §82.3 (as amended March 10, 2017).

LOW-RISE RESIDENTIAL BUILDING is a building, other than a hotel/motel, that is Occupancy Group:

R-2, multifamily, with three habitable stories or less; or

R-3, single-family; or

U-building, located on a residential site.

LPG is liquefied petroleum gas.

MANUAL is capable of being operated by personal intervention.

MANUFACTURED DEVICE is any heating, cooling, ventilation, lighting, water heating, refrigeration, cooking, plumbing fitting, insulation, door, fenestration product, or any other appliance, device, equipment, or system subject to Sections 110.0 through 110.9 of Part 6.

MECHANICAL COOLING is lowering the temperature within a space using refrigerant compressors or absorbers, desiccant dehumidifiers, or other systems that require energy to directly condition the space. Systems that are solely energy recovery ventilation (ERV) or heat recovery ventilation (HRV) are not considered mechanical cooling. In nonresidential, ~~high-rise residential~~multifamily buildings, and hotel/motel buildings, cooling of a space by direct or indirect evaporation of water alone is not considered mechanical cooling.

MECHANICAL HEATING is raising the temperature within a space using electric resistance heaters, fossil fuel burners, heat pumps, or other systems that require energy to directly condition the space. Systems that only use solar energy or heat recovery as the heat source are not mechanical heating systems.

MERV is the minimum efficiency reporting value as determined by ASHRAE Standard 52.2 Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

METAL BUILDING is a complete integrated set of mutually dependent components and assemblies that form a building, which consists of a steel-framed superstructure and metal skin. This does not include structural glass or metal panels such as in a curtainwall system.

MICROCHANNEL CONDENSER is an air-cooled condenser for refrigeration systems which utilizes multiple small parallel gas flow passages in a flat configuration with fin surfaces bonded between the parallel gas passages.

MINISPLIT AIR CONDITIONERS AND HEAT PUMPS are air conditioner or heat pump systems that have a single outdoor section and one or more indoor sections. The indoor sections cycle on and off in unison in response to a single indoor thermostat.

MODELING ASSUMPTIONS are the conditions (such as weather conditions, thermostat settings and schedules, internal gain schedules, etc.) that are used for calculating a building's annual energy consumption as specified in the Alternative Calculation Methods (ACM) Approval Manuals.

Multifamily Building is any of the following:

A building of Occupancy Group R-2, other than a hotel/motel building or timeshare property,

A building of Occupancy Group R-3 that is a nontransient congregate residence, other than boarding houses of more than 6 guests and alcohol or drug abuse recovery homes of more than 6 guests, or

A building of Occupancy Group R-4.

MULTIPLE-SPLIT AIR CONDITIONERS AND HEAT PUMPS are air conditioner or heat pump systems that have two or more indoor sections. The indoor sections operate independently and can be used to condition multiple zones in response to multiple indoor thermostats.

MULTIPLE ZONE SYSTEM is an air distribution system that supplies air to more than one Space Conditioning Zone, each of which has one or more devices (such as dampers, cooling coils, and heating coils) that regulate airflow, cooling, or heating capacity to the zone.

NATURAL GAS AVAILABILITY. For newly constructed buildings, natural gas is available if a gas service line can be connected to the site without a gas main extension. For addition and alteration, natural gas is available if a gas service line is connected to the existing building.

NEEA is the Northwest Energy Efficiency Alliance.

NEEA ADVANCED WATER HEATER SPECIFICATION is the Northwest Energy Efficiency Alliance (NEEA) specification version ~~6.0~~7.0 for heat pump water heaters.

NET EXHAUST FLOW RATE is the exhaust flow rate for a hood, minus any internal discharge makeup airflow rate.

NEWLY CONDITIONED SPACE is any space being converted from unconditioned to directly conditioned or indirectly conditioned space. Newly conditioned space must comply with the requirements for an addition. See Section 141.0 for nonresidential occupancies and Section 150.2 for residential occupancies.

NEWLY CONSTRUCTED BUILDING is a building that has never been used or occupied for any purpose.

NONDUCTED SYSTEM is an air conditioner or heat pump that is permanently installed; directly heats or cools air within the conditioned space; and uses one or more indoor coils that are mounted on walls or ceilings within the conditioned space. The system may be of a modular design that allows for combining multiple outdoor coils and compressors to create one unified system.

NONRESIDENTIAL BUILDING is any building which is identified in the California Building Code Table; Description of Occupancy as Group A, B, E, F, H, I, M, or S, and is a U; as defined by Part 2 of Title 24 of the California Code or Regulation.
NOTE: Requirements for high-rise residential buildings and hotels/motels are included in the nonresidential sections of Part 6.

NONRESIDENTIAL BUILDING OCCUPANCY TYPES are building types in which a minimum of 90 percent of the building floor area functions as one of the following, which do not qualify as any other Building Occupancy Types more specifically defined in Section 100.1, and which do not have a combined total of more than 10 percent of the area functioning of any Nonresidential Function Areas specifically defined in Section 100.1:

Assembly Building is a building with meeting halls in which people gather for civic, social, or recreational activities. These include civic centers, convention centers and auditoriums.

Commercial and Industrial Storage Building is a building with building floor areas used for storing items.

Financial Institution Building is a building with floor areas used by an institution which collects funds from the public and places them in financial assets, such as deposits, loans, and bonds.

Industrial/Manufacturing Facility Building is a building with building floor areas used for performing a craft, assembly or manufacturing operation.

Grocery Store Building is a building with building floor areas used for the display and sale of food.

Gymnasium Building is a building with building floor areas used for physical exercises and recreational sport events and activities.

Library Building is a building with building floor area used for repository of literary materials, and for reading reference such as books, periodicals, newspapers, pamphlets and prints.

Museum Building is a building with building floor areas in which objects of historical, scientific, artistic or cultural interests are curated, treated, preserved, exhibited and stored.

Office Building is a building of CBC Group B Occupancy with building floor areas in which business, clerical or professional activities are conducted.

Parking Garage Building is a building with building floor areas used for parking vehicles, and consists of at least a roof over the parking area enclosed with walls on all sides. The building includes areas for vehicle maneuvering to reach designated parking spaces. If the roof of a parking structure is also used for parking, the section without an overhead roof is considered an outdoor parking lot instead of a parking garage.

Religious Facility Building is a building with building floor areas used for assembly of people to worship.

Restaurant Building is a building with building floor areas in which food and drink are prepared and served to customers in return for money.

Retail Store Building is a building with building floor areas used for the display and sale of merchandise except food.

School Building is a building used by an educational institution. The building floor area can include classrooms or educational laboratories, and may include an auditorium, gymnasium, kitchen, library, multipurpose room, cafeteria, student union, or workroom. A maintenance or storage building is not a school building.

Sports Arena Building is a building with building floor areas used for public viewing of sporting events and activities. Sports arenas are classified according to the number of spectators they are able to accommodate, as follows:

Class I Facility is used for competition play for 5000 or more spectators.

Class II Facility is used for competition play for up to 5000 spectators.

Class III Facility is used for competition play for up to 2000 spectators.

Class IV Facility is normally used for recreational play and there is limited or no provision for spectators.

Motion Picture Theater Building is a building with building floor areas used for showing motion pictures to audiences.

Performance Arts Theater Building is a building with building floor areas used for showing performing arts that include plays, music or dance to audiences.

NONRESIDENTIAL COMPLIANCE MANUAL is the manual developed by the Commission, under Section 25402.1(e) of the Public Resources Code, to aid designers, builders, and contractors in meeting the energy efficiency requirements for nonresidential, high-rise residential, and hotel/motel buildings.

NONRESIDENTIAL FUNCTION AREAS are those areas, rooms, and spaces within Nonresidential Buildings that fall within the following particular definitions, and are defined according to the most specific definition:

Aisle Way is the passage or walkway between storage racks permanently anchored to the floor in a Commercial or Industrial Storage Building, where the racks are used to store materials such as goods and merchandise.

Atrium is a large-volume indoor space created by openings between two or more stories but is not used for an enclosed stairway, elevator hoistway, escalator opening, or utility shaft for plumbing, electrical, air-conditioning or other equipment.

Audience Seating Area is a room or area with fixed seats for public meetings or gatherings.

Auditorium Area is a room or area with a stage and fixed seats used for public meetings or gatherings.

Auto Repair / Maintenance Area is an area used to repair or maintain automotive equipment and/or vehicles.

Barber, Beauty Salon, Spa Area is a room or area in which the primary activity is manicures, pedicures, facials, or the cutting or styling of hair.

Civic Meeting Place Area is a space in a government building designed or used for public debate, discussion, or public meetings of governmental bodies.

Classroom, Lecture, Training, Vocational Area is a room or area where an audience or class receives instruction.

Commercial and Industrial Storage, Commercial and Industrial Area includes the following:

Warehouse is a room or areas used for storing of items such as goods, merchandise and materials.

Shipping & Handling is a room or areas used for packing, wrapping, labeling and shipping out goods, merchandise and materials.

Commercial and Industrial Storage Area (refrigerated) is a room or area used for storing items where mechanical refrigeration is used to maintain the space temperature at 55° F or less.

Convention, Conference, Multipurpose and Meeting Area are rooms or areas that are designed or used for meetings, conventions or events, and that have neither fixed seating nor fixed staging.

Copy Room is a room or area used for copying, scanning, or binding documents.

Corridor Area is a passageway or route into which compartments or rooms open.

Dining Areas include the following:

Bar/Lounge is a room or area where wait staff serve patrons with liquor, cocktails, wine and beer in a relaxed atmosphere, usually with tables and chairs.

Fine Dining is a room or area where wait staff serve patrons with meals in an elegant and formal atmosphere.

Cafeteria/Fast Food is a room or area where customers pick up their food at a counter and there is little or no wait staff or table service.

Family Dining is a room or area where wait staff serve patrons with meals in a causal atmosphere.

Electrical/Mechanical/Telephone Room is a room in which the building's electrical switchbox or control panels, telephone switchbox, and/or HVAC controls or equipment is located.

Exercise/Fitness Center and Gymnasium Area is a room or area equipped for gymnastics, exercise equipment, or indoor athletic activities.

Financial Transaction Area is a room or area used by an institution that collects funds from the public and places them in financial assets such as deposits, loans and bonds, and includes tellers, work stations, and customers' waiting areas; to complete financial transactions. Financial transaction areas do not include private offices, hallways, restrooms, or other support areas.

General Manufacturing, Commercial and Industrial Work Area is a room or area in which an art, craft, assembly or manufacturing operation is performed. Lighting installed in these areas is classified as follows:

High bay: Where the luminaires are 25 feet or more above the floor.

Low bay: Where the luminaires are less than 25 feet above the floor.

Precision: Where visual tasks of small size or fine detail such as electronics assembly, fine woodworking, metal lathe operation, fine hand painting and finishing, egg processing operations, or tasks of similar visual difficulty are performed.

Healthcare Facilities may have a room or area as follows:

Exam/Treatment Room is a room or area that does not provide overnight patient care and that is used to provide physical and mental care through medical, dental, or psychological examination and treatment, including laboratories and treatment spaces.

Imaging Room is a diagnostic room and area for application and review of results from imaging technologies including x-ray, ultrasound, computerized tomography (CT), and magnetic resonance imaging (MRI).

Medical Supply Room is a room or area used for storing medical supplies.

Nursery is a room or area for providing medical care for newly born infants.

Nurse's Station is a room or area where health care staff work when not directly interacting with patients.

Operating Room is a room or area where surgical operations are carried out in a sterile environment. This category also applies to veterinary operating rooms.

Patient Room is a room or area that is occupied by one or more patients during a stay in a healthcare facility or hospital.

Physical Therapy Room is a room or area for providing physical therapy treatment.

Recovery Room is a room or area that is equipped with apparatus for meeting postoperative emergencies and in which surgical patients are kept during the immediate postoperative period for care and recovery from anesthesia.

Hotel Function Area is a hotel room or area such as a hotel ballroom, meeting room, exhibit hall or conference room, together with prefunction areas and other spaces ancillary to its function.

Kitchen/Food Preparation Area is a room or area with cooking facilities or where food is prepared.

Laundry Area is a room or area primarily designed or used for laundering activities.

Library Area is a room or area primarily designed or used as a repository for literary materials, such as books, periodicals, newspapers, pamphlets and prints, kept for reading or reference.

Reading Area is a room or area in a library containing tables, chairs, or desks for patrons to use for the purpose of reading books and other reference documents. Library reading areas include reading, circulation, and checkout areas. Reading areas do not include private offices, meeting, photocopy, or other rooms not used specifically for reading by library patrons.

Stack Area is a room or area in a library with grouping of shelving sections. Stack aisles include pedestrian paths located in stack areas.

Lobby, Main Entry ~~Lobby~~ is the contiguous area in buildings including hotel/motel that is directly located by the main entrance of the building through which persons must pass, including any ancillary reception, waiting and seating areas.

Locker Room is a room or area for changing clothing, sometimes equipped with lockers.

Lounge/Breakroom or Waiting Area is a room or area in which people sit, wait and relax.

Mall is a roofed or covered common pedestrian area within a mall building that serves as access for two or more tenants.

Multipurpose Room is a room that can be used for multipurpose activities such as meetings, instructional activities and social gatherings. Multipurpose rooms are typically found in offices, schools, convention centers, and assisted living facilities.

Museum Areas include the following:

Exhibit/Display is a room or area in a museum that has for its primary purpose exhibitions, having neither fixed seating nor fixed staging. An exhibit does not include a gallery or other place where art is for sale. An exhibit does not include a lobby, conference room, or other occupancies where the primary function is not exhibitions.

Restoration Room is a room or area in which the primary function is the care of works of artistic, historical, or scientific value. A restoration does not include a gallery or other place where art is for sale. A restoration does not include a lobby, conference room, or other occupancies where the primary function is not the care or exhibit of works of artistic, historical, or scientific value.

Office Area is a room or area in a building of CBC Group B Occupancy in which business, clerical or professional activities are conducted.

Parking Garage Areas include the following:

Parking Zone and Ramps in a Parking Garage is used for the purpose of parking and maneuvering of vehicles ~~on a single floor~~. Parking areas include sloping floors of a parking garage. Ramps and driveways specifically for the purpose of moving vehicles between floors of a parking garage. Parking areas and ramps do not include Daylight ~~Transition~~ Adaptation Zones~~, Dedicated Ramps,~~ or the roof of a Parking Garage, which may be present in a Parking Garage.

Daylight Adaptation Zone in a Parking Garage is the interior path of travel for vehicles ~~to enter~~adjacent to the entrance or exit of a parking garage as needed for visual adaptation to transition from exterior daylight levels to interior light levels. Daylight ~~Transition~~ Adaptation Zones only include the path of vehicular travel and do not include adjacent Parking Areas.

~~**Dedicated Ramps** in Parking Garages are driveways specifically for the purpose of moving vehicles between floors of a parking garage and which have no adjacent parking. Dedicated ramps do not include sloping floors of a parking structure, which are considered Parking Areas.~~

Pharmacy Area is a room or area where medicinal drugs are dispensed and sold, usually in a retail store.

Religious Worship Area is a room or area in which the primary function is for an assembly of people to worship. Religious worship does not include classrooms, offices, or other areas in which the primary function is not for an assembly of people to worship.

Restroom is a room providing personal facilities such as toilets and washbasins.

Retail Sales Areas include the following:

Grocery Sales is a room or area that has as its primary purpose the sale of foodstuffs requiring additional preparation prior to consumption.

Retail Merchandise Sales is a room or area in which the primary activity is the sale of merchandise.

Fitting Room is a room or area where the retail customers try out clothing before purchasing.

Server Room is a room smaller than 500 square feet, within a larger building, in which networking equipment and Information Technology (IT) server equipment is housed, and a minimum of five IT servers are installed in frame racks.

Server Aisle is an aisle of racks of Information Technology (IT) server equipment in a Server Room. While networking equipment may also be housed on these racks, it is largely a room to manage server equipment.

Playing Area for Sports Arena is an area where sports are played in front an audience.

~~Scientific~~ Laboratory, Scientific Area is a room or area where research, experiments, and measurement in medical and physical sciences are performed requiring examination of fine details. The area may include workbenches, countertops, scientific instruments, and associated floor spaces. Scientific laboratory does not refer to film, computer, and other laboratories where scientific experiments are not performed.

Stairs is a series of steps providing passage for persons from one level of a building to another, including escalators.

Stairwell is a vertical shaft in which stairs are located.

Support Area is a room or area used as a passageway, utility room, storage space, or other type of space associated with or secondary to the function of an occupancy that is listed in these regulations.

Tenant Lease Area is a room or area in a building intended for lease for which a specific tenant is not identified at the time of building permit application.

Theater Areas include the following:

Motion Picture Theater is an assembly room or area with rows of seats for the showing of motion pictures.

Performance Theater is an assembly room or area with rows of seats for the viewing of dramatic performances, lectures, musical events and similar live performances.

Transportation Function Areas include the following:

Baggage Area is a room or area in a transportation facility such as an airport where the travelers reclaim their baggage.

Ticketing Area is a room or area in a transportation facility such as an airport or a train station where travelers purchase tickets, check in baggage, or inquire about travel information.

Videoconferencing Studio is a room or area with permanently installed videoconferencing cameras, audio equipment, and playback equipment for both audio-based and video-based two-way communication between local and remote sites.

NONSTANDARD PART LOAD VALUE (NPLV) is a single- number part-load efficiency figure of merit for chillers referenced to conditions other than IPLV conditions. (See "integrated part load value.")

NORTH-FACING (See "orientation.")

OCCUPANCY is the purpose for which a building or part thereof is used or intended to be used.

OCCUPANCY, HUMAN is any occupancy that is intended primarily for human activities.

OCCUPANCY GROUP is a classification of occupancy defined in Chapter 3 of the CBC (Title 24, Part 2).

OCCUPANCY TYPE is a description of occupancy that is more specific than occupancy group and that relates to determining the amount of lighting, ventilation, or other services needed for that portion of the building.

OCCUPIABLE SPACE is any enclosed space that is intended for human occupancy, including all habitable spaces as well as bathrooms, toilets, closets, halls, storage and utility areas, laundry areas, and similar areas. (See also “habitable space”.)

OCCUPIED STANDBY MODE is when a zone is scheduled to be occupied and an occupant sensor indicates zero population within the zone.

ONLINE CAPACITY is the total combined capacity in actual cubic feet per minute of compressed air at a given pressure from all online compressors.

ONLINE COMPRESSORS are all the compressors that are physically connected to compressed air piping and are available to serve peak load. Online compressors do not include back up compressors whose only purpose is to be available when an online compressor fails.

OPEN COOLING TOWER is an open, or direct contact, cooling tower which exposes water directly to the cooling atmosphere, thereby transferring the source heat load from the water directly to the air by a combination of heat and mass transfer.

OPENADR 2.0a is the OpenADR Alliance document titled, “OpenADR 2.0 Profile Specification A Profile,” 2011.

OPENADR 2.0b is the OpenADR Alliance document titled, “OpenADR 2.0 Profile Specification B Profile,” 2015.

OPERABLE FENESTRATION is designed to be opened or closed.

OPTIMUM START CONTROLS are controls that are designed to automatically adjust the start time of a space conditioning system each day with the intent of bringing the space to desired occupied temperature levels at the beginning of scheduled occupancy.

OPTIMUM STOP CONROLS are controls that are designed to setup or setback thermostat setpoints before scheduled unoccupied periods based upon the thermal lag and acceptable drift in space temperature that is within comfort limits.

OSHPD is the California Office of Statewide Health Planning and Development

ORIENTATION, CARDINAL is one of the four principal directional indicators, north, east, south, and west, which are marked on a compass, also called cardinal directions.

ORIENTATION, EAST-FACING is oriented to within 45° of true east, including 45°00'00" south of east (SE), but excluding 45°00'00" north of east (NE).

ORIENTATION, NORTH-FACING is oriented to within 45° of true north, including 45°00'00" east of north (NE), but excluding 45°00'00" west of north (NW).

ORIENTATION, SOUTH-FACING is oriented to within 45° of true south including 45°00'00" west of south (SW), but excluding 45°00'00" east of south (SE).

ORIENTATION, WEST-FACING is oriented to within 45° of true west, including 45°00'00" north of due west (NW), but excluding 45°00'00" south of west (SW).

OUTDOOR AIR (Outside air) is air taken from outdoors and not previously circulated in the building.

OUTDOOR LIGHTING is electrical lighting used to illuminate outdoor areas.

OUTDOOR AREAS are areas external to a building. These include but are not limited to the following areas:

Building entrance way is the external area of any operable doorway in or out of a building, including overhead doors. These areas serve any doorway, set of doors (including elevator doors such as in parking garages), turnstile, vestibule, or other form of portal that is ordinarily used to gain access to the building by its users and occupants. Where buildings have separate one-way doors to enter and to leave, this also includes any area serving any doors ordinarily used to leave the building.

Building façade is the exterior surfaces of a building, not including horizontal roofing, signs, and surfaces not visible from any public accessible viewing location.

Canopy is a permanent structure, other than a parking garage area, consisting of a roof and supporting building elements, with the area beneath at least partially open to the elements. A canopy may be freestanding or attached to surrounding structures. A canopy roof may serve as the floor of a structure above.

Carport is a covered, open-sided structure designed or used primarily for the purpose of parking vehicles, having a roof over the parking area. Typically, carports are free-standing or projected from the side of the building and are only two or fewer car lengths deep. A Carport is not a Garage.

Hardscape is the area of an improvement to a site that is paved or has other structural features such as curbs, plazas, entries, parking lots, site roadways, driveways, walkways, sidewalks, bikeways, water features and pools, storage or service yards, loading docks, amphitheaters, outdoor sales lots, and private monuments and statuary.

Outdoor sales frontage is the portion of the perimeter of an outdoor sales area immediately adjacent to a public street, road, or sidewalk.

Outdoor sales lot is an uncovered paved area used exclusively for the display of vehicles, equipment or other merchandise for sale. All internal and adjacent access drives, walkway areas, employee and customer parking areas, vehicle service or storage areas are not outdoor sales lot areas, but are considered hardscape.

Parking lot is an uncovered area for the purpose of parking vehicles. Parking lot is a type of hardscape.

Paved area is an area that is paved with concrete, asphalt, stone, brick, gravel, or other improved wearing surface, including the curb.

Principal viewing location is anywhere along the adjacent highway, street, road or sidewalk running parallel to an outdoor sales frontage.

Public monuments are statuary, buildings, structures, and/or hardscape on public land.

Outdoor Sales canopy is a canopy specifically to cover and protect an outdoor sales area.

Stairways and Ramps. Stairways are one or more flights of stairs with the necessary landings and platforms connecting them to form a continuous and uninterrupted passage from one level to another. An exterior stairway is open on at least one side, except for required structural columns, beams, handrails and guards. The adjoining open areas shall be either yards, courts or public ways. The other sides of the exterior stairway need not be open. Ramps are walking surfaces with a slope steeper than 5 percent.

Vehicle service station is a gasoline, natural gas, diesel, or other fuel dispensing station.

OUTDOOR LIGHTING ZONE is a geographic area designated by the California Energy Commission in accordance with Part 1, Section 10-114, that determines requirements for outdoor lighting, including lighting power densities and specific control, equipment or performance requirements. Lighting zones are numbered LZ0, LZ1, LZ2, LZ3 and LZ4.

OVERHANG is a contiguous opaque surface, oriented horizontally and projecting outward horizontally from an exterior vertical surface.

~~**OVERHANG PROJECTION** is the horizontal distance, measured outward horizontally from the surface of exposed exterior glazing at the head of a window to the outward edge of an overhang.~~

~~**OVERHANG RISE** is the vertical distance between the projected edge of an overhang and the sill of the vertical fenestration below it.~~

PART 1 means Part 1 of Title 24 of the California Code of Regulations.

PART 6 means Part 6 of Title 24 of the California Code of Regulations.

PART-LOAD OPERATION occurs when a system or device is operating below its maximum rated capacity.

PARTICLE SIZE EFFICIENCY is the fraction (percentage) of particles that are captured on air filter equipment as determined during rating tests conducted in accordance with ASHRAE Standard 52.2 or AHRI Standard 680. Particle Size Efficiency is measured in three particle size ranges: 0.3-1.0, 1.0-3.0, 3.0-10 microns.

Photosynthetic photon efficacy (PPE) is photosynthetic photon flux divided by input electric power in units of micromoles per second per watt, or micromoles per joule as defined by ANSI/ASABE S640.

Photosynthetic photon flux (PPF) is the rate of flow of photons between 400 to 700 nanometers in wavelength from a radiation source as defined by ANSI/ASABE S640.

POOLS,~~ ANSI/NSPI-5~~ ANSI/APSP/ICC-5 is the American National Standards Institute and National Spa and Pool Institute document titled "American National Standard for Residential Inground Swimming Pools" ~~2016~~2012 (ANSI/~~NSPI-~~ APSP/ICC 5a ~~2016~~2012) with Addenda A.

POOLS, AUXILIARY POOL LOADS are features or devices that circulate pool water in addition to that required for pool filtration, including, but not limited to, solar pool heating systems, filter backwashing, pool cleaners, waterfalls, fountains, and spas.

POOLS, BACKWASH VALVE is a diverter valve designed to backwash filters located between the circulation pump and the filter, including, but not limited to, slide, push-pull, multiport, and full-flow valves.

POOLS, MULTISPEED PUMP is a pump capable of operating at two or more speeds and includes two-speed and variable-speed pumps.

POOLS, NSF/ANSI/CAN 50 is the NSF International (formerly National Sanitation Foundation) Standard and American National Standards Institute document titled "~~Circulation System Components and Related Materials for Swimming Pools, Spas/Hot Tubs~~ Equipment and Chemicals for Swimming Pools, Spas, Hot Tubs, and Other Recreational Water Facilities" ~~2016~~2019 (NSF/ANSI/CAN 50 – ~~2016~~2019).

POOLS, RESIDENTIAL are permanently installed residential in-ground swimming pools intended for use by a single-family home for noncommercial purposes and with dimensions as defined in ANSI/NSPI-5.

PRESSURE BOUNDARY is the primary air enclosure boundary separating indoor and outdoor air. For example, a volume that has more leakage to the outside than to the conditioned space would be considered outside the pressure boundary. Exposed earth in a crawl space or basement shall not be considered part of the pressure boundary.

PRIMARY AIRFLOW is the airflow (~~cfm~~ cfm or L/s) supplied to the zone from the air-handling unit at which the outdoor air intake is located. It includes outdoor intake air and recirculated air from that air-handling unit but does not include air transferred or air recirculated to the zone by other means.

PRIMARY STORAGE is compressed air storage located upstream of the distribution system and any pressure flow regulators.

PROCESS is an activity or treatment that is not related to the space conditioning, lighting, service water heating, or ventilating of a building as it relates to human occupancy.

PROCESS BOILER is a type of boiler with a capacity (rated maximum input) of 300,000 Btus per hour (Btu/h) or more that serves a process.

PROCESS, COVERED is a process that is regulated under Part 6, Sections 120.6 and 140.9, which includes computer rooms, data centers, elevators, escalators and moving walkways, laboratories, enclosed parking garages, commercial kitchens, refrigerated warehouses, commercial refrigeration, compressed air systems, ~~and~~ process boilers, and controlled environment horticultural spaces.

PROCESS, EXEMPT is a process that is not a covered process regulated under Part 6.

PROCESS LOAD is an energy load resulting from a process.

PROCESS SPACE is a nonresidential space that is designed to be thermostatically controlled to maintain a process environment temperature less than 55º F or to maintain a process environment temperature greater than 90º F for the whole space that the system serves, or that is a space with a space-conditioning system designed and controlled to be incapable of operating at temperatures above 55º F or incapable of operating at temperatures below 90º F at design conditions.

PROPOSED DESIGN BUILDING is a building that is simulated by Commission-approved compliance software to determine the energy consumption resulting from all of the characteristics and energy consuming features that are actually proposed for a building, as specified by the Alternative Calculation Method (ACM) Approval Manual.

PUBLIC AREAS are spaces generally open to the public at large, customers or congregation members, or similar spaces where occupants need to be prevented from controlling lights for safety, security, or business reasons.

R-VALUE is the measure of the thermal resistance of insulation or any material or building component expressed in ft^2-hr-°F/Btu.

RADIANT BARRIER is a highly reflective, low emitting material installed at the underside surface of the roof deck and the inside surface of gable ends or other exterior vertical surfaces in attics to reduce solar heat gain.

RAISED FLOOR is a floor (partition) over a crawl space, or an unconditioned space, or ambient air.

READILY ACCESSIBLE is capable of being reached quickly for operation, repair or inspection, without requiring climbing or removing obstacles, or resorting to access equipment.

RECOOL is the cooling of air that has been previously heated by space-conditioning equipment or systems serving the same building.

RECOVERED ENERGY is energy used in a building that (1) is recovered from space conditioning, service water heating, lighting, or process equipment after the energy has performed its original function; (2) provides space conditioning, service water heating, or lighting; and (3) would otherwise be wasted.

REFERENCE APPENDICES is the support document for the Building Energy Efficiency Standards and the ACM Approval Manuals. The document consists of three sections: the Reference Joint Appendices (JA), the Reference Residential Appendices (RA), and the Reference Nonresidential Appendices (NA).

REFLECTANCE, SOLAR is the ratio of the reflected solar flux to the incident solar flux.

REFRIGERATED CASE is a manufactured commercial refrigerator or freezer, including but not limited to display cases, reach-in cabinets, meat cases, and frozen food and soda fountain units.

REFRIGERATED SPACE is a space constructed for storage or handling of products, where mechanical refrigeration is used to maintain the space temperature at 55° F or less.

REFRIGERATED WAREHOUSE is a building or a space greater than or equal to 3,000 square feet constructed for storage or handling of products, where mechanical refrigeration is used to maintain the space temperature at 55° F or less.

REHEAT is the heating of air that has been previously cooled by cooling equipment or supplied by an economizer.

RELOCATABLE PUBLIC SCHOOL BUILDING is a relocatable building as defined by Title 24, Part 1, Section 4-314, which is subject to Title 24, Part 1, Chapter 4, Group 1.

REPAIR is the reconstruction or renewal for the purpose of maintenance of any component, system, or equipment of an existing building. Repairs shall not increase the preexisting energy consumption of the repaired component, system, or equipment. Replacement of any component, system, or equipment for which there are requirements in the Standards is considered an alteration and not a repair.

RESIDENTIAL BUILDING (See "high-rise residential building" and "low-rise residential building.")

RESIDENTIAL COMPLIANCE MANUAL is the manual developed by the Commission, under Section 25402.1 of the Public Resources Code, to aid designers, builders, and contractors in meeting Energy Efficiency Standards for low-rise residential buildings.

RESIDENTIAL SPACE TYPE is one of the following:

Bathroom is a room or area containing a sink used for personal hygiene, toilet, shower, or a tub.

Closet is a nonhabitable room used for the storage of linens, household supplies, clothing, nonperishable food, or similar uses, and which is not a hallway or passageway.

Garage is a nonhabitable building or portion of building, attached to or detached from a residential dwelling unit, in which motor vehicles are parked.

Kitchen is a room or area used for cooking, food storage and preparation and washing dishes, including associated counter tops and cabinets, refrigerator, stove, ovens, and floor area.

Laundry is a nonhabitable room or space which contains plumbing and electrical connections for a washing machine or clothes dryer.

Storage building is a nonhabitable detached building used for the storage of tools, garden equipment, or miscellaneous items.

Utility room is a nonhabitable room or building which contains only HVAC, plumbing, or electrical controls or equipment; and which is not a bathroom, closet, garage, or laundry room.

RESNET 380 is the Residential Energy Services Network document titled "Standard for Testing Airtightness of Building Enclosures, Dwelling Unit, and Sleeping Unit Enclosures, Airtightness of Heating and Cooling Air Distribution Systems, and Airflow of Mechanical Ventilation Systems" ~~2016~~2019 (ANSI/RESNET/ICC 380-~~2016~~2019).

ROOF is the outside cover of a building or structure including the structural supports, decking, and top layer that is exposed to the outside with a slope less than 60° from the horizontal.

ROOF, LOW-SLOPED is a roof that has a ratio of rise to run of less than 2:12 (9.5° from the horizontal).

ROOF, STEEP-SLOPED is a roof that has a ratio of rise to run of greater than or equal to 2:12 (9.5° from the horizontal).

ROOFING PRODUCT is the top layer of the roof that is exposed to the outside, which has properties including but not limited to solar reflectance, thermal emittance, and mass.

ROOF RECOVER is the process of installing an additional roof covering over a prepared existing roof covering without removing the existing roof covering.

ROOF RECOVER BOARD is a rigid type board, installed directly below a low-sloped roof membrane, with or without above deck thermal insulation, to: (a) improve a roof system's compressive strength, (b) physically separate the roof membrane from the thermal insulation, or (c) physically separate a new roof covering from an underlying roof membrane as part of a roof overlay project.

ROOF REPLACEMENT is the process of removing the existing roof covering, repairing any damaged substrate and installing a new roof covering.

RUNOUT is piping that is no more than 12 feet long and that connects to a fixture or an individual terminal unit.

SAE J1772 is the SAE International document titled "SAE Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler" (SAE J1772_201710).

SATURATED CONDENSING TEMPERATURE (also known as CONDENSING TEMPERATURE) is: (a) for single component and azeotropic refrigerants, the saturation temperature corresponding to the refrigerant pressure at the condenser entrance, or (b) for zeotropic refrigerants, the arithmetic average of the Dew Point and Bubble Point temperatures corresponding to the refrigerant pressure at the condenser entrance.

SCIENTIFIC EQUIPMENT is measurement, testing or metering equipment used for scientific research or investigation, including but not limited to manufactured cabinets, carts and racks.

SEASONAL ENERGY EFFICIENCY RATIO (SEER) is the total cooling output of an air conditioner in Btu during its normal usage period for cooling divided by the total electrical energy input in watt-hours during the same period, as determined using the applicable test method in the Appliance Efficiency Regulations.

SEAL CLASS A is a ductwork sealing category that requires sealing all transverse joints, longitudinal seams, and duct wall penetrations. Duct wall penetrations are openings made by pipes, conduit, tie rods, or wires. Longitudinal seams are joints oriented in the direction of airflow. Transverse joints are connections of two duct sections oriented perpendicular to airflow. Openings for rotating shafts shall be sealed with bushings or other devices that seal off air leakage. All connections shall be sealed, including but not limited to spin-ins, taps, other branch connections, access doors, access panels, and duct connections to equipment. Sealing that would void product listings is not required. All duct pressure class ratings shall be designated in the design documents.

SERVICE WATER HEATING is heating of water for sanitary purposes for human occupancy, other than for comfort heating.

SENSIBLE ENERGY RECOVERY RATIO is a ratio of the change in the dry-bulb temperature of the outdoor air supply to the difference in dry-bulb temperature between the outdoor air and entering exhaust airflow, with no adjustment to account for that portion of the dry-bulb temperature change in the leaving supply airflow that is the result of leakage of entering exhaust airflow rather than heat exchange between the airstreams.

SHADING is the protection from heat gains because of direct solar radiation by permanently attached exterior devices or building elements, interior shading devices, glazing material, or adherent materials.

SHADING COEFFICIENT (SC) is the ratio of the solar heat gain through a fenestration product to the solar heat gain through an unshaded 1/8-inch-thick clear double strength glass under the same set of conditions. For nonresidential, high-rise residential, and hotel/motel buildings, this shall exclude the effects of mullions, frames, sashes, and interior and exterior shading devices.

SIDELIT DAYLIT ZONE, PRIMARY is the area in plan view directly adjacent to each vertical glazing, one window head height deep into the area, and window width plus 0.5 times window head height wide on each side of the rough opening of the window, minus any area on a plan beyond a permanent obstruction that is 6 feet or taller as measured from the floor.

SIDELIT DAYLIT ZONE, SECONDARY is the area in plan view directly adjacent to each vertical glazing, two window head heights deep into the area, and window width plus 0.5 times window head height wide on each side of the rough opening of the window, minus any area on a plan beyond a permanent obstruction that is 6 feet or taller as measured from the floor.

SIGN definitions include the following:

Electronic Message Center (EMC) is a pixilated image producing electronically controlled sign formed by any light source. Bare lamps used to create linear lighting animation sequences through the use of chaser circuits, also known as “chaser lights” are not considered an EMC.

Illuminated face is a side of a sign that has the message on it. For an exit sign it is the side that has the word “EXIT” on it.

Sign, cabinet is an internally illuminated sign consisting of frame and face, with a continuous translucent message panel, also referred to as a panel sign.

Sign, channel letter is an internally illuminated sign with multiple components, each built in the shape of an individual three dimensional letter or symbol that are each independently illuminated, with a separate translucent panel over the light source for each element.

Sign, double-faced is a sign with two parallel opposing faces.

Sign, externally illuminated is any sign or a billboard that is lit by a light source that is external to the sign directed towards and shining on the face of the sign.

Sign, internally illuminated is a sign that is illuminated by a light source that is contained inside the sign where the message area is luminous, including cabinet signs and channel letter signs.

Sign, traffic is a sign for traffic direction, warning, and roadway identification.

Sign, unfiltered is a sign where the viewer perceives the light source directly as the message, without any colored filter between the viewer and the light source, including neon, cold cathode, and LED signs.

SINGLE- -FAMILY ~~RESIDENCE~~ BUILDING is any of the following:

A residential building of Occupancy Group R-3 with two or less dwelling units,

A building ~~that is~~ of Occupancy Group R-3, other than a multifamily building or hotel/motel building,

A townhouse,

A building of Occupancy Group R-3.1, or

A building of Occupancy Group U when located on a residential site.

SINGLE PACKAGE VERTICAL AIR CONDITIONER (SPVAC): Is a type of air-cooled small or large commercial package air-conditioning and heating equipment; factory assembled as a single package having its major components arranged vertically, which is an encased combination of cooling and optional heating components; is intended for exterior mounting on, adjacent interior to, or through an outside wall; and is powered by single or three-phase current. It may contain separate indoor grille, outdoor louvers, various ventilation options, indoor free air discharge, ductwork, wall plenum, or sleeve. Heating components may include electrical resistance, steam, hot water, gas, or no heat but may not include reverse cycle refrigeration as a heating means.

SINGLE PACKAGE VERTICAL HEAT PUMP (SPVHP): Is an SPVAC that utilizes reverse cycle refrigeration as its primary heat source, with secondary supplemental heating by means of electrical resistance, steam, hot water, or gas.

SINGLE ZONE SYSTEM is an air distribution system that supplies air to one thermal zone controlled by a single thermostat.

SITE-BUILT is fenestration designed to be field-glazed or field assembled units using specific factory cut or otherwise factory formed framing and glazing units that are manufactured with the intention of being assembled at the construction site. These include storefront systems, curtain walls and atrium roof systems.

SITE SOLAR ENERGY is thermal, chemical, or electrical energy derived from direct conversion of incident solar radiation at the building site.

SKYLIGHT is fenestration installed on a roof less than 60° from the horizontal.

SKYLIGHT AREA is the area of the rough opening for the skylight.

SKYLIGHT TYPE is one of the following three types of skylights: glass mounted on a curb, glass not mounted on a curb or plastic (assumed to be mounted on a curb).

SKYLIT DAYLIT ZONE is the rough area in plan view under each skylight, plus 0.7 times the average ceiling height in each direction from the edge of the rough opening of the skylight, minus any area on a plan beyond a permanent obstruction that is taller than one-half of the distance from the floor to the bottom of the skylight. The bottom of the skylight is measured from the bottom of the skylight well for skylights having wells, or the bottom of the skylight if no skylight well exists. For the purpose of determining the skylit daylit zone, the geometric shape of the skylit daylit zone shall be identical to the plan view geometric shape of the rough opening of the skylight; for example, for a rectangular skylight the skylit daylit zone plan area shall be rectangular, and for a circular skylight the skylit daylit zone plan area shall be circular. For skylight located in an atrium, the skylit daylit zone shall include the floor area directly under the atrium, and the area of the top floor that is directly under the skylight, plus 0.7 times the average ceiling height of the top floor, in

each direction from the edge of the rough opening of the skylight, minus any area on a plan beyond a permanent obstruction that is taller than one-half of the distance from the top floor to the bottom of the skylight.

SMACNA is the Sheet Metal and Air-Conditioning Contractors National Association.

SMACNA HVAC DUCT CONSTRUCTION STANDARDS is the Sheet Metal Contractors' National Association document "HVAC Duct Construction Standards Metal and Flexible - 3rd Edition," 2006 (2006 ANSI/SMACNA-006-2006 HVAC Duct Construction Standards Metal and Flexible 3rd Edition).

SMACNA RESIDENTIAL COMFORT SYSTEM INSTALLATION STANDARDS is the Sheet Metal Contractors' National Association document titled "Residential Comfort System Installation Standards, Eighth Edition." (2016).

SOCIAL SERVICES BUILDING is a space where public assistance and social services are provided to individuals or families.

SOLAR ELECTRIC GENERATION SYSTEM or **PHOTOVOLTAIC SYSTEM** is the complete set of all components for converting sunlight into electricity through the photovoltaic process, including the array of panels, inverter(s) and the balance of system components required to enable the system to effectively deliver power to reduce a building's consumption of electricity from the utility grid.

SOLAR REFLECTANCE INDEX (SRI) is a measure of the roof's ability to reject solar heat which includes both reflectance and emittance.

SOLAR SAVINGS FRACTION (SSF) is the fraction of domestic hot water demand provided by a solar water-heating system.

SOLAR ZONE is a section of the roof designated and reserved for the future installation of a solar electric or solar thermal system.

SOUTH-FACING (See "orientation.")

SPA is a vessel that contains heated water in which humans can immerse themselves, is not a pool, and is not a bathtub.

SPACE-CONDITIONING SYSTEM is a system that provides mechanical heating, or mechanical cooling within or associated with conditioned spaces in a building, and may incorporate use of components such as chillers/compressors, fluid distribution systems (e.g., air ducts, water piping, refrigerant piping), pumps, air handlers, cooling and heating coils, air or water cooled condensers, economizers, terminal units, and associated controls.

Stand-Alone Dehumidifier is a product with the sole purpose of dehumidifying the space and does not include a portable air conditioner, room air conditioner, or packaged terminal air conditioner. Stand-alone dehumidifier is a self-contained, electrically operated, and mechanically encased assembly consisting of 1) a refrigerated surface (evaporator) that condenses moisture from the atmosphere, 2) a refrigerating system, including an electric motor, 3) an air-circulating fan, and 4) a means for collecting or disposing of the condensate.

STANDARD DESIGN BUILDING is a building that is automatically simulated by Commission-approved compliance software to establish the Energy Budget that is the maximum energy consumption allowed by a Proposed Design Building to comply with the Title 24 Building Energy Efficiency Standards. The Standard Design building is simulated using the same location and having the same characteristics of the Proposed Design building, but assuming minimal compliance with the mandatory and prescriptive requirements that are applicable to the proposed building, as specified by the Alternative Calculation Methods Approval Manual.

STORAGE, COLD, is a storage area within a refrigerated warehouse where space temperatures are maintained at or above 32° F.

STORAGE, FROZEN is a storage area within a refrigerated warehouse where the space temperatures are maintained below 32° F.

TENANT SPACE is a portion of a building occupied by a tenant.

THERMAL MASS is solid or liquid material with a high overall heat capacity to store energy for heating or cooling requirements.

THERMAL RESISTANCE (R) is a measurement of the resistance over time of a material or building component to the passage of heat in (hr × ft² × ºF)/Btu.

THERMOSTAT is an automatic control device or system used to maintain temperature at a fixed or adjustable setpoint.

THERMOSTATIC EXPANSION VALVE (TXV) is a refrigerant metering valve, installed in an air conditioner or heat pump, which controls the flow of liquid refrigerant entering the evaporator in response to the superheat of the gas leaving it.

TIME DEPENDENT VALUATION (TDV) ENERGY is the time varying energy caused to be used by the building to provide space conditioning and water heating and for specified buildings lighting. TDV energy accounts for the energy used at the building site and consumed in producing and in delivering energy to a site, including, but not limited to, power generation, transmission and distribution losses.

TINTED GLASS is colored glass by incorporation of a mineral admixture resulting in a degree of tinting. Any tinting reduces both visible and radiant transmittance.

TOTAL HEAT OF REJECTION (THR) is the heat rejected by refrigeration system compressors at design conditions, consisting of the design cooling capacity plus the heat of compression added by the compressors.

TOWNHOUSE is a single--family dwelling unit constructed in a group of three or more attached units in which each unit extends from the foundation to roof and with open space on at least two sides.

TRANSCRITICAL CO_2 REFRIGERATION SYSTEM is a type of refrigeration system that uses CO_2 as the refrigerant where the ultimate heat rejection to ambient air can take place above the critical point.

> **TRANSCRITICAL MODE** is a system operating condition for a refrigeration system wherein the refrigerant pressure and temperature leaving the compressor is such that the refrigerant is at or above the critical point. Typically used in reference to CO_2 refrigeration systems.
>
> **SUBCRITICAL MODE** is a system operating condition for a refrigeration system wherein the refrigerant pressure and temperature leaving the compressor is such that the refrigerant is below the critical point. Typically used in reference to CO_2 refrigeration systems.

Transient is the occupancy for not more than 30 days of a dwelling unit or sleeping unit.

TRIM COMPRESSOR is a compressor that is designated for part-load operation, handling the short term variable trim load of end uses, in addition to the fully loaded base compressors.

U-FACTOR is the overall coefficient of thermal transmittance of a fenestration, wall, floor, or roof/ceiling component, in Btu/(hr × ft² × ºF), including air film resistance at both surfaces.

UL is the Underwriters Laboratories.

UL 181 is the Underwriters Laboratories document titled "Standard for Safety for Factory-Made Air Ducts and Air Connectors," 2017 (UL 181).

UL 181A is the Underwriters Laboratories document titled "Standard for Safety for Closure Systems for Use With Rigid Air Ducts," 2017 (UL 181A).

UL 181B is the Underwriters Laboratories document titled "Standard for Safety for Closure Systems for Use With Flexible Air Ducts and Air Connectors," 2017 (UL 181B).

UL 723 is the Underwriters Laboratories document titled "Standard for Safety for Test for Surface Burning Characteristics," ~~2017~~2018 (UL 723).

UL 727 is the Underwriters Laboratories document titled "Standard for Safety for Oil-Fired Central Furnaces," ~~2006~~2018 (UL727).

UL 731 is the Underwriters Laboratories document titled "Standard for Safety for Oil-Fired Unit Heaters," ~~2012~~2018 (UL 731).

UL 1077 is the Underwriters Laboratories document titled "Standard for Safety for Supplementary Protectors for Use in Electrical Equipment", 2015 (UL 1077)**.**

UL 1574 is the Underwriters Laboratories document entitled " Standard for Safety for Track Lighting Systems," ~~2016~~2020 (UL 1574).

UL 1598 is the Underwriters Laboratories document titled "Standard for Safety for Luminaires," ~~2012~~2020 (UL 1598).

UL 1741 is the Underwriter Laboratories documents titled "Standard for Safety for Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources," 2020 (UL 1741).

UL 1973 is the Underwriter Laboratories documents titled "Standard for Safety for Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications)," 2018 (ANSI/CAN/UL-1973:2018).

UL 2108 is the Underwriters Laboratories document titled "Standard for Safety for Low Voltage Lighting Systems," ~~2017~~2019 (UL 2108).

UL 8750 is the Underwriters Laboratories document titled "Standards for Safety for Light Emitting Diode (LED) Equipment for Use in Lighting Products," ~~2018~~2021 (UL 2108).

UL 9540 is the Underwriter Laboratories documents titled "Standard for Safety for Energy Storage Systems and Equipment" 2020 (ANSI/CAN/UL 9540:2020)

UNCONDITIONED SPACE is enclosed space within a building that is not directly conditioned, or indirectly conditioned.

UNIFORM ENERGY FACTOR (UEF) of a water heater is a measure of overall water heater efficiency, as determined using the applicable test method in the Appliance Efficiency Regulations.

USDOE 10 CFR 430 is the regulation issued by Department of Energy and available in the Code of Federal Regulation - Title 10, Chapter II, Subchapter D, Part 430 – Energy Conservation Program for Consumer Products. Relevant testing methodologies are specified in applicable appendices.~~"Appendix N to subpart B of Part 430 – Uniform test method for measuring the energy consumption of furnaces and boilers."~~**USDOE 10 CFR 431** is the regulation issued by Department of Energy and available in the Code of Federal Regulation - Title 10, Chapter II, Subchapter D, Part 431 - Energy Conservation Program for Certain Commercial and Industrial equipment. Relevant testing methodologies are specified in "Subpart E to Part 431 – Uniform test method for the measurement of energy efficiency of commercial packaged boilers."

VAPOR RETARDER CLASS is a measure of the ability of a material or assembly to limit the amount of moisture that passes through the material or assembly meeting Section 202 of the California Building Code.

VARIABLE AIR VOLUME (VAV) SYSTEM is a space-conditioning system that maintains comfort levels by varying the volume of supply air to the zones served.

VENDING MACHINE is a machine for vending and dispensing refrigerated or nonrefrigerated food and beverages or general merchandise.

VENTILATION SYSTEM, BALANCED is a mechanical device intended to remove air from buildings, and simultaneously replace it with outdoor air.

VENTILATION SYSTEM, CENTRAL FAN INTEGRATED, or CFI is a ventilation system configuration in which the ventilation ductwork is connected to the duct system of a dwelling unit space conditioning system to enable distribution of ventilation air to the dwelling unit while the space conditioning system air handling unit is operating. ~~a central fan forced air space conditioning system that also intends to bring outdoor air into buildings, causing indoor air to flow out of the building through ventilation relief outlets or normal leakage paths through the building envelope.~~

VENTILATION SYSTEM, ENERGY RECOVERY, or ERV is a mechanical device intended to remove air from buildings, simultaneously replace it with outdoor air, and in the process transfer heat from the warmer to the colder of the simultaneous airflows and transfer moisture from the most humid to least humid of the simultaneous airflows.

VENTILATION SYSTEM, EXHAUST is a mechanical device intended to remove air from buildings, causing outdoor air to enter by ventilation inlets or normal leakage paths through the building envelope.

VENTILATION SYSTEM, HEAT RECOVERY, or HRV is a mechanical device intended to remove air from buildings, simultaneously replace it with outdoor air, and in the process transfer heat from the warmer to the colder of the simultaneous airflows.

VENTILATION SYSTEM, SUPPLY is a mechanical device intended to bring outdoor air into buildings, causing indoor air to flow out of the building through ventilation relief outlets or normal leakage paths through the building envelope.

VERY VALUABLE MERCHANDISE is rare or precious objects, including, but not limited to, jewelry, coins, small art objects, crystal, ceramics, or silver, the selling of which involves customer inspection of very fine detail from outside of a locked case.

VIRTUAL END NODE (VEN) is an interface with a demand responsive control system that accepts signals transmitted through OpenADR, consistent with the specifications in OpenADR 2.0a or 2.0b.

WALL TYPE is a type of wall assembly having a specific heat capacity, framing type, and U-factor.

WATER BALANCE IN EVAPORATIVE COOLING TOWERS The water balance of a cooling tower is:

M = E + B, where:

M = makeup water (from the mains water supply)

E = losses due to evaporation

B = losses due to blowdown

WEST-FACING (See "orientation")

WINDOW FILM is fenestration attachment products that consists of a flexible adhesive-backed polymer film which may be applied to the interior or exterior surface of an existing glazing system.

WOOD HEATER is an enclosed wood-burning appliance used for space heating and/or domestic water heating.

WOOD STOVE (See "wood heater.")

ZONAL describes characterized by or relating to a zone or zones.

ZONE, CRITICAL is a zone serving a process where reset of the zone temperature setpoint during a demand shed event might disrupt the process, including but not limited to computer rooms, data centers, telecom and private branch exchange (PBX) rooms, and laboratories.

ZONE, NONCRITICAL is a zone that is not a critical zone.

ZONE, SPACE-CONDITIONING, is a space or group of spaces within a building with sufficiently similar comfort conditioning requirements so that comfort conditions, as specified in Section 140.4(b)3 or 150.0(h), as applicable, can be maintained throughout the zone by a single controlling device.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

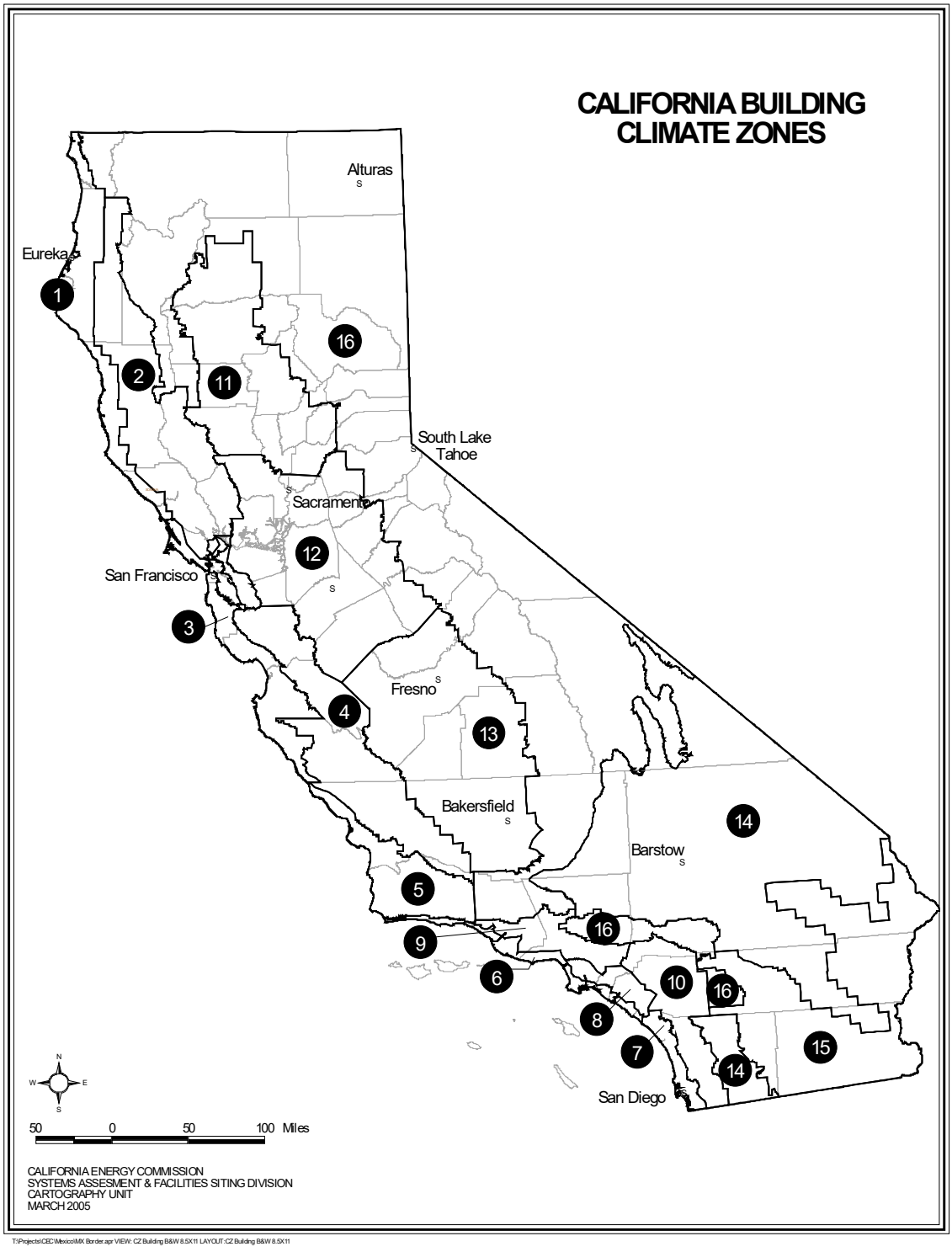

FIGURE 100.1-A—CALIFORNIA CLIMATE ZONES

Climate Zones for Residential and Nonresidential Occupancies

SECTION 100.2 – CALCULATION OF TIME DEPENDENT VALUATION (TDV) ENERGY

Time Dependent Valuation (TDV) energy shall be used to compare proposed designs to their energy budget when using the performance compliance approach. TDV energy is calculated by multiplying the site energy use (electricity kWh, natural gas therms, or fuel oil or LPG gallons) for each energy type times the applicable TDV multiplier. TDV multipliers vary for each hour of the year and by energy type (electricity, natural gas or propane), by Climate Zone and by building type (low-rise residential or nonresidential, high-rise residential or hotel/motel). TDV multipliers are summarized in Reference Joint Appendix JA3. TDV multipliers for propane shall be used for all energy obtained from depletable sources other than electricity and natural gas.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SUBCHAPTER 2
ALL OCCUPANCIES—MANDATORY REQUIREMENTS FOR THE MANUFACTURE, CONSTRUCTION AND INSTALLATION OF SYSTEMS, EQUIPMENT AND BUILDING COMPONENTS

SECTION 110.0 – SYSTEMS AND EQUIPMENT—GENERAL

Sections 110.1 through 110.12 specify requirements for manufacturing, construction, and installation of certain systems, equipment, appliances and building components that are installed in buildings within the scope of Section 100.0(a).

NOTE: The requirements of Sections 110.0 through 110.12 apply to newly constructed buildings. Sections 141.0 and 150.2 specify which requirements of Sections 110.1 through 110.12 also apply to additions and alterations to existing buildings.

(a) **General Requirements.** Systems, equipment, appliances and building components shall only be installed in a building within the scope of Section 100.0(a) if:

1. The manufacturer has certified that the system, equipment, appliances or building component complies with the applicable manufacturing provisions of Sections 110.1 through 110.12, and
2. The system, equipment, appliance or building component complies with all applicable installation provisions of Sections 110.1 through 110.12.

(b) **Certification Requirements for Manufactured Systems, Equipment, Appliances and Building Components.**

1. Appliances that are within the scope of Section 1601 of the Appliance Efficiency Regulations shall only be installed if they have been certified to the Energy Commission by the manufacturer, pursuant to the provisions of Title 20 California Code of Regulations, Section 1606; or
2. Systems, equipment, appliances and building components that are required by Part 6 or the Reference Appendices to be certified to the Energy Commission, which are not appliances that are within the scope of Section 1601 of the Appliance Efficiency Regulations, shall only be installed if they are certified by the manufacturer in a declaration, executed under penalty of perjury under the laws of the State of California, that:
   A. all the information provided pursuant to the certification is true, complete, accurate and in compliance with all applicable requirements of Part 6; and
   B. the equipment, product, or device was tested using the test procedure specified in Part 6 if applicable.
3. The certification status of any system, equipment, appliance or building component shall be confirmed only by reference to:
   A. A directory published or approved by the Commission; or
   B. A copy of the application for certification from the manufacturer and the letter of acceptance from the Commission staff; or
   C. Written confirmation from the publisher of a Commission-approved directory that a device has been certified; or
   D. A Commission-approved label on the device.

NOTE: Part 6 does not require a builder, designer, owner, operator, or enforcing agency to test any certified device to determine its compliance with minimum specifications or efficiencies adopted by the Commission.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code

SECTION 110.1 – MANDATORY REQUIREMENTS FOR APPLIANCES

(a) Any appliance regulated by the Appliance Efficiency Regulations, Title 20 California Code of Regulations, Section 1601 et seq., may be installed only if the appliance fully complies with Section 1608(a) of those regulations.

(b) Except for those circumstances described in Section 110.1(c), conformance with efficiency levels required to comply with Part 6 mandatory, prescriptive and performance standards shall be verified utilizing data from either:

1. The Energy Commission's database of certified appliances maintained pursuant to Title 20 California Code of Regulations, Section 1606, and which is available at: www.energy.ca.gov/appliances/database/; or
2. An equivalent directory published by a federal agency; or
3. An approved trade association directory as defined in Title 20 California Code of Regulations, Section 1606(h).

(c) Conformance with efficiency levels required to comply with Part 6 mandatory, prescriptive and performance standards shall be demonstrated either by default to the mandatory efficiency levels specified in Part 6 or by following procedures approved by the Commission pursuant to Section 10-109 of Title 24, Part 1, when:

1. Data to verify conformance with efficiency levels required to comply with Part 6 mandatory, prescriptive and performance standards is not available pursuant to subdivision (b); or
2. Field verification and diagnostic testing is required for compliance with Part 6 and the Energy Commission has not approved a field verification and diagnostic test protocol that is applicable to the appliance; or
3. The appliance meets the requirements of Section 110.1(a) but has been site-modified in a way that affects its performance; or
4. The U.S. Department of Energy has approved a waiver from federal test procedures, pursuant to 10 CFR Section 430.27 or Section 431.401 and that waiver fails to specify how the efficiency of the system shall be determined.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code

SECTION 110.2 – MANDATORY REQUIREMENTS FOR SPACE-CONDITIONING EQUIPMENT

Certification by Manufacturers. Any space-conditioning equipment listed in this section may be installed only if the manufacturer has certified to the Commission that the equipment complies with all the applicable requirements of this section.

(a) **Efficiency.** Equipment shall meet the applicable efficiency requirements in TABLE 110.2-A through TABLE 110.2-K subject to the following:

1. If more than one efficiency standard is listed for any equipment in TABLE 110.2-A through TABLE 110.2-K, the equipment shall meet all the applicable standards that are listed; and
2. If more than one test method is listed in TABLE 110.2-A through TABLE 110.2-K, the equipment shall comply with the applicable efficiency standard when tested with each listed test method; and
3. Where equipment serves more than one function, it shall comply with the efficiency standards applicable to each function; and
4. Where a requirement is for equipment rated at its "maximum rated capacity" or "minimum rated capacity," the capacity shall be as provided for and allowed by the controls, during steady-state operation.

EXCEPTION 1 to Section 110.2(a): Water-cooled centrifugal water-chilling packages that are not designed for operation at ANSI/AHRI Standard 550/590 test conditions of 44°F leaving chilled water temperature and 85°F entering condenser water temperature with 3 gallons per minute per ton condenser water flow shall have a maximum full load kW/ton and NPLV ratings adjusted using the following equation:

Adjusted maximum full-load kW/ton rating = (full-load kW/ton from TABLE 110.2-D) / Kadj

Adjusted maximum NPLV rating = (IPLV from TABLE 110.2-D) / Kadj

Where:

Kadj = (A) × (B)

$A = 0.00000014592 \times (LIFT)^4 - 0.0000346496 \times (LIFT)^3 + 0.00314196 \times (LIFT)^2 - 0.147199 \times (LIFT) + 3.9302$

LIFT = LvgCond – LvgEvap (°F)

LvgCond = Full-load leaving condenser fluid temperature (°F)

LvgEvap = Full-load leaving evaporator fluid temperature (°F)

$B = (0.0015 \times LvgEvap) + 0.934$

The adjusted full-load and NPLV values are only applicable for centrifugal chillers meeting all of the following full-load design ranges:

- Minimum Leaving Evaporator Fluid Temperature: 36°F

- Maximum Leaving Condenser Fluid Temperature: 115°F
- LIFT ≥ 20°F and ≤ 80°F

Centrifugal chillers designed to operate outside of these ranges are not covered by this exception.

EXCEPTION 2 to Section 110.2(a): Positive displacement (air-cooled and water-cooled) chillers with a leaving evaporator fluid temperature higher than 32°F shall show compliance with TABLE 110.2-D when tested or certified with water at standard rating conditions, per the referenced test procedure.

EXCEPTION 3 to Section 110.2(a): Equipment primarily serving refrigerated warehouses or commercial refrigeration.

(b) **Controls for Heat Pumps with Supplementary Electric Resistance Heaters.** Heat pumps with supplementary electric resistance heaters shall have controls:

1. That prevent supplementary heater operation when the heating load can be met by the heat pump alone; and
2. In which the cut-on temperature for compression heating is higher than the cut-on temperature for supplementary heating, and the cut-off temperature for compression heating is higher than the cut-off temperature for supplementary heating.

EXCEPTION 1 to Section 110.2(b): The controls may allow supplementary heater operation during:

A. Defrost; and

B. Transient periods such as start-ups and following room thermostat setpoint advance, if the controls provide preferential rate control, intelligent recovery, staging, ramping or another control mechanism designed to preclude the unnecessary operation of supplementary heating.

EXCEPTION 2 to Section 110.2(b): Room air-conditioner heat pumps.

(c) **Thermostats.** All heating or cooling systems not controlled by a central energy management control system (EMCS) shall have a setback thermostat.

1. **Setback Capabilities.** All thermostats shall have a clock mechanism that allows the building occupant to program the temperature setpoints for at least four periods within 24 hours. Thermostats for heat pumps shall meet the requirements of Section 110.2(b).

EXCEPTION to Section 110.2(c): Gravity gas wall heaters, gravity floor heaters, gravity room heaters, non-central electric heaters, fireplaces or decorative gas appliances, wood stoves, room air conditioners, and room air-conditioner heat pumps.

(d) **Gas-Fired and Oil-Fired Furnace Standby Loss Controls.** Gas-fired and oil-fired forced air furnaces with input ratings ≥225,000 Btu/hr shall also have an intermittent ignition or interrupted device (IID), and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for furnaces where combustion air is drawn from the conditioned space. All furnaces with input ratings ≥225,000 Btu/h, including electric furnaces, that are not located within the conditioned space shall have jacket losses not exceeding 0.75 percent of the input rating.

(e) **Open and Closed ~~Circuit~~ Cooling Towers.** All open and closed ~~circuit~~ cooling tower installations shall comply with the following:

1. Be equipped with Conductivity or Flow-based Controls that maximize cycles of concentration based on local water quality conditions. Controls shall automate system bleed and chemical feed based on conductivity, or in proportion to metered makeup volume, metered bleed volume, recirculating pump run time, or bleed time. Conductivity controllers shall be installed in accordance with manufacturer's specifications in order to maximize accuracy.

2. Documentation of Maximum Achievable Cycles of Concentration. Building owners shall document the maximum cycles of concentration based on local water supply as reported annually by the local water supplier, and using the calculator approved by the Energy Commission. The calculator is intended to determine maximum cycles based on a Langelier Saturation Index (LSI) of 2.5 or less. Building owner shall document maximum cycles of concentration on the mechanical compliance form which shall be reviewed and signed by the Professional Engineer (P.E.) of Record.
3. Be equipped with a Flow Meter with an analog output for flow either hardwired or available through a gateway on the makeup water line.
4. Be equipped with an Overflow Alarm to prevent overflow of the sump in case of makeup water valve failure. Overflow alarm shall send an audible signal or provide an alert via the Energy Management Control System to the tower operator in case of sump overflow.
5. Be equipped with Efficient Drift Eliminators that achieve drift reduction to 0.002 percent of the circulated water volume for counter-flow towers and 0.005 percent for cross-flow towers.

EXCEPTION to Section 110.2(e): Open and closed cooling ~~T~~towers with rated capacity < 150 tons.

(f) **Low Leakage Air-Handling Units**. To qualify as a low leakage air-handling unit for use for meeting the requirements for applicable low leakage air-handling unit compliance credit(s) available in the performance standards set forth in Sections 150.1(b) and 140.1, the manufacturer shall certify to the Energy Commission that the air-handling unit meets the specifications in Reference Joint Appendix JA9.

TABLE 110.2-A AIR CONDITIONERS AND CONDENSING UNITS – MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category	Efficiency [a,~~b~~]	Test Procedure[c]
Air conditioners, air cooled both split system and single package	≥ 65,000 Btu/h and < 135,000 Btu/h	11.2 EER[b] 14.8~~12.9~~ IEER[b]	ANSI/AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	11.0 EER[b] 14.2~~12.4~~ IEER[b]	ANSI/AHRI 340/360
	≥ 240,000 Btu/h and < 760,000 Btu/h	10.0 EER[b] 13.2~~11.6~~ IEER[b]	
	≥ 760,000 Btu/h	9.7 EER[b] 12.5~~11.2~~ IEER[b]	
Air conditioners, water cooled	≥ 65,000 Btu/h and < 135,000 Btu/h	12.1 EER[b] 13.9 IEER[b]	ANSI/AHRI 340/360
	≥135,000 Btu/h and < 240,000 Btu/h	12.5 EER[b] 13.9 IEER[b]	ANSI/AHRI 340/360
	≥240,000 Btu/h and < 760,000 Btu/h	12.4 EER[b] 13.6 IEER[b]	ANSI/AHRI 340/360
	≥ 760,000 Btu/h	12.2EER[b] 13.5 IEER[b]	ANSI/AHRI 340/360
Air conditioners, evaporatively cooled	≥65,000 Btu/h and < 135,000 Btu/h	12.1 EER[b] 12.3 IEER[b]	ANSI/AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	12.0 EER[b] 12.2 IEER[b]	ANSI/AHRI 340/360
	≥240,000 Btu/h and < 760,000 Btu/h	11.9 EER[b] 12.1 IEER[b]	ANSI/AHRI 340/360
	≥ 760,000 Btu/h	11.7 EER[b] 11.9 IEER[b]	ANSI/AHRI 340/360
Condensing units, air cooled	≥ 135,000 Btu/h	10.5 EER 11.8 IEER	ANSI/AHRI 365

Condensing units, water cooled	≥ 135,000 Btu/h	13.5 EER 14.0 IEER	
Condensing units, evaporatively cooled	≥ 135,000 Btu/h	13.5 EER 14.0 IEER	

[a] IEERs are only applicable to equipment with capacity control as specified by ANSI/AHRI 340/360 test procedures

[b] Deduct 0.2 from the required EERs and IEERs for units with a heating section other than electric resistance heat.

[c] Applicable test procedure and reference year are provided under the definitions.

TABLE 110.2-B HEAT PUMPS, MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category	Rating Condition~~Efficiency~~ [a,b]	Efficiency [a,b]	Test Procedure[c]
Air Cooled (Cooling Mode), both split system and single package	≥ 65,000 Btu/h and < 135,000 Btu/h		11.0 EER 14.1~~12.2~~ IEER	ANSI/AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h		10.6 EER 13.5~~11.6~~ IEER	
	≥ 240,000 Btu/h		9.5 EER 12.5~~10.6~~ IEER	
Water source (cooling mode)	≥ 65,000 Btu/h and < 135,000 Btu/h	86ºF entering water	13.0 EER	ISO-13256-1
Groundwater source (cooling mode)	< 135,000 Btu/h	59ºF entering water	18.0 EER	ISO-13256-1
Ground source (cooling mode)	< 135,000 Btu/h	77ºF entering water	14.1 EER	ISO-13256-1
Water source water-to-water (cooling mode)	< 135,000 Btu/h	86ºF entering water	10.6 EER	ISO-13256-2
Groundwater source water-to-water (cooling mode)	< 135,000 Btu/h	59ºF entering water	16.3 EER	ISO-13256-2~~1~~
Ground source brine-to-water (cooling mode)	< 135,000 Btu/h	77ºF entering water	12.1 EER	ISO-13256-2

Air Cooled (Heating Mode) Split system and single package	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling capacity)	47° F db/43° F wb outdoor air	3.4~~3.3~~ COP	ANSI/AHRI 340/360
		17° F db/15° F wb outdoor air	2.25 COP	
	≥ 135,000 Btu/h (cooling capacity)	47° F db/43° F wb outdoor air	3.3~~3.2~~ COP	
		17° F db/15° F wb outdoor air	2.05 COP	

CONTINUED: TABLE 110.2-B HEAT PUMPS, MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category	Subcategory or Rating Condition	Efficiency [a]	Test Procedure[c]
Water source (heating mode)	< 135,000 Btu/h (cooling capacity)	68ºF entering water	4.3 COP	ISO-13256-1
	≥ 135,000 Btu/h and < 240,000 Btu/h	68ºF entering water	2.90 COP	
Groundwater source (heating mode)	< 135,000 Btu/h (cooling capacity)	50ºF entering water	3.7 COP	ISO-13256-1
Ground source (heating mode)	< 135,000 Btu/h (cooling capacity)	32ºF entering water	3.2 COP	ISO-13256-1
Water source water-to-water (heating mode)	< 135,000 Btu/h (cooling capacity)	68ºF entering water	3.7 COP	ISO-13256-2
Groundwater source water-to-water (heating mode)	< 135,000 Btu/h (cooling capacity)	50ºF entering water	3.1 COP	ISO-13256-2
Ground source brine-to-water (heating mode)	< 135,000 Btu/h (cooling capacity)	32ºF entering water	2.5 COP	ISO-13256-2

[a] IEERs are only applicable to equipment with capacity control as specified by ANSI/AHRI 340/360 test procedures.

[b] Deduct 0.2 from the required EERs and IEERs for units with a heating section other than electric resistance heat.

[c] Applicable test procedure and reference year are provided under the definitions.

TABLE 110.2-C AIR-COOLED GAS-ENGINE HEAT PUMPS

Equipment Type	Size Category	Subcategory or Rating Condition	Efficiency	Test Procedure[a]
Air-Cooled Gas-Engine Heat Pump (Cooling Mode)	All Capacities	95° F db Outdoor Air	0.60 COP	ANSI Z21.40.4A
Air-Cooled Gas-Engine Heat Pump (Heating Mode)	All Capacities	47° F db/43° F wb Outdoor Air	0.72 COP	ANSI Z21.40.4A
[a] Applicable test procedure and reference year are provided under the definitions.				

TABLE 110.2-D WATER CHILLING PACKAGES – MINIMUM EFFICIENCY REQUIREMENTS [a,b]

Equipment Type	Size Category	Path A Efficiency [a,b]	Path B Efficiency [a,b]	Test Procedure [c]
Air Cooled, With Condenser Electrically Operated	< 150 Tons	≥ 10.100 EER ≥ 13.700 IPLV	≥ 9.700 EER ≥15.800 IPLV	AHRI 550/590
	≥ 150 Tons	≥ 10.100 EER ≥ 14.000 IPLV	≥ 9.700 EER ≥16.100 IPLV	
Air Cooled, Without Condenser Electrically Operated	All Capacities	Air-cooled chillers without condensers must be rated with matching condensers and comply with the air-cooled chiller efficiency requirements.		
Water Cooled, Electrically Operated, Reciprocating	All Capacities	Reciprocating units must comply with the water-cooled positive displacement efficiency requirements.		AHRI 550/590
Water Cooled, Electrically Operated Positive Displacement	< 75 Tons	≤0.750kW/ton ≤ 0.600 IPLV	≤ 0.780 kW/ton ≤ 0.500 IPLV	AHRI 550/590
	≥ 75 tons and < 150 tons	≤ 0.720 kW/ton ≤ 0.560 IPLV	≤ 0.750 kW/ton ≤ 0.490 IPLV	
	≥ 150 tons and < 300 tons	≤ 0.660 kW/ton ≤ 0.540 IPLV	≤ 0.680 kW/ton ≤ 0.440 IPLV	
	≥ 300 Tons and < 600 tons	≤ 0.610kW/ton ≤ 0.520 IPLV	≤ 0.625 kW/ton ≤ 0.410 IPLV	
	≥ 600 tons	≤ 0.560 kW/ton ≤ 0.500 IPLV	≤ 0.585 kW/ton ≤ 0.380 IPLV	
Water Cooled, Electrically Operated, Centrifugal	< 150 Tons	≤ 0.610 kW/ton ≤ 0.550IPLV	≤ 0.695 kW/ton ≤ 0.440 IPLV	
	≥ 150 tons and < 300 tons	≤ 0.610 kW/ton ≤ 0.550 IPLV	≤ 0.635 kW/ton ≤ 0.400 IPLV	
	≥ 300 tons and < 400 tons	≤ 0.560 kW/ton ≤ 0.520 IPLV	≤ 0.595 kW/ton ≤ 0.390 IPLV	
	≥ 400 tons and < 600 tons	≤ 0.560 kW/ton ≤ 0.500 IPLV	≤ 0.585 kW/ton ≤ 0.380 IPLV	
	≥ 600 tons	≤ 0.560 kW/ton ≤ 0.500 IPLV	≤ 0.585 kW/ton ≤ 0.380 IPLV	

CONTINUED: TABLE 110.2-D WATER CHILLING PACKAGES – MINIMUM EFFICIENCY REQUIREMENTS [a,b]

Equipment Type	Size Category	Path A Efficiency [a,b]	Path B Efficiency [a,b]	Test Procedure [c]
Air Cooled Absorption, Single Effect	All Capacities	≥0.600 COP	N.A. [d]	ANSI/AHRI 560
Water Cooled Absorption, Single Effect	All Capacities	≥ 0.700 COP	N.A. [d]	
Absorption Double Effect, Indirect-Fired	All Capacities	≥ 1.000 COP ≥ 1.050 IPLV	N.A. [d]	
Absorption Double Effect, Direct-Fired	All Capacities	≥ 1.000 COP ≥1.000 IPLV	N.A. [d]	
Water Cooled Gas Engine Driven Chiller	All Capacities	≥ 1.2 COP ≥ 2.0 IPLV	N.A. [d]	ANSI Z21.40.4A

[a] No requirements for:

- Centrifugal chillers with design leaving evaporator temperature < 36°F; or
- Positive displacement chillers with design leaving fluid temperature ≤ 32°F; or
- Absorption chillers with design leaving fluid temperature < 40°F.

[b] Must meet the minimum requirements of Path A or Path B. However, both the full load (COP) and IPLV must be met to fulfill the requirements of the applicable Path.

[c] See Section 100.1 for definitions.

[d] NA means not applicable.

TABLE 110.2-E PACKAGED TERMINAL AIR CONDITIONERS AND PACKAGED TERMINAL HEAT PUMPS – MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Efficiency	Test Procedure [c]
PTAC (Cooling mode) Newly constructed or newly conditioned buildings or additions	All Capacities	95°F db Outdoor Air	14.0 - (0.300 × Cap/1000) [a] EER	ANSI/AHRI/CSA 310/380
PTAC (Cooling mode) Replacements [b]	All Capacities	95°F db Outdoor Air	10.9 - (0.213 × Cap/1000) [a] EER	
PTHP (Cooling mode) Newly constructed or newly conditioned buildings or additions	All Capacities	95°F db Outdoor Air	14.0 - (0.300 × Cap/1000) [a] EER	
PTHP (Cooling mode) Replacements [b]	All Capacities	95°F db Outdoor Air	10.8 - (0.213 × Cap/1000) [a] EER	
PTHP (Heating Mode) Newly constructed or newly conditioned buildings or additions	All Capacities	-	3.7 - (0.052 × Cap/1000) [a] COP	
PTHP (Heating mode) Replacements [b]	All Capacities	-	2.9 - (0.026 × Cap/1000) [a] COP	
SPVAC (Cooling Mode)	<65,000 Btu/h	95°F db / 75°F wb Outdoor Air	11.0 EER	ANSI/AHRI 390
	≥65,000 Btu/h and <135,000 Btu/h	95°F db / 75°F wb Outdoor Air	10.0 EER	
	≥135,000 Btu/h and <240,000 Btu/h	95°F db / 75°F wb Outdoor Air	10.0 EER	
~~SPVAC (Cooling Mode) nonweatherized space constrained~~	~~≤ 30,000 Btu/h~~	~~"95°F db / 75°F wb outdoor air"~~	~~9.20 EER~~	
	~~> 30,000 Btu/h and ≤ 36,000 Btu/h~~	~~"95°F db / 75°F wb outdoor air"~~	~~9.00 EER~~	
SPVHP (Cooling Mode)	<65,000 Btu/h	95°F db / 75°F wb Outdoor Air	11.0 EER	
	≥65,000 Btu/h and <135,000 Btu/h	95°F db / 75°F wb Outdoor Air	10.0 EER	
	≥135,000 Btu/h and <240,000 Btu/h	95°F db / 75°F wb Outdoor Air	10.0 EER	
~~SPVHP (Cooling Mode) nonweatherized space constrained~~	~~≤ 30,000 Btu/h~~	~~95°F db / 75°F wb Outdoor Air~~	~~9.20 EER~~	
	~~> 30,000 Btu/h and ≤ 36,000 Btu/h~~	~~95°F db / 75°F wb Outdoor Air~~	~~9.00 EER~~	
SPVHP (Heating Mode)	<65,000 Btu/h	47°F db / 43°F wb Outdoor Air	3.3 COP	

	≥65,000 Btu/h and <135,000 Btu/h	47°F db / 43°F wb Outdoor Air	3.0 COP	
	≥135,000 Btu/h and <240,000 Btu/h	47°F db / 43°F wb Outdoor Air	3.0 COP	
~~SPVHP (Heating Mode) nonweatherized space constrained~~	~~≤ 30,000 Btu/h~~	~~47°F db / 43°F wb Outdoor Air~~	~~3.00 COP~~	
	~~> 30,000 Btu/h and ≤ 36,000 Btu/h~~	~~47°F db / 43°F wb Outdoor Air~~	~~3.00 COP~~	

a Cap means the rated cooling capacity of the product in Btu/h. If the unit's capacity is less than 7000 Btu/h, use 7000 Btu/h in the calculation. If the unit's capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculation.

b Replacement units must be factory labeled as follows: "MANUFACTURED FOR REPLACEMENT APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEWLY CONSTRUCTED BUILDINGS." Replacement efficiencies apply only to units with existing sleeves less than 16 inches high or less than 42 inch wide and having a cross-sectional area less than 670 square inches.

c Applicable test procedure and reference year are provided under the definitions.

TABLE 110.2-F HEAT TRANSFER EQUIPMENT

Equipment Type	Subcategory	Minimum Efficiency[a]	Test Procedure [b]
Liquid-to-liquid heat exchangers	Plate type	NR	ANSI/AHRI 400

[a] NR means no requirement.
[b] Applicable test procedure and reference year are provided under the definitions.

TABLE 110.2-G PERFORMANCE REQUIREMENTS FOR HEAT REJECTION EQUIPMENT

Equipment Type	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Condition	Performance Required [a,b,c,d]	Test Procedure [e]
Propeller or axial fan Open-circuit cooling towers	All	95°F entering water 85°F leaving water 75°F entering air wb	≥ 42.1 gpm/hp	CTI ATC-105 and CTI STD-201 RS
Centrifugal fan Open-circuit cooling towers	All	95°F entering water 85°F leaving water 75°F entering air wb	≥ 20.0 gpm/hp	
Propeller or axial fan closed-circuit cooling towers	All	102°F entering water 90°F leaving water 75°F entering air wb	≥ 16.1 gpm/hp	CTI ATC-105S and CTI STD-201 RS
Centrifugal fan closed-circuit cooling towers	All	102°F entering water 90°F leaving water 75°F entering air wb	≥ 7.0 gpm/hp	
Propeller or axial fan evaporative condensers	All	R-507A test fluid 165°F entering gas temp 105°F condensing temp 75°F entering air wb	≥ 157,000 Btu/h • hp	CTI ATC-106
	All	Ammonia test fluid 140°F entering gas temp 96.3°F condensing temp 75°F entering air wb	≥ 134,000 Btu/h • hp	
Centrifugal fan evaporative condensers	All	R-507A test fluid 165°F entering gas temp 105°F condensing temp 75°F entering air wb	≥ 135,000 Btu/h • hp	
	All	Ammonia test fluid 140°F entering gas temp 96.3°F condensing temp 75°F entering air wb	≥ 110,000 Btu/h • hp	
Air cooled condensers	All	125°F condensing temperature R22 test fluid 190°F entering gas temperature 15°F subcooling 95°F entering drybulb	≥ 176,000 Btu/h·hp	ANSI/AHRI 460

[a] For purposes of this table, open-circuit cooling tower performance is defined as the water flow rating of the tower at the given rated conditions divided by the fan motor nameplate power.

[b] For purposes of this table, closed-circuit cooling tower performance is defined as the process water flow rating of the tower at the given rated conditions divided by the sum of the fan motor nameplate rated power and the integral spray pump motor nameplate power.

[c] For purposes of this table air-cooled condenser performance is defined as the heat rejected from the refrigerant divided by the fan motor nameplate power.

[d] Open cooling towers shall be tested using the test procedures in CTI ATC-105. Performance of factory assembled open cooling towers shall be either certified as base models as specified in CTI STD-201 or verified by testing in the field by a CTI approved testing agency. Open factory assembled cooling towers with custom options added to a CTI certified base model for the purpose of safe maintenance or to reduce environmental or noise impact shall be rated at 90 percent of the CTI certified performance of the associated base model or at the manufacturer's stated performance, whichever is less. Base models of open factory assembled cooling towers are open cooling towers configured in exact accordance with the Data of Record submitted to CTI as specified by CTI STD-201. There are no certification requirements for field erected cooling towers.

[e] Applicable test procedure and reference year are provided under the definitions.

For refrigerated warehouses or commercial refrigeration applications, condensers shall comply with requirements specified by Section 120.6(a) or Section 120.6(b).

TABLE 110.2-H Electrically Operated Variable Refrigerant Flow (VRF) Air Conditioners
Minimum Efficiency Requirements

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure[a]
VRF Air Conditioners, Air Cooled	<65,000 Btu/h	All	VRF Multi-split System	13.0 SEER	ANSI/AHRI 1230
	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System	11.2 EER 15.5 IEER [b]	
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System	11.0 EER 14.9 IEER [b]	
	≥240,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System	10.0 EER 13.9 IEER [b]	

[a] Applicable test procedure and reference year are provided under the definitions.

[b] IEERs are only applicable to equipment with capacity control as specified by ANSI/AHRI 1230 test procedures.

TABLE 110.2-I Electrically Operated Variable Refrigerant Flow Air-to-Air and Applied Heat Pumps - Minimum Efficiency Requirements

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure [b]
VRF Air Cooled, (cooling mode)	<65,000 Btu/h	All	VRF Multi-split System	13.0 SEER	AHRI 1230
	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System [a]	11.0 EER 14.6 IEER [c]	
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System [a]	10.6 EER 13.9 IEER [c]	
	≥240,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System [a]	9.5 EER 12.7 IEER [c]	
VRF Water source (cooling mode)	<65,000 Btu/h	All	VRF Multi-split systems [a] 86ºF entering water	12.0 EER 16.0~~15.8~~ IEER [c]	AHRI 1230
	≥65,000 Btu/h and <135,000 Btu/h	All	VRF Multi-split System [a] 86ºF entering water	12.0 EER 16.0~~15.8~~ IEER [c]	
	≥135,000 Btu/h and < 240,000	All	VRF Multi-split System [a] 86ºF entering water	10.0 EER 14.0~~13.8~~ IEER [c]	
	≥ 240,000 Btu/h	All	VRF Multi-split System[a] 86ºF entering water	10.0 EER 12.0 IEER	
VRF Groundwater source (cooling mode)	<135,000 Btu/h	All	VRF Multi-split System [a] 59ºF entering water	16.2 EER	AHRI 1230

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure [b]
	≥135,000 Btu/h	All	VRF Multi-split System [a] 59ºF entering water	13.8 EER	
VRF Ground source (cooling mode)	<135,000 Btu/h	All	VRF Multi-split System [a] 77ºF entering water	13.4 EER	AHRI 1230
	≥135,000 Btu/h	All	VRF Multi-split System [a] 77ºF entering water	11.0 EER	

CONTINUED: TABLE 110.2-I Electrically Operated Variable Refrigerant Flow Air-to-Air and Applied Heat Pumps - Minimum Efficiency Requirements

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure [b]
VRF Air Cooled (heating mode)	<65,000 Btu/h (cooling capacity)	---	VRF Multi-split System	7.7 HSPF	AHRI 1230
	≥65,000 Btu/h and <135,000 Btu/h (cooling capacity)	---	VRF Multi-split system 47ºF db/ 43ºF wb outdoor air	3.3 COP	
			VRF Multi-split system 17ºF db/15ºF wb outdoor air	2.25 COP	
	≥135,000 Btu/h (cooling capacity)	---	VRF Multi-split system 47ºF db/ 43ºF wb outdoor air	3.2 COP	
			VRF Multi-split system 17ºF db/15ºF wb outdoor air	2.05 COP	
VRF Water source (heating mode)	< 65,000 Btu/h (cooling capacity)	---	VRF Multi-split System 68°F entering water	4.3 COP	AHRI 1230
	≥65,000 Btu/h and <135,000 Btu/h (cooling capacity)	---	VRF Multi-split System 68ºF entering water	4.3 COP	
	≥135,000 Btu/h and < 240,000 Btu/h (cooling capacity)	---	VRF Multi-split System 68ºF entering water	4.0 COP	
	≥ 240,000 Btu/h (cooling capacity)	---	VRF Multi-split System 68°F entering water	3.9 COP	

VRF Groundwater source (heating mode)	<135,000 Btu/h (cooling capacity)	---	VRF Multi-split System 50ºF entering water	3.6 COP	AHRI 1230
	≥135,000 Btu/h (cooling capacity)	---	VRF Multi-split System 50ºF entering water	3.3 COP	
VRF Ground source (heating mode)	<135,000 Btu/h (cooling capacity)	---	VRF Multi-split System 32ºF entering water	3.1 COP	AHRI 1230
	≥135,000 Btu/h (cooling capacity)	---	VRF Multi-split System 32ºF entering water	2.8 COP	

[a] Deduct 0.2 from the required EERs and IEERs for Variable Refrigerant Flow (VRF) Multi-split system units with a heating recovery section.

[b] Applicable test procedure and reference year are provided under the definitions.

[c] IEERs are only applicable to equipment with capacity control as specified by ANSI/AHRI 1230 test procedures.

TABLE 110.2-J Warm-Air Furnaces and Combination Warm-Air Furnaces/Air-Conditioning Units, Warm-Air Duct Furnaces, and Unit Heaters

Equipment Type	Size Category (Input)	Subcategory or Rating Condition[b]	Minimum Efficiency[d,e]	Test Procedure[a]
Warm-Air Furnace, Gas-Fired	≥ 225,000 Btu/h	Maximum Capacity[b]	81~~80~~% E_t	Section 2.39, Thermal Efficiency, ANSI Z21.47
Warm-Air Furnace, oil-Fired	≥ 225,000 Btu/h	Maximum Capacity[b]	82~~81~~% E_t	Section 42, Combustion, UL 727
Warm-Air Duct Furnaces, Gas-Fired	All Capacities	Maximum Capacity[b]	80% E_c	Section 2.10, Efficiency, ANSI Z83.8
Warm-Air Unit Heaters, Gas-Fired	All Capacities	Maximum Capacity[b]	80% E_c	Section 2.10, Efficiency, ANSI Z83.8
Warm-Air Unit Heaters, Oil-Fired	All Capacities	Maximum Capacity[b]	81% E_c	Section 40, Combustion, UL 731

[a] Applicable test procedure and reference year are provided under the definitions.

[b] Compliance of multiple firing rate units shall be at maximum firing rate.

[c] Combustion units not covered by the U.S. Department of Energy Code of Federal Regulations 10 CFR 430 (3-phase power or cooling capacity greater than or equal to 19 kW) may comply with either rating.

[d] E_t= thermal efficiency. Units must also include an interrupted or intermittent ignition device (IID), have jacket losses not exceeding 0.75% of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.

[e] E_c= combustion efficiency (100% less flue losses). See test procedure for detailed discussion.

[f] As of August 8, 2008, according to the Energy Policy Act of 2005, units must also include interrupted or intermittent ignition device (IID) and have either power venting or an automatic flue damper.

TABLE 110.2-K Gas- and Oil-Fired Boilers, Minimum Efficiency requirements

Equipment Type	Sub Category	Size Category (Input)	Minimum Efficiency [b,c]		Test Procedure [a]
			Before 1/10/2023~~3/2/2020~~	On or After 1/10/2023~~3/2/2020~~	
Boiler, hot water	Gas-Fired	< 300,000 Btu/h	82% AFUE	82% AFUE	DOE 10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h [d]	80% E_t	84~~80~~% E_t	DOE 10 CFR Part 431
		> 2,500,000 Btu/h and <10,000,000 Btu/h-[e]	82% E_c	85~~82~~% E_c	
		>10,000,000 Btu/h	82% E_c	82% E_c	DOE 10 CFR Part 431
	Oil-Fired [e]	< 300,000 Btu/h	84% AFUE	84% AFUE	DOE 10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h [d]	82% E_t	87~~82~~% E_t	DOE 10 CFR Part 431
		> 2,500,000 Btu/h and <10,000,000 Btu/h-[e]	84% E_c	88~~84~~% E_c	
		>10,000,000 Btu/h	84% E_c	84% E_c	DOE 10 CFR Part 431
Boiler, steam	Gas-Fired	< 300,000 Btu/h	80% AFUE	80% AFUE	DOE 10 CFR Part 430
		>300,000 Btu/h and <2,500,000 Btu/h		81% E_t	DOE 10 CFR Part 431
		>2,500,000 Btu/h and <10,000,000 Btu/h		82% E_t	DOE 10 CFR Part 431
		>10,000,000 Btu/h		79% E_t	DOE 10 CFR Part 431
	Gas-Fired all, except natural draft[f]	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h [d]	79% E_t	81~~79~~% E_t	DOE 10 CFR Part 431
		> 2,500,000 Btu/h and <10,000,000 Btu/h-[e]	79% E_t	82~~79~~% E_t	DOE 10 CFR Part 431
		>10,000,000 Btu/h	79% E_t	79% E_t	DOE 10 CFR Part 431
	Gas-Fired, natural draft[f]	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h [d]	77% E_t	81~~79~~% E_t	DOE 10 CFR Part 431

		> 2,500,000 Btu/h and <10,000,000 Btu/h[e]	77% E_t	8279% E_t	DOE 10 CFR Part 431
		>10,000,000 Btu/h	77% E_t	79% E_t	DOE 10 CFR Part 431
	Oil-Fired [e]	< 300,000 Btu/h	82% AFUE	82% AFUE	DOE 10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h [d]	81% E_t	8481% E_t	DOE 10 CFR Part 431
		> 2,500,000 Btu/h and <10,000,000 Btu/h-[e]	81% E_t	8581% E_t	DOE 10 CFR Part 431
		10,000,000 Btu/h	81% E_t	81% E_t	DOE 10 CFR Part 431

[a] Applicable test procedure and reference year are provided under the definitions.

[b] Ec = combustion efficiency (100% less flue losses).See test procedure for detailed information~~reference document for detailed information~~.

[c] Et= thermal efficiency. See test procedure for detailed information.

[d] Maximum capacity - ~~minimum and~~ maximum rating per the certified unit capacity~~s as provided for and allowed by the unit's controls~~.

[e] Included oil-fired (residual).

[f] Federal efficiency standards do not distinguish between natural draft gas-fired steam boilers and other gas-fired steam boilers on or after January 10, 2023.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, Public Resources Code

SECTION 110.3 – MANDATORY REQUIREMENTS FOR SERVICE WATER-HEATING SYSTEMS AND EQUIPMENT

(a) **Certification by Manufacturers**. Any service water-heating system or equipment may be installed only if the manufacturer has certified that the system or equipment complies with all of the requirements of this subsection for that system or equipment.

1. Temperature controls for service water heating systems. Service water-heating systems shall be equipped with automatic temperature controls capable of adjustment from the lowest to the highest acceptable temperature settings for the intended use as listed in Table 3, Chapter 50 of the ASHRAE Handbook, HVAC Applications Volume or Table 613.1 of the California Plumbing Code for healthcare facilities.

   EXCEPTION to Section 110.3(a)1: Residential occupancies.

(b) **Efficiency.** Equipment shall meet the applicable requirements of the Appliance Efficiency Regulations as required by Section 110.1, subject to the following:

1. If more than one standard is listed in the Appliance Efficiency Regulations, the equipment shall meet all the standards listed; and
2. If more than one test method is listed in the Appliance Efficiency Regulations, the equipment shall comply with the applicable standard when tested with each test method; and
3. Where equipment can serve more than one function, such as both heating and cooling, or both space heating and water heating, it shall comply with all the requirements applicable to each function; and
4. Where a requirement is for equipment rated at its "maximum rated capacity" or "minimum rated capacity," the capacity shall be as provided for and allowed by the controls, during steady-state operation.

(c) **Installation.** Any service water-heating system or equipment may be installed only if the system or equipment complies with all of the applicable requirements of this subsection for the system or equipment.

1. **Outlet temperature controls.** On systems that have a total capacity greater than 167,000 Btu/hr, outlets that require higher than service water temperatures as listed in the ASHRAE Handbook, Applications Volume, shall have separate remote heaters, heat exchangers, or boosters to supply the outlet with the higher temperature.

   EXCEPTION to section 110.3(c)1: Systems covered by California Plumbing Code Section 613.0 shall instead follow the requirements of that section.

2. **Controls for hot water distribution systems.** Service hot water systems with circulating pumps or with electrical heat trace systems shall be capable of automatically turning off the system.

   EXCEPTION to Section 110.3(c)2: Systems serving healthcare facilities.

3. **Insulation.** Unfired service water heater storage tanks and backup tanks for solar water-heating systems shall have:

   A. External insulation with an installed R-value of at least R-12; or

   B. Internal and external insulation with a combined R-value of at least R-16; or

   C. The heat loss of the tank surface based on an 80°F water-air temperature difference shall be less than 6.5 Btu per hour per square foot.

4. **Water Heating Recirculation Loops Serving Multiple Dwelling Units, High-Rise Residential, Hotel/Motel, and Nonresidential Occupancies.** A water heating recirculation loop is a type of hot water distribution system that reduces the time needed to deliver hot water to fixtures that are distant from the water heater, boiler or other water heating equipment. The recirculation loop is comprised of a supply portion, connected to branches that serve multiple dwelling units, guest rooms, or fixtures and a return portion that completes the loop back to the water heating equipment. A water heating recirculation loop shall meet the following requirements:

A. **Air release valve or vertical pump installation.** An automatic air release valve shall be installed on the recirculation loop piping on the inlet side of the recirculation pump and no more than 4 feet from the pump. This valve shall be mounted on top of a vertical riser at least 12" in length and shall be accessible for replacement and repair. Alternatively, the pump shall be installed on a vertical section of the return line.

B. **Recirculation loop backflow prevention.** A check valve or similar device shall be located between the recirculation pump and the water heating equipment to prevent water from flowing backwards though the recirculation loop.

C. **Equipment for pump priming.** A hose bibb shall be installed between the pump and the water heating equipment. An isolation valve shall be installed between the hose bibb and the water heating equipment. This hose bibb is used for bleeding air out of the pump after pump replacement.

D. **Pump isolation valves.** Isolation valves shall be installed on both sides of the pump. These valves may be part of the flange that attaches the pump to the pipe. One of the isolation valves may be the same isolation valve as in Item C.

E. **Cold water supply and recirculation loop connection to hot water storage tank.** Storage water heaters and boilers shall be plumbed in accordance with the manufacturer's specifications. The cold water piping and the recirculation loop piping shall not be connected to the hot water storage tank drain port.

F. **Cold water supply backflow prevention.** A check valve shall be installed on the cold water supply line between the hot water system and the next closest tee on the cold water supply line. The system shall comply with the expansion tank requirements as described in the California Plumbing Code Section 608.3.

5. **Service water heaters in state buildings.** Any newly constructed building constructed by the State shall derive its service water heating from a system that provides at least 60 percent of the energy needed for service water heating from site solar energy or recovered energy, per the statutory requirement of California Public Resources Code Section 25498.

   EXCEPTION to Section 110.3(c)5: Buildings for which the state architect determines that service water heating from site solar energy or recovered energy is economically or physically infeasible.

6. **Isolation valves.** Instantaneous water heaters with an input rating greater than 6.8 kBTU/hr (2 kW) shall have isolation valves on both the cold water supply and the hot water pipe leaving the water heater, and hose bibbs or other fittings on each valve for flushing the water heater when the valves are closed.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, Public Resources Code

SECTION 110.4 – MANDATORY REQUIREMENTS FOR POOL AND SPA SYSTEMS AND EQUIPMENT

(a) **Certification by Manufacturers.** Any pool or spa heating system or equipment may be installed only if the manufacturer has certified that the system or equipment has all of the following:

1. **Efficiency.** A thermal efficiency that complies with the Appliance Efficiency Regulations; and
2. **On-off switch.** A readily accessible on-off switch, mounted on the outside of the heater that allows shutting off the heater without adjusting the thermostat setting; and
3. **Instructions.** A permanent, easily readable, and weatherproof plate or card that gives instruction for the energy efficient operation of the pool or spa heater and for the proper care of pool or spa water when a cover is used; and
4. **Electric resistance heating.** No electric resistance heating.

   EXCEPTION 1 to Section 110.4(a)4: Listed package units with fully insulated enclosures, and with tight-fitting covers that are insulated to at least R-6.

   EXCEPTION 2 to Section 110.4(a)4: Pools or spas deriving at least 60 percent of the annual heating energy from site solar energy or recovered energy.

(b) **Installation.** Any pool or spa system or equipment shall be installed with all of the following:

1. **Piping.** At least 36 inches of pipe shall be installed between the filter and the heater or dedicated suction and return lines, or built-in or built-up connections shall be installed to allow for the future addition of solar heating equipment;
2. **Covers.** A cover for outdoor pools or outdoor spas that have a heat pump or gas heater; and
3. **Directional inlets and time switches for pools.** If the system or equipment is for a pool:
   i. The pool shall have directional inlets that adequately mix the pool water; and
   ii. A time switch or similar control mechanism shall be installed as part of a pool water circulation control system that will allow all pumps to be set or programmed to run only during the off-peak electric demand period and for the minimum time necessary to maintain the water in the condition required by applicable public health standards.

SECTION 110.5 – NATURAL GAS CENTRAL FURNACES, COOKING EQUIPMENT, POOL AND SPA HEATERS, AND FIREPLACES: PILOT LIGHTS PROHIBITED

Any natural gas system or equipment listed below may be installed only if it does not have a continuously burning pilot light:

(a) Fan-type central furnaces.

(b) Household cooking appliances.

EXCEPTION to Section 110.5(b): Household cooking appliances without an electrical supply voltage connection and in which each pilot consumes less than 150 Btu/hr.

(c) Pool heaters.

(d) Spa heaters.

(e) Indoor and outdoor fireplaces.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, Public Resources Code

SECTION 110.6 – MANDATORY REQUIREMENTS FOR FENESTRATION PRODUCTS AND EXTERIOR DOORS

(a) **Certification of Fenestration Products and Exterior Doors other than Field-fabricated.** Any fenestration product and exterior door, other than field-fabricated fenestration products and field-fabricated exterior doors, may be installed only if the manufacturer has certified to the Commission, or if an independent certifying organization approved by the Commission has certified that the product complies with all of the applicable requirements of this subsection.

1. **Air leakage.** Manufactured fenestration products and exterior doors shall have air infiltration rates not exceeding 0.3 cfm/ft² of window area, 0.3 cfm/ft² of door area for residential doors, 0.3 cfm/ft² of door area for nonresidential single doors (swinging and sliding), and 1.0 cfm/ft² for nonresidential double doors (swinging), when tested according to NFRC-400 or ASTM E283 at a pressure differential of 75 pascals (or 1.57 pounds/ft²), incorporated herein by reference.

   NOTES TO SECTION 110.6(a)1:Pet doors must meet 0.3 cfm/ft² when tested according to ASTM E283 at 75 pascals (or 1.57 pounds/ft²). AAMA/WDMA/CSA 101/I.S.2/A440-2011 specification is equivalent to ASTM E283 at a pressure differential of 75 pascals (or 1.57 pounds/ft²) and satisfies the air leakage certification requirements of this section.

   EXCEPTION to Section 110.6(a)1: Field-fabricated fenestration and field-fabricated exterior doors.

2. **U-factor.** The fenestration product and exterior door's U-factor shall be rated in accordance with NFRC 100, or use the applicable default U-factor set forth in TABLE 110.6-A.

   EXCEPTION 1 to Section 110.6(a)2: If the fenestration product is a skylight ~~or a vertical site-built fenestration product~~ in a building covered by the nonresidential standards with less than 200 square feet of ~~site-built fenestration~~skylight area, the default U-factor may be calculated as set forth in Reference Nonresidential Appendix NA6.

   EXCEPTION 2 to Section 110.6(a)2: If the fenestration product is an alteration consisting of any area replacement of glass in a skylight product ~~or in a vertical site-built fenestration product,~~ in a building covered by the nonresidential standards, the default U-factor may be calculated as set forth in Reference Nonresidential Appendix NA6.

3. **Solar Heat Gain Coefficient (SHGC).** The fenestration product's SHGC shall be rated in accordance with NFRC 200, or use the applicable default SHGC set forth in TABLE 110.6-B.

   EXCEPTION 1 to Section 110.6(a)3: If the fenestration product is a skylight ~~or a vertical site-built fenestration product~~ in a building covered by the nonresidential standards with less than 200 square feet of ~~site-built fenestration~~skylight area, the default SHGC may be calculated as set forth in Reference Nonresidential Appendix NA6.

   EXCEPTION 2 to Section 110.6(a)3: If the fenestration product is an alteration consisting of any area replacement of glass in a skylight product ~~or in a vertical site-built fenestration product,~~ in a building covered by the nonresidential standards, the default SHGC may be calculated as set forth in Reference Nonresidential Appendix NA6.

4. **Visible Transmittance (VT).** The fenestration product's VT shall be rated in accordance with NFRC 200 or ASTM E972, for tubular daylighting devices VT shall be rated using NFRC 203**.**

   EXCEPTION 1 to Section 110.6(a)4: If the fenestration product is a skylight ~~or a vertical site-built fenestration product~~ in a building covered by the nonresidential standards with less than 200 square feet of ~~site-built fenestration~~skylight area, the default VT may be calculated as set forth in Reference Nonresidential Appendix NA6.

   EXCEPTION 2 to Section 110.6(a)4: If the fenestration product is an alteration consisting of any area; replacement of glass in a skylight product ~~or in a vertical site-built fenestration product~~ in a building covered by the nonresidential standards, the default VT may be calculated as set forth in Reference Nonresidential Appendix NA6.

5. **Labeling.** Fenestration products and exterior doors shall:

   A. Have a temporary label for manufactured fenestration products and exterior doors or a label certificate when the Component Modeling Approach (CMA) is used and for site-built fenestration meeting the requirements of Section 10-111(a)1. The temporary label shall not be removed before inspection by the enforcement agency; and

   B. Have a permanent label or a label certificate when the Component Modeling Approach (CMA) is used and for site-built fenestration meeting the requirements of Section 10-111(a)2 if the product is rated using NFRC procedures.

6. **Fenestration Acceptance Requirements.** Before an occupancy permit is granted, site-built fenestration products in other than ~~low-rise residential~~single-family buildings shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified in the Reference Nonresidential Appendix NA7 to ensure that site-built fenestration meets Standards requirements, including a matching label certificate for product(s) installed and be readily accessible at the project location. A Certificate of Acceptance certifying that the fenestration product meets the acceptance requirements shall be completed, signed and submitted to the enforcement agency.

   EXCEPTION to Section 110.6(a): Fenestration products removed and reinstalled as part of a building alteration or addition.

(b) **Installation of Field-Fabricated Fenestration and Exterior Doors.** Field-fabricated fenestration and field-fabricated exterior doors may be installed only if the compliance documentation has demonstrated compliance for the installation using U-factors from Table 110.6-A and SHGC values from Table 110.6-B. Field-fabricated fenestration and field-fabricated exterior doors shall be caulked between the fenestration products or exterior door and the building, and shall be weatherstripped.

EXCEPTION to Section 110.6(b): Unframed glass doors and fire doors need not be weatherstripped or caulked.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code

TABLE 110.6-A DEFAULT FENESTRATION PRODUCT U-FACTORS

Frame	Product Type	Single Pane [3, 4] U-Factor	Double Pane [1, 3, 4] U-Factor	Glass Block [2,3] U-Factor
Metal	Operable	1.28	0.79	0.87
	Fixed	1.19	0.71	0.72
	Greenhouse/Garden Window	2.26	1.40	N.A.
	Glazed Doors	1.25	0.77	N.A.
	Skylight	1.98	1.30	N.A.
Metal, Thermal Break	Operable	N.A.	0.66	N.A.
	Fixed	N.A.	0.55	N.A.
	Greenhouse/Garden Window	N.A.	1.12	N.A.
	Glazed Doors	N.A.	0.59	N.A.
	Skylight	N.A.	1.11	N.A.
Nonmetal	Operable	0.99	0.58	0.60
	Fixed	1.04	0.55	0.57
	Glazed Doors	0.99	0.53	N.A.
	Greenhouse/Garden Windows	1.94	1.06	N.A.
	Skylight	1.47	0.84	N.A.

1. For all dual-glazed fenestration products, adjust the listed U-factors as follows:

    a. Add 0.05 for products with dividers between panes if spacer is less than 7/16 inch wide.

    b. Add 0.05 to any product with true divided lite (dividers through the panes).

2. Translucent or transparent panels shall use glass block values when not rated by NFRC 100.

3. Visible Transmittance (VT) shall be calculated by using Reference Nonresidential Appendix NA6.

4. Windows with window film applied that is not rated by NFRC 100 shall use the default values from this table.

TABLE 110.6-B DEFAULT SOLAR HEAT GAIN COEFFICIENT (SHGC)

FRAME TYPE	PRODUCT	GLAZING	FENESTRATION PRODUCT SHGC		
			Single Pane[2,3] SHGC	Double Pane[2,3] SHGC	Glass Block[1,2] SHGC
Metal	Operable	Clear	0.80	0.70	0.70
	Fixed	Clear	0.83	0.73	0.73
	Operable	Tinted	0.67	0.59	N.A.
	Fixed	Tinted	0.68	0.60	N.A.
Metal, Thermal Break	Operable	Clear	N.A.	0.63	N.A.
	Fixed	Clear	N.A.	0.69	N.A.
	Operable	Tinted	N.A.	0.53	N.A.
	Fixed	Tinted	N.A.	0.57	N.A.
Nonmetal	Operable	Clear	0.74	0.65	0.70
	Fixed	Clear	0.76	0.67	0.67
	Operable	Tinted	0.60	0.53	N.A.
	Fixed	Tinted	0.63	0.55	N.A.

1 Translucent or transparent panels shall use glass block values when not rated by NFRC 200.

2. Visible Transmittance (VT) shall be calculated by using Reference Nonresidential Appendix NA6.

3. Windows with window film applied that is not rated by NFRC 200 shall use the default values from this table.

SECTION 110.7 – MANDATORY REQUIREMENTS TO LIMIT AIR LEAKAGE

All joints, penetrations and other openings in the building envelope that are potential sources of air leakage shall be caulked, gasketed, weather stripped, or otherwise sealed to limit infiltration and exfiltration.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, Public Resources Code

SECTION 110.8 – MANDATORY REQUIREMENTS FOR INSULATION, ROOFING PRODUCTS AND RADIANT BARRIERS

(a) **Insulation Certification by Manufacturers.** All insulation shall be certified by Department of Consumer Affairs, Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation that the insulation conductive thermal performance is approved pursuant to the California Code of Regulations, Title 24, Part 12, Chapters 12-13, Article 3, "Standards for Insulating Material."

(b) **Installation of Urea Formaldehyde Foam Insulation.** Urea formaldehyde foam insulation may be applied or installed only if:

1. It is installed in exterior side walls; and
2. A four-mil-thick plastic polyethylene vapor retarder or equivalent plastic sheathing vapor retarder is installed between the urea formaldehyde foam insulation and the interior space in all applications.

(c) **Flame Spread Rating of Insulation.** All insulating material shall be installed in compliance with the flame spread rating and smoke density requirements of the CBC.

(d) **Installation of Insulation in Existing Buildings.** Insulation installed in an existing attic, or on an existing duct or water heater, shall comply with the applicable requirements of Subsections 1, 2, and 3 below. If a contractor installs the insulation, the contractor shall certify to the customer, in writing, that the insulation meets the applicable requirements of Subsections 1, 2, and 3 below.

1. **Attics.** If insulation is installed in the existing attic of a ~~low-rise residential~~single-family building, the R-value of the total amount of insulation (after addition of insulation to the amount, if any, already in the attic) shall meet the requirements of Section 150.0(a).

   EXCEPTION to Section 110.8(d)1: Where the accessible space in the attic is not large enough to accommodate the required R-value, the entire accessible space shall be filled with insulation provided such installation does not violate Section ~~1203.2~~1202.2 of Title 24, Part 2 or Section 806 of Title 24, Part 2.5.

2. **Water heaters.** If external insulation is installed on an existing unfired water storage tank or on an existing back-up tank for a solar water-heating system, it shall have an R-value of at least R-12, or the heat loss of the tank surface based on an 80°F water-air temperature difference shall be less than 6.5 Btu per hour per square foot.

3. **Ducts.** If insulation is installed on an existing space-conditioning duct, it shall comply with Section 604.0 of the CMC.

(e) RESERVED

(f) RESERVED

(g) **Insulation Requirements for Heated Slab Floors.** Heated slab floors shall be insulated according to the requirements in TABLE 110.8-A.

1. Insulation materials in ground contact must:
   A. Comply with the certification requirements of Section 110.8(a); and
   B. Have a water absorption rate for the insulation material alone without facings that are no greater than 0.3 percent when tested in accordance with Test Method A – 24 Hour-Immersion of ASTM C272.
   C. Water vapor permeance no greater than 2.0 perm/inch when tested in accordance with ASTM E96.
2. Insulation installation must:
   A. Be covered with a solid guard that protects against damage from ultraviolet radiation, moisture, landscaping operation, equipment maintenance, and wind; and

B. Include a rigid plate, which penetrates the slab and blocks the insulation from acting as a conduit for insects from the ground to the structure above the foundation.

TABLE 110.8-A SLAB INSULATION REQUIREMENTS FOR HEATED SLAB FLOOR

Insulation Location	Insulation Orientation	Installation Requirements	Climate Zone	Insulation R-Value
Outside edge of heated slab, either inside or outside the foundation wall	Vertical	From the level of the top of the slab, down 16 inches or to the frost line, whichever is greater. Insulation may stop at the top of the footing where this is less than the required depth. For below grade slabs, vertical insulation shall be extended from the top of the foundation wall to the bottom of the foundation (or the top of the footing) or to the frost line, whichever is greater.	1 – 15	5
			16	10
Between heated slab and outside foundation wall	Vertical and Horizontal	Vertical insulation from top of slab at inside edge of outside wall down to the top of the horizontal insulation. Horizontal insulation from the outside edge of the vertical insulation extending 4 feet toward the center of the slab in a direction normal to the outside of the building in plan view.	1 – 15	5
			16	10 vertical and 7 horizontal

(h) **Wet Insulation Systems.** When insulation is installed on roofs above the roofing membrane or layer used to seal the roof from water penetration, the effective R-value of the insulation shall be as specified in Reference Joint Appendix JA4.

(i) **Roofing Products Solar Reflectance and Thermal Emittance.**

1. In order to meet the requirements of Sections 140.1, 140.2, 140.3(a)1, 141.0(b)2B, 150.1(c)11, 150.2(b)1H or 150.2(b)2, a roofing product's thermal emittance and an aged solar reflectance shall be certified and labeled according to the requirements of Section 10-113.

   EXCEPTION 1 to Section 110.8(i)1: Roofing products that are not certified according to Section 10-113 shall assume the following default aged solar reflectance/thermal emittance values:

   A. For asphalt shingles: 0.08/0.75

   B. For all other roofing products: 0.10/0.75

2. If CRRC testing for an aged solar reflectance is not available for any roofing products, the aged value shall be derived from the CRRC initial value using the equation $\rho_{aged}=[0.2+\beta[\rho_{initial}-0.2]$, where $\rho_{initial}$ = the initial solar reflectance and soiling resistance β is listed by product type in TABLE 110.8-B.

TABLE 110.8-B VALUES OF SOILING RESISTANCE β BY PRODUCT TYPE

Product Type	CRRC Product Category	β
Field-Applied Coating	Field-Applied Coating	0.65
Other	Not A Field-Applied Coating	0.70

3. Solar Reflectance Index (SRI), calculated as specified by ASTM E 1980-01, may be used as an alternative to thermal emittance and an aged solar reflectance when complying with the requirements of Sections 140.2, 140.3(a)1, 141.0(b)2B, 150.1(c)11, 150.2(b)1H,or 150.2(b)2. SRI calculations shall be based on moderate wind velocity of 2-6 meters per second. The SRI shall be calculated based on the aged solar reflectance value of the roofing products.

4. Liquid applied roof coatings applied to low-sloped roofs in the field as the top surface of a roof covering shall:

   A. Be applied across the entire roof surface to meet the dry mil thickness or coverage recommended by the coating manufacturer, taking into consideration the substrate on which the coating is applied; and

   B. Meet the minimum performance requirements listed in TABLE 110.8-C or the minimum performance requirements of ASTM C836, D3468, D6083 or D6694, whichever are appropriate to the coating material.

      EXCEPTION 1 to Section 110.8(i)4B: Aluminum-pigmented asphalt roof coatings shall meet the requirements of ASTM D2824 and be installed as specified by ASTM D3805.

      EXCEPTION 2 to Section 110.8(i)4B: Cement-based roof coatings shall contain a minimum of 20 percent cement and shall meet the requirements of ASTM C1583, ASTM D822, and ASTM D5870.

TABLE 110.8-C MINIMUM PERFORMANCE REQUIREMENTS FOR LIQUID APPLIED ROOF COATINGS

Physical Property	ASTM Test Procedure	Requirement
Initial percent elongation (break)	D 2370	Minimum 200% @ 73° F (23° C)
Initial percent elongation (break) OR Initial Flexibility	D 2370 D522, Test B	Minimum 60% @ 0° F (-18° C) Minimum pass 1” mandrel @ 0° F (-18° C)
Initial tensile strength (maximum stress)	D 2370	Minimum 100 psi (1.38 Mpa) @ 73° F (23° C)
Initial tensile strength (maximum stress) OR Initial Flexibility	D 2370 D522, Test B	Minimum 200 psi (2.76 Mpa) @ 0° F (-18° C) Minimum pass 1” mandrel @ 0° F (-18° C)
Final percent elongation (break) after accelerated weathering 1000 h	D2370	Minimum 100% @ 73° F (23° C)
Final percent elongation (break) after accelerated weathering 1000 h OR Flexibility after accelerated weathering 1000 h	D2370 D522, Test B	Minimum 40% @ 0° F (-18° C) Minimum pass 1” mandrel @ 0° F (-18° C)
Permeance	D 1653	Maximum 50 perms
Accelerated weathering 1000 h	D 4798	No cracking or checking[1]
1. Any cracking or checking visible to the eye fails the test procedure.		

(j) **Radiant Barrier.** A radiant barrier shall have an emittance of 0.05 or less, tested in accordance with ASTM C1371 or ASTM E408, and shall be certified to the Department of Consumer Affairs as required by Title 24, Part12, Chapter 12-13, Standards for Insulating Material.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, Public Resources Code

SECTION 110.9 – MANDATORY REQUIREMENTS FOR LIGHTING CONTROLS

(a) All lighting control devices and systems and all light sources subject to the requirements of Section 110.9 shall meet the following requirements:

1. Shall be installed only if the lighting control or light source complies with all of the applicable requirements of Section 110.9.
2. Lighting controls may be individual devices or systems consisting of two or more components.

(b) **All Lighting Controls.** Lighting controls listed in Section 110.9(b) shall comply with the requirements listed below; and all components of the system considered together as installed shall meet all applicable requirements for the application for which they are installed as required in Sections 130.0 through 130.5, Sections 140.6 through 140.8, Section 141.0, and Section 150.0(k).

1. **Time-Switch Lighting Controls.** All controls that provide time-switch functionality, including all automatic and astronomical time-switch controls, shall have program backup capabilities that prevent the loss of the device's schedule for at least 7 days, and the device's date and time for at least 72 hours if power is interrupted. In addition:
   A. Time-Switch Controls installed in nonresidential buildings shall
      i. ~~For each connected load, b~~Be capable of providing manual override to each connected load and of resuming normally scheduled operation after a manual override is initiated within 2 hours; and
      ii. Provide an automatic holiday shutoff feature that turns off all connected loads for at least 24 hours and then resumes normally scheduled operation.
   B. Astronomical Time-Switch Controls shall:
      i. Have sunrise and sunset prediction accuracy within plus-or-minus 15 minutes and timekeeping accuracy within 5 minutes per year;
      ii. Be capable of displaying date, current time, sunrise time, sunset time, and switching times for each step during programming;
      iii. Be capable of automatically adjusting for daylight savings time; and
      iv. Have the ability to independently offset the on and off for each channel by at least 90 minutes before and after sunrise or sunset.
   C. Multilevel Time-Switch Controls shall include at least two separately programmable steps per zone.
   D. Time-Switch Controls installed outdoors shall have setback functions that allow the lighting on each controlled channel to be switched or dimmed to lower levels. The set back functions shall be capable of being programmed by the user for at least one specific time of day.
2. **Daylighting Controls.** Controls that provide automatic daylighting functionality shall:
   A. Automatically return to its most recent time delay settings within 60 minutes of the last received input when left in calibration mode;
   B. Have a set point control that easily distinguishes settings to within 10 percent of full scale adjustment;
   C. Provide a linear response within 5 percent accuracy over the range of illuminance measured by the light sensor; and
   D. Be capable of being calibrated in a manner that the person initiating the calibration is remote from the sensor during calibration to avoid influencing calibration accuracy, for example by having a light sensor that is physically separated from where the calibration adjustments are made.
3. **Dimmers.** Controls that provide dimming functionality shall:

A. Be capable of reducing lighting power consumption by a minimum of 65% when at its lowest setting;

B. Provide reduced flicker operation, meaning that directly controlled light sources shall be provided electrical power such that the light output has an amplitude modulation of less than 30 percent for frequencies less than 200 Hz without causing premature lamp failure;

C. Provide an off setting that produces a zero lumen output; and

D. For wall box dimmers and associated switches designed for use in three way circuits, be capable of turning lights off, and on to the level set by the dimmer if the lights are off.

4. **Occupant Sensing Controls.** Occupant sensing controls include occupant sensors, motion sensors, and vacancy sensors, including those with a Partial-ON or Partial-OFF function. Occupant sensing controls shall:

   A. Be capable of automatically turning the controlled lights in the area either off or down no more than 20 minutes after the area has been vacated;

   B. For manual-on controls, have a grace period of no less than 15 seconds and no more than 30 seconds to turn on lighting automatically after the sensor has timed out; and

   C. Provide a visible status signal that indicates that the device is operating properly, or that it has failed or malfunctioned. The visible status signal may have an override that turns off the signal.

   EXCEPTION to Section 110.9(b)4: Occupant Sensing Control systems may consist of a combination of single or multilevel Occupant, Motion, or Vacancy Sensor Controls, provided that components installed to comply with manual-on requirements shall not be capable of conversion by occupants from manual-on to automatic-on functionality.

5. **RESERVED** ~~**Part-Night Outdoor Lighting Controls**, as defined in Section 100.1, shall meet all of the following requirements:~~

~~A. Have sunrise and sunset prediction accuracy within +/- 15 minutes, using both light sensing and time measurement; and~~

~~B. Have the ability to reduce or turn off outdoor luminaire power at night as required in Section 130.2(c) ; and~~

~~C. Shall be programmable to reduce or turn off outdoor luminaire power at any time as determined by the user. Time-based scheduling control is allowed to be relative to both sunset and sunrise, and to the midpoint between sunset and sunrise.~~

6. **Sensors used to detect occupants.** Sensors that are used by occupant sensing controls to detect occupants shall meet all of the following requirements:

   A. Sensors shall not incorporate switches or mechanical devices that allow the sensor to be disabled without changing the settings of the control.

   B. Sensors that utilize ultrasonic radiation for detection of occupants shall:

      i. comply with 21 C.F.R. part 1002.12;

      ii. not emit audible sound; and

      iii. not emit ultrasound in excess of the decibel levels shown in Table 110.9-A measured no more than five feet from the source, on axis.

   C. Sensors that utilize microwave radiation for detection of occupants shall:

      i. comply with 47 C.F.R. parts 2 and 15; and

      ii. not emit radiation in excess of 1 milliwatt per square centimeter measured at no more than 5 centimeters from the emission surface of the device.

7. **Indicator Lights.** Indicator lights integral to lighting controls shall consume no more than one watt of power per indicator light.

(c) **Track Lighting Integral Current Limiter.** An integral current limiter for line-voltage track lighting shall be recognized for compliance with Part 6 only if it meets all of the following requirements:

1. Shall have the identical volt-ampere (VA) rating of the current limiter, as installed and rated for compliance with Part 6 clearly marked as follows; and:
   A. So that it is visible for the enforcement agency's field inspection without opening coverplates, fixtures, or panels; and
   B. Permanently marked on the circuit breaker; and
   C. On a factory-printed label that is permanently affixed to a nonremovable base-plate inside the wiring compartment.
2. Shall have a conspicuous factory installed label permanently affixed to the inside of the wiring compartment warning against removing, tampering with, rewiring, or bypassing the device; and
3. Each electrical panel from which track lighting integral current limiters are energized shall have a factory printed label permanently affixed and prominently located, stating the following: "NOTICE: Current limiting devices installed in track lighting integral current limiters connected to this panel shall only be replaced with the same or lower amperage. Adding track or replacement of existing current limiters with higher continuous ampere rating will void the track lighting integral current limiter certification, and will require resubmittal of compliance documentation to the enforcement agency responsible for compliance with the California Title 24, Part 6 Building Energy Efficiency Standards."

(d) **Track Lighting Supplementary Overcurrent Protection Panel.** A Track Lighting Supplementary Overcurrent Protection Panel shall be used only for line-voltage track lighting and shall be recognized for compliance with Part 6 only if it meets all of the following requirements:

1. Shall be listed as defined in Section 100.1; and
2. Shall have a permanently installed label that is prominently located stating the following: "NOTICE: This Panel for Track Lighting Energy Code Compliance Only. The overcurrent protection devices in this panel shall only be replaced with the same or lower amperage. No other overcurrent protective device shall be added to this panel. Adding to, or replacement of existing overcurrent protective device(s) with higher continuous ampere rating, will void the panel listing and require resubmittal of compliance documentation to the enforcement agency responsible for compliance with the California Title 24, Part 6 Building Energy Efficiency Standards."

TABLE 110.9-A - ULTRASOUND MAXIMUM DECIBEL VALUES

Mid-frequency of Sound Pressure Third-Octave Band (in kHz)	**Maximum db Level within Third-Octave Band (in dB reference 20 micropascals)**
Less than 20	80
20 or more to less than 25	105
25 or more to less than 31.5	110
31.5 or more	115

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 52943, Public Resources Code

SECTION 110.10 – MANDATORY REQUIREMENTS FOR SOLAR ~~READY BUILDINGS~~READINESS

(a) **Covered Occupancies.**

1. **Single- ~~-~~Family Residences.** Single- ~~-~~family residences located in subdivisions with ten or more single- ~~-~~family residences and where the application for a tentative subdivision map for the residences has been deemed complete approved by the enforcement agency, which do not have a photovoltaic system installed, shall comply with the requirements of Sections 110.10(b) through 110.10(e).
2. **Low-rise Multifamily Buildings.** Low-rise multi-family buildings that do not have a photovoltaic system installed shall comply with the requirements of Sections 110.10(b) through 110.10(d).
3. **Hotel/Motel Occupancies and High-rise Multifamily Buildings.** Hotel/motel occupancies and high-rise multifamily buildings with ten habitable stories or fewer, which do not have a photovoltaic system installed, shall comply with the requirements of Sections 110.10(b) through 110.10(d).
4. **Nonresidential Buildings.** Nonresidential buildings with three habitable stories or fewer, other than ~~healthcare facilities~~I-2 and I-2.1 buildings, which do not have a photovoltaic system installed, shall comply with the requirements of Sections 110.10(b) through 110.10(d).

(b) **Solar Zone.**

1. **Minimum Solar Zone Area.** The solar zone shall have a minimum total area as described below. The solar zone shall comply with access, pathway, smoke ventilation, and spacing requirements as specified in Title 24, Part 9 or other Parts of Title 24 or in any requirements adopted by a local jurisdiction. The solar zone total area shall be comprised of areas that have no dimension less than five feet and are no less than 80 square feet each for buildings with roof areas less than or equal to 10,000 square feet or no less than 160 square feet each for buildings with roof areas greater than 10,000 square feet.
   A. **Single- ~~-~~Family Residences.** The solar zone shall be located on the roof or overhang of the building and have a total area no less than 250 square feet.

      EXCEPTION 1 to Section 110.10(b)1A: Single- ~~-~~family residences with a permanently installed domestic solar water-heating system meeting the installation criteria specified in the Reference Residential Appendix RA4 and with a minimum solar savings fraction of 0.50.

      EXCEPTION 2 to Section 110.10(b)1A: Single- ~~-~~family residences with three habitable stories or more and with a total floor area less than or equal to 2000 square feet and having a solar zone total area no less than 150 square feet.

      EXCEPTION 3 to Section 110.10(b)1A: Single- ~~-~~family residences located in the Wildland-Urban Interface Fire Area as defined in Title 24, Part 2 and having a whole-house fan and having a solar zone total area no less than 150 square feet.

      EXCEPTION 4 to Section 110.10(b)1A: Buildings with a designated solar zone area that is no less than 50 percent of the potential solar zone area. The potential solar zone area is the total area of any low-sloped roofs where the annual solar access is 70 percent or greater and any steep-sloped roofs oriented between 90° and 300° of true north where the annual solar access is 70 percent or greater. Solar access is the ratio of solar insolation including shade to the solar insolation without shade. Shading from obstructions located on the roof or any other part of the building shall not be included in the determination of annual solar access.

      EXCEPTION 5 to Section 110.10(b)1A: Single- ~~-~~family residences having a solar zone total area no less than 150 square feet and where all thermostats are demand responsive controls and comply with Section 110.12(a), and are capable of receiving and responding to Demand Response Signals prior to granting of an occupancy permit by the enforcing agency.

      EXCEPTION 6 to Section 110.10(b)1A: Single- ~~-~~family residences meeting the following conditions:

A. All thermostats are demand responsive controls that comply with Section 110.12(a), and are capable of receiving and responding to Demand Response Signals prior to granting of an occupancy permit by the enforcing agency.

B. Comply with one of the following measures:

i. Install a dishwasher that meets or exceeds the ENERGY STAR Program requirements with a refrigerator that meets or exceeds the ENERGY STAR Program requirements, a whole-house fan driven by an electronically commutated motor, or an SAE J1772 Level 2 Electric Vehicle Supply Equipment (EVSE or EV Charger) with a minimum of 40 amperes; or

ii. Install a home automation system capable of, at a minimum, controlling the appliances and lighting of the dwelling and responding to demand response signals; or

iii. Install alternative plumbing piping to permit the discharge from the clothes washer and all showers and bathtubs to be used for an irrigation system in compliance with the *California Plumbing Code* and any applicable local ordinances; or

iv. Install a rainwater catchment system designed to comply with the *California Plumbing Code* and any applicable local ordinances, and that uses rainwater flowing from at least 65 percent of the available roof area.

B. **Low-rise and High-rise Multifamily Buildings, Hotel/Motel Occupancies, and Nonresidential Buildings.** The solar zone shall be located on the roof or overhang of the building or on the roof or overhang of another structure located within 250 feet of the building or on covered parking installed with the building project, and shall have a total area no less than 15 percent of the total roof area of the building excluding any skylight area. The solar zone requirement is applicable to the entire building, including mixed occupancy.

EXCEPTION 1 to Section 110.10(b)1B: High-rise Multifamily Buildings, Hotel/Motel Occupancies, and Nonresidential Buildings with a permanently installed solar electric system having a nameplate DC power rating, measured under Standard Test Conditions, of no less than one watt per square foot of roof area.

EXCEPTION 2 to Section 110.10(b)1B: High-rise Multifamily Buildings, Hotel/Motel Occupancies with a permanently installed domestic solar water-heating system complying with Section 150.1(c)8Biii.

EXCEPTION 3 to Section 110.10(b)1B: Buildings with a designated solar zone area that is no less than 50 percent of the potential solar zone area. The potential solar zone area is the total area of any low-sloped roofs where the annual solar access is 70 percent or greater and any steep-sloped roofs oriented between 90° and 300° of true north where the annual solar access is 70 percent or greater. Solar access is the ratio of solar insolation including shade to the solar insolation without shade. Shading from obstructions located on the roof or any other part of the building shall not be included in the determination of annual solar access.

EXCEPTION 4 to Section 110.10(b)1B: Low-rise and high-rise multifamily buildings with all thermostats in each dwelling unit are demand response controls that comply with Section 110.12(a), and are capable of receiving and responding to Demand Response Signals prior to granting of an occupancy permit by the enforcing agency. In addition, either A or B below:

A. In each dwelling unit, comply with one of the following measures:

i. Install a dishwasher that meets or exceeds the ENERGY STAR Program requirements with either a refrigerator that meets or exceeds the ENERGY STAR Program requirements or a whole-house fan driven by an electronically commutated motor; or

ii. Install a home automation system that complies with Section 110.12(a) and is capable of, at a minimum, controlling the appliances and lighting of the dwelling and responding to demand response signals; or

iii. Install alternative plumbing piping to permit the discharge from the clothes washer and all showers and bathtubs to be used for an irrigation system in compliance with the *California Plumbing Code* and any applicable local ordinances; or

iv. Install a rainwater catchment system designed to comply with the *California Plumbing Code* and any applicable local ordinances, and that uses rainwater flowing from at least 65 percent of the available roof area.

B. Meet the Title 24, Part 11, Section A4.106.8.2 requirements for electric vehicle charging spaces.

EXCEPTION 5 to Section 110.10(b)1B: Buildings where the roof is designed and approved to be used for vehicular traffic or parking or for a heliport.

2. **Azimuth Range.** All sections of the solar zone located on steep-sloped roofs shall ~~be oriented~~have an azimuth range between 90° and 300° of true north.

3. **Shading.**

A. No obstructions, including but not limited to, vents, chimneys, architectural features, and roof mounted equipment, shall be located in the solar zone.

B. Any obstruction, located on the roof or any other part of the building that projects above a solar zone shall be located at least twice the distance, measured in the horizontal plane, of the height difference between the highest point of the obstruction and the horizontal projection of the nearest point of the solar zone, measured in the vertical plane.

EXCEPTION to Section 110.10(b)3: Any roof obstruction, located on the roof or any other part of the building, that is oriented north of all points on the solar zone.

4. **Structural Design Loads on Construction Documents.** For areas of the roof designated as solar zone, the structural design loads for roof dead load and roof live load shall be clearly indicated on the construction documents.

NOTE: Section 110.10(b)4 does not require the inclusion of any collateral loads for future solar energy systems.

(c) **Interconnection Pathways.**

1. The construction documents shall indicate a location reserved for inverters and metering equipment and a pathway reserved for routing of conduit from the solar zone to the point of interconnection with the electrical service.

2. For single ~~-~~family residences and central water-heating systems, the construction documents shall indicate a pathway for routing of plumbing from the solar zone to the water-heating system.

(d) **Documentation.** A copy of the construction documents or a comparable document indicating the information from Sections 110.10(b) through 110.10(c) shall be provided to the occupant.

(e) **Main Electrical Service Panel.**

1. The main electrical service panel shall have a minimum busbar rating of 200 amps.

2. The main electrical service panel shall have a reserved space to allow for the installation of a double pole circuit breaker for a future solar electric installation. The reserved space shall be permanently marked as "For Future Solar Electric".

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402, 25402.1, and 25605, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, 25605, and 25943, Public Resources Code

SECTION 110.11 – MANDATORY REQUIREMENTS FOR ELECTRICAL POWER DISTRIBUTION SYSTEM

Certification by Manufacturers. Any electrical power distribution system equipment listed in this section may be installed only if the manufacture has certified to the Commission that the equipment complies with all the applicable requirements of this section.

(a) **Low-voltage dry-type distribution transformer** shall be certified by the Manufacturer as required by the Title 20 Appliance Efficiency Regulations.

EXCEPTION to Section 110.11(a):.

1. autotransformer;
2. drive (isolation) transformer;
3. grounding transformer;
4. machine-tool (control) transformer;
5. non-ventilated transformer;
6. rectifier transformer;
7. regulating transformer;
8. sealed transformer;
9. special-impedance transformer;
10. testing transformer;
11. transformer with tap range of 20 percent or more;
12. uninterruptible power supply transformer; or
13. welding transformer.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, Public Resources Code

SECTION 110.12 – MANDATORY REQUIREMENTS FOR DEMAND MANAGEMENT

Buildings, other than healthcare facilities, that install or are required to install demand responsive controls shall comply with the applicable demand responsive control requirements of Sections 110.12(a) through 110.12(~~d~~e).

(a) Demand responsive controls.

1. All demand responsive controls shall be either:
   A. A certified OpenADR 2.0a or OpenADR 2.0b Virtual End Node (VEN), as specified under Clause 11, Conformance, in the applicable OpenADR 2.0 Specification; or
   B. Certified by the manufacturer as being capable of responding to a demand response signal from a certified OpenADR 2.0b Virtual End Node by automatically implementing the control functions requested by the Virtual End Node for the equipment it controls.
2. All demand responsive controls shall be capable of communicating with the VEN using ~~one or more of the following: Wi-Fi, ZigBee, BACnet, Ethernet, or hard-wiring~~a wired or wireless bi-directional communication pathway.
3. ~~Demand responsive controls may incorporate and use additional protocols beyond those specified in Sections 110.12(a)1 and 2.~~
4. When communications are disabled or unavailable, all demand responsive controls shall continue to perform all other control functions provided by the control.
5. Demand responsive control thermostats shall comply with Reference Joint Appendix 5 (JA5), Technical Specifications For Occupant Controlled Smart Thermostats.

(b) **Demand Responsive Zonal HVAC Controls.** Nonresidential HVAC systems with DDC to the Zone level shall be programmed to allow centralized demand shed for noncritical zones as follows:

1. The controls shall have a capability to remotely increase the operating cooling temperature set points by 4° or more in all noncritical zones on signal from a centralized contact or software point within an Energy Management Control System (EMCS).
2. The controls shall have a capability to remotely decrease the operating heating temperature set points by 4° or more in all noncritical zones on signal from a centralized contact or software point within an EMCS.
3. The controls shall have capabilities to remotely reset the temperatures in all noncritical zones to original operating levels on signal from a centralized contact or software point within an EMCS.
4. The controls shall be programmed to provide an adjustable rate of change for the temperature increase, decrease, and reset.
5. The controls shall have the following features:
   A. Disabled. Disabled by authorized facility operators; and
   B. Manual control. Manual control by authorized facility operators to allow adjustment of heating and cooling set points globally from a single point in the EMCS; and
   C. Automatic Demand Shed Control. Upon receipt of a demand response signal, the space-conditioning systems shall conduct a centralized demand shed, as specified in Sections 110.12(b)1 and 110.12(b)2, for noncritical zones during the demand response period.

(c) **Demand Responsive Lighting Controls.** Nonresidential general lighting systems subject to the requirements of Section 130.1(b) with a general lighting power of 4,000 watts or greater, shall have controls that are~~Lighting controls in nonresidential buildings larger than 10,000 square feet shall be~~ capable of automatically reducing lighting power in response to a Demand Response Signal. General

lighting shall be reduced in a manner consistent with the uniform level of illumination requirements in TABLE 130.1-A.

1. For compliance testing, the lighting controls shall demonstrate a lighting power reduction in controlled spaces of a minimum of 15 percent below the total installed lighting power as described in NA7.6.3. The controls may provide additional demand responsive functions or abilities.

~~**EXCEPTION 1 to 110.12(c):** Spaces with a lighting power density of 0.5 watts per square foot or less are not required to install demand responsive controls and do not count toward the 10,000 square foot threshold.~~

EXCEPTION ~~2~~ to 110.12(c): Spaces where a health or life safety statute, ordinance, or regulation does not permit the general lighting to be reduced are not required to install demand responsive controls and do not count toward the ~~10,000 square foot~~4,000 watt threshold.

(d) **Demand Responsive Electronic Message Center Control.** Controls for electronic message centers greater than 15 kW shall be capable of reducing the lighting power by a minimum of 30 percent when receiving a demand response signal.

EXCEPTION to Section 110.12(d): Electronic message centers that are not permitted by a health or life safety statute, ordinance, or regulation to be reduced.

(e) **Demand Responsive Controlled Receptacles.** Controlled receptacles in buildings shall be capable of automatically turning off all loads connected to the receptacle in response to a demand response signal.

Exception 1 to 110.12(e): Buildings not required to have demand responsive lighting controls.

Exception 2 to 110.12(e): Spaces where a health or life safety statute, ordinance, or regulation does not permit the receptacles to be automatically controlled.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SUBCHAPTER 3
NONRESIDENTIAL, ~~HIGH-RISE RESIDENTIAL,~~ HOTEL/MOTEL OCCUPANCIES, AND COVERED PROCESSES—MANDATORY REQUIREMENTS

SECTION 120.0— GENERAL

Sections 120.1 through 120.9 establish requirements for the design and installation of building envelopes, ventilation, space-conditioning and service water-heating systems and equipment in nonresidential~~, high-rise residential,~~ and hotel/motel buildings, as well as covered processes that are within the scope of Section 100.0(a).

NOTE: The requirements of Sections 120.1 through 120.9 apply to newly constructed buildings. Section 141.0 specifies which requirements of Sections 120.1 through 120.9 also apply to additions or alterations to existing buildings.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 120.1 – REQUIREMENTS FOR VENTILATION AND INDOOR AIR QUALITY

(a) **General Requirements.**

1. All occupiable spaces in ~~high-rise residential buildings,~~ hotel/motel buildings, and nonresidential buildings other than healthcare facilities shall comply with the applicable requirements of Section 120.1(a) through 120.1(g). Healthcare facilities shall be ventilated in accordance with Chapter 4 of the California Mechanical Code.

2. The required outdoor air-ventilation rate and the air-distribution system design shall be clearly identified on the plans in accordance with Section 10-103 of Title 24, Part 1.

(b) Reserved~~**High-rise Residential Buildings.**~~

~~Attached dwellings units shall comply with the requirements of subsections 1 and 2 below. Occupiable spaces other than attached dwelling units shall comply with the requirements of section 120.1(c).~~

~~1. **Air Filtration.**~~

~~A. System types specified in subsections i, ii, and iii shall be provided with air filters in accordance with Sections 120.1(b)1B through 1D. System types specified in subsection i shall also comply with Section 120.1(b)1E.~~

~~i. Mechanical space conditioning systems that supply air to an occupiable space through ductwork exceeding 10 ft (3 m) in length.~~

~~ii. Mechanical supply-only ventilation systems that provide outside air to an occupiable space.~~

~~iii. The supply side of mechanical balanced ventilation systems, including heat recovery ventilation systems and energy recovery ventilation systems that provide outside air to an occupiable space.~~

~~B. System Design and Installation.~~

~~i. The system shall be designed to ensure that all recirculated air or outdoor air supplied to the occupiable space is filtered before passing through any system thermal conditioning components.~~

~~**EXCEPTION to Section 120.1(b)1Bi:** For heat recovery ventilators and energy recovery ventilators the location of the filters required by Section 120.1(b) may be downstream of a system thermal conditioning component, provided the system is equipped with ancillary filtration upstream of the system's thermal conditioning component.~~

~~ii. All systems shall be designed to accommodate the clean-filter pressure drop imposed by the system air filter(s). The design airflow rate, and maximum allowable clean-filter pressure drop at the design airflow rate applicable to each air filter shall be determined and reported on labels according to subsection iv below.~~

~~Systems specified in Section 120.1(b)1Ai shall be equipped with air filters that meet either subsection a or b below:~~

~~a. Nominal two-inch minimum depth filter(s) shall be sized by the system designer; or~~

~~b. Nominal one-inch minimum depth filters(s) shall be allowed if the filter(s) are sized according to Equation 120.1-A, based on a maximum face velocity of 150 ft per minute and according to the maximum allowable clean filter pressure drop specified in Section 120.1(b)1Dii~~

~~$A_{face} = Q_{filter} / V_{face}$ (Equation 120.1-A)~~

~~Where,~~

~~A_{face} = air filter face area, the product of air filter nominal length × nominal width, ft^2~~

~~Q_{filter} = design airflow rate for the air filter, ft^3/min~~

V_{face} = air filter face velocity ≤ 150, ft/min

iii. All system air filters shall be located and installed in such a manner as to be accessible for regular service by the system owner.

iv. All system air filter installation locations shall be labeled to disclose the applicable design airflow rate and the maximum allowable clean-filter pressure drop. The labels shall be permanently affixed to the air filter installation location, readily legible, and visible to a person replacing the air filter.

C. Air Filter Efficiency. The system shall be provided with air filter(s) having a designated efficiency equal to or greater than MERV 13 when tested in accordance with ASHRAE Standard 52.2, or a particle size efficiency rating equal to or greater than 50 percent in the 0.30-1.0 µm range and equal to or greater than 85 percent in the 1.0-3.0 µm range, when tested in accordance with AHRI Standard 680.

D. Air Filter Pressure Drop. All systems shall be provided with air filter(s) that conform to the applicable maximum allowable clean-filter pressure drop specified by i, ii or iii below, when tested using ASHRAE Standard 52.2, or as rated using AHRI Standard 680, for the applicable design airflow rate(s) for the system air filter(s).

i. The maximum allowable clean-filter pressure drop determined by the system design for the nominal two inch minimum depth air filter required by Section 120.1(b)1Biia; or

ii. A maximum of 25 PA (0.1 in. of water) clean-filter pressure drop shall be allowed for a nominal one-inch depth air filter sized according to Section 120.1(b)1Biib; or

iii. For system specified in 120.1(b)1Aii, and 120.1(b)1Aiii, the maximum allowable clean filter pressure drop determined by the system design.

E. Air Filter Product Labeling. Systems described in 120.1(b)1Ai shall be equipped with air filters that have been labeled by the manufacturer to disclose the efficiency and pressure drop ratings that demonstrate conformance with Sections 120.1(b)1.

EXCEPTION to Section 120.1(b)1: Evaporative coolers are not subject to the air filtration requirements of Section 120.1(b)1.

Attached dwelling units. All dwelling units shall meet the requirements of ASHRAE Standard 62.2, Ventilation and Acceptable Indoor Air Quality in Residential Buildings, subject to the amendments specified in subsection A below. All dwelling units shall comply with the Acceptance requirements specified in subsection B below.

A. Amendments to ASHRAE 62.2 requirements.

i. Window operation is not a permissible method of providing the dwelling unit ventilation airflow specified in subsections iv or v below.

ii. Continuous operation of central forced air system air handlers used in central fan integrated ventilation systems is not a permissible method of providing the dwelling unit ventilation airflow required in Section 4 of ASHRAE Standard 62.2.

EXCEPTION to Section 120.1(b)2Aii: The Energy Commission may approve continuous operation of central fan integrated ventilation systems pursuant to Section 10-109(h).

iii. Air filtration shall conform to the specifications in Section 120.1(b)1. Compliance with ASHRAE 62.2 Sections 6.7 (Minimum Filtration) and 6.7.1 (Filter Pressure Drop) shall not be required.

iv. Multifamily attached dwelling units shall comply with subsections a and b.

a. Mechanical ventilation airflow shall be provided at rates determined in accordance with Equation 120.1-B.

Total Required Ventilation Rate [ASHRAE 62.2.4.1.1]

$$Q_{tot} = 0.03A_{floor} + 7.5(N_{br} + 1) \quad \text{(Equation 120.1-B)}$$

~~Where,~~

~~Q_{tot} = total required ventilation rate, cfm~~

~~A_{floor} = dwelling-unit floor area, ft2~~

~~N_{br} = number of bedrooms (not to be less than 1)~~

~~b. The mechanical ventilation system shall comply with one of the following subsections 1 or 2 below. When subsection 2 is utilized for compliance, all dwelling units in the multifamily building shall use the same ventilation system type.~~

~~1. A balanced mechanical ventilation system shall provide the required dwelling-unit ventilation airflow.~~

~~2. Continuously operating supply ventilation systems or continuous operating exhaust ventilation systems shall be allowed to be used to provide the required dwelling unit ventilation airflow if the dwelling-unit envelope leakage is less than or equal to 0.3 cubic feet per minute at 50 Pa (0.2 in. of water) per ft² of dwelling unit envelope surface area as confirmed by field verification and diagnostic testing in accordance with Reference Nonresidential Appendix NA7.18.2.~~

~~v. Multifamily building central ventilation systems that serve multiple dwelling-units shall be balanced to provide ventilation airflow to each dwelling-unit served at a rate equal to or greater than the rate specified by Equation 120.1-B, but not more than twenty percent greater than the specified rate. These systems shall utilize balancing means to ensure the dwelling unit airflows can be adjusted to meet this balancing requirement. These system balancing means may include but not be limited to constant air regulation devices, orifice plates, and variable speed central fans.~~

~~vi. Kitchen range hoods shall be rated for sound in accordance with Section 7.2 of ASHRAE 62.2.~~

~~**EXCEPTION to Section 120.1(b)2Avi:** Kitchen range hoods may be rated for sound at a static pressure determined at working speed as specified in HVI 916 Section 7.2.~~

~~vii. Compliance with ASHRAE 62.2 Section 6.5.2 (Space Conditioning System Ducts) shall not be required.~~

~~viii. Compliance with ASHRAE 62.2 Section 4.4 (Control and Operation) shall require manual switches associated with dwelling unit ventilation systems to have a label clearly displaying the following text, or equivalent text: "This switch controls the indoor air quality ventilation for the home. Leave it on unless the outdoor air quality is very poor."~~

~~B. High-Rise Residential Dwelling Unit Acceptance.~~

~~i. **Airflow Performance**. The dwelling-unit ventilation airflow required by Section 120.1(b)2Aiv or 120.1(b)2Av shall be confirmed through field verification and diagnostic testing in accordance with Reference Nonresidential Appendix NA7.18.1.~~

~~ii. Kitchen Range Hoods. The installed kitchen range hood shall be field-verified in accordance with Reference Nonresidential Appendix NA7.18.1 to confirm the model is rated by HVI to comply with the following requirements:~~

~~a. The minimum ventilation airflow rate as specified in Section 5 of ASHRAE 62.2.~~

~~b. The maximum sound rating as specified in Section 120.1(b)2Avi.~~

(c) **Nonresidential and Hotel/Motel Buildings.** All occupiable spaces shall meet the requirements of ~~subsection 1~~Section 120.1(c)1, and shall also comply with either ~~2~~Section 120.1(c)2 or ~~3~~Section 120.1(c)3.~~:~~

1. **Air Filtration.**

A. Mechanical system types specified in subsections i, ii, and iii below ~~described in Section 120.1(b)1A~~ shall be designed to ensure that all recirculated air and all outdoor air supplied to the occupiable

space is filtered before passing through any system thermal conditioning components. Air Filters shall conform to the requirements of Sections 120.1(c)1B, 120.1(c)1C and 120.1(c)1D.~~provided with air filters to clean the outside and return air prior to its introduction into occupied spaces.~~

i. Mechanical space conditioning systems that supply air to an occupiable space through ductwork exceeding 10 ft (3 m) in length.

ii. Mechanical supply-only ventilation systems and makeup air systems that provide outside air to an occupiable space.

iii. The supply side of mechanical balanced ventilation systems, including heat recovery ventilation systems and energy recovery ventilation systems that provide outside air to an occupiable space.

EXCEPTION to Section 120.1(c)1A: For heat recovery ventilators and energy recovery ventilators the location of the filters required by Section 120.1(c)1A may be downstream of a system thermal conditioning component, provided the system is equipped with ancillary filtration upstream of the system's thermal conditioning component

B. Air Filter Efficiency. The filters shall have a designated efficiency equal to or greater than MERV 13 when tested in accordance with ASHRAE Standard 52.2, or a particle size efficiency rating equal to or greater than 50 percent in the 0.30-1.0 µm range, and equal to or greater than 85 percent in the 1.0-3.0 µm range when tested in accordance with AHRI Standard 680; and

C. Systems shall be equipped with air filters that meet either subsection i or ii below.

i. Nominal two inch minimum depth filter(s); or

ii. Nominal one inch minimum depth filter(s) shall be allowed if the filter(s) are sized according to Equation 120.1-A, based on a maximum face velocity of 150 ft per minute.

$A_{face} = Q_{filter} / V_{face}$ (Equation 120.1-A)

Where,

A_{face} = air filter face area, the product of air filter nominal length × nominal width, ft^2

Q_{filter} = design airflow rate for the air filter, ft^3/min

V_{face} = air filter face velocity ≤ 150, ft/min

D. Filter racks or grilles shall be gasketed or sealed to eliminate any gaps around the filter to prevent air from bypassing the filter.

2. **Natural Ventilation.** Naturally ventilated spaces shall be designed in accordance with 120.1(c)2A through 120.1(c)2C and include a mechanical ventilation system designed in accordance with 120.1(c)3:

A. Floor area to be ventilated. Spaces or portions of spaces to be naturally ventilated shall be located within a distance based on the ceiling height, as specified in i, ii and iii. The ceiling height (H) to be used in i, ii or iii shall be the minimum ceiling height in the space, or for ceilings that are increasing in height as distance from the operable openings is increased, the ceiling height shall be determined as the average height of the ceiling within 20 ft from the operable opening. [ASHRAE 62.1:6.4.1]

i. Single Side Opening. For spaces with operable opening on one side of the space, the maximum distance from the operable opening shall be not more than 2H. [ASHRAE 62.1:6.4.1.1]

ii. Double Side Opening. For spaces with operable openings on two opposite sides of the space, the maximum distance from the operable opening shall be not more than 5H. [ASHRAE 62.1:6.4.1.2]

iii. Corner Opening. For spaces with operable openings on two adjacent sides of a space, the maximum distance from the operable openings shall be not more than 5H along a line drawn between the two openings that are the farthest apart. Floor area outside that line shall comply with i or ii. [ASHRAE 62.1:6.4.1.3]

iv. Ceiling Height. The ceiling height (~~h~~H) to be used in Section 120.1(c)2Ai through 120.1(c)2Aiii shall be the minimum ceiling height in the space.

EXCEPTION to Section 120.1(c)2Aiv: For ceilings that are increasing in height as distance from the opening is increased, the ceiling height shall be determined as the average height of the ceiling within 20 feet from the operable openings. [ASHRAE 62.1:6.4.1.4]

B. Location and Size of Openings. Spaces or portions of spaces to be naturally ventilated shall be permanently open to operable wall openings directly to the outdoors. The openable area shall be not less than 4 percent of the net occupiable floor area. Where openings are covered with louvers or otherwise obstructed, the openable area shall be based on the net free unobstructed area through the opening. Where interior rooms, or portions of rooms, without direct openings to the outdoors are ventilated through adjoining rooms, the opening between rooms shall be permanently unobstructed and have a free area of not less than 8 percent of the area of the interior room or less than 25 square feet. [ASHRAE 62.1:6.4.2]

C. Control and Accessibility. The means to open the required operable opening shall be readily accessible to building occupants whenever the space is occupied. Controls shall be designed to coordinate operation of the natural and mechanical ventilation systems. [ASHRAE 62.1:6.4.3]

EXCEPTION 1 to Section 120.1(c)2: The mechanical ventilation system shall not be required where natural ventilation openings complying with 120.1(c)2 are either permanently open or have controls that prevent the openings from being closed during periods of expected occupancy.

EXCEPTION 2 to Section 120.1(c)2: The mechanical ventilation system shall not be required where the zone is not served by a space conditioning system.

3. **Mechanical Ventilation.** Occupiable spaces shall be ventilated with a mechanical ventilation system capable of providing an outdoor airflow rate to the zone (V_z) ~~to the zone~~ no less than Equation 120.1-F ~~the larger of A or B~~ as described below:

~~A. The outdoor airflow rate to the zone (V_z) shall be determined in accordance with Equation 120.1-F; or~~

$$V_z = R_{at} \times A_z \quad \text{(Equation 120.1-F)}$$

Where:

R_{at} = Total outdoor airflow rate required per unit area as determined from Table 120.1-A.

A_z = Zone floor area, ~~is~~ meaning the net occupiable floor area of the ventilation zone in square feet.

~~B.~~ **EXCEPTION 1 to Section 120.1(c)3: Designed Occupancy.** For spaces designed for an expected number of occupants per the Exception to Section 1004.5 of the CBC, or spaces with fixed seating per Section 1004.6 of the CBC, the outdoor airflow rate to the zone (V_z) shall be determined in accordance with Equation 120.1-G;

$$V_z = \text{The larger of } R_p \times P_z \text{ or } R_a \times A_z \quad \text{(Equation 120.1-G)}$$

Where:

R_p = 15 cubic feet per minute of outdoor airflow per person

P_z = The expected number of occupants. The expected number of occupants shall be the expected number specified by the building designer. For spaces with fixed seating, the expected number of occupants shall be determined in accordance with the California Building Code.

R_a = The minimum ventilation airflow rate allowed for DCV in Table 120.1-A. If R_a is not defined for an occupancy category, $R_a = 0$.

A_z = Zone floor area, meaning the net occupiable floor area of the ventilation zone in square feet.

EXCEPTION 2 to Section 120.1(c)3: Transfer air. The rate of outdoor air required by Section 120.1(c)3 may be provided with air transferred from other ventilated space if:

A. Use of transfer air is in accordance with Section 120.1(g); and

B. The outdoor air that is supplied to all spaces combined, is sufficient to meet the requirements of Section 120.1(c)3 for each space individually.

4. **Exhaust Ventilation.** The design exhaust airflow shall be determined in accordance with the requirements in Table 120.1-B. Exhaust makeup air shall be permitted to be any combination of outdoor air, recirculated air, or transfer air. [ASHRAE 62.1:6.5.1]

(d) **Operation and Control Requirements for Minimum Quantities of Outdoor Air.**

1. **Times of occupancy.** The minimum rate of outdoor air required by Section 120.1(c) shall be supplied to each space at all times when the space is usually occupied.

   EXCEPTION 1 to Section 120.1(d)1: Demand control ventilation. In intermittently occupied spaces that do not have processes or operations that generate dusts, fumes, mists, vapors or gasses and are not provided with local exhaust ventilation (such as indoor operation of internal combustion engines or areas designated for unvented food service preparation), the rate of outdoor air may be reduced if the ventilation system serving the space is controlled by a demand control ventilation device complying with Section 120.1(d)4 or by an occupant sensor ventilation control device complying with Section 120.1(d)5.

   EXCEPTION 2 to Section 120.1(d)1: Temporary reduction. The rate of outdoor air provided to a space may be reduced below the level required by Section 120.1(c) for up to 30 minutes at a time if the average rate for each hour is equal to or greater than the required ventilation rate.

2. **Pre-occupancy.** The lesser of the minimum rate of outdoor air required by Section 120.1(c) or three complete air changes shall be supplied to the entire building during the 1-hour period immediately before the building is normally occupied.

3. **Required Demand Control Ventilation.** Demand ventilation controls complying with Section 120.1(d)4 are required for a space with a design occupant density, or a maximum occupant load factor for egress purposes in the CBC, greater than or equal to 25 people per 1000 square feet (40 square feet or less per person) if the ventilation system serving the space has one or more of the following:

   A. an air economizer; or

   B. modulating outside air control; or

   C. design outdoor airflow rate > 3,000 cfm.

   EXCEPTION 1 to Section 120.1(d)3: Where space exhaust is greater than the design ventilation rate specified in Section 120.1(c)3 minus 0.2 cfm per ft² of conditioned area.

   EXCEPTION 2 to Section 120.1(d)3: Spaces that have processes or operations that generate dusts, fumes, mists, vapors, or gases and are not provided with local exhaust ventilation, such as indoor operation of internal combustion engines or areas designated for unvented food service preparation, daycare sickrooms, science labs, barber shops or beauty and nail salons shall not install demand control ventilation.

   EXCEPTION 3 to Section 120.1(d)3: Spaces with an area of less than 150 square feet, or a design occupancy of less than 10 people as specified by Section 120.1(c)3.

4. **Demand Control Ventilation Devices.**

   A. For each system with demand control ventilation (DCV), CO_2 sensors shall be installed in each room that meets the criteria of Section 120.1(d)3 with no less than one sensor per 10,000 ft² of floor space. When a zone or a space is served by more than one sensor, a signal from any sensor indicating that CO_2 is near or at the setpoint within the zone or space shall trigger an increase in ventilation.

   B. CO_2 sensors shall be located in the room between 3 ft and 6 ft above the floor or at the anticipated height of the occupants' heads.

C. Demand ventilation controls shall maintain CO_2 concentrations less than or equal to 600 ppm plus the outdoor air CO_2 concentration in all rooms with CO_2 sensors.

EXCEPTION to Section 120.1(d)4C: The outdoor air ventilation rate is not required to be larger than the design outdoor air ventilation rate required by Section 120.1(c)3 regardless of CO_2 concentration.

D. Outdoor air CO_2 concentration shall be determined by one of the following:

i. CO_2 concentration shall be assumed to be 400 ppm without any direct measurement; or

ii. CO_2 concentration shall be dynamically measured using a CO_2 sensor located within 4 ft of the outdoor air intake.

E. When the system is operating during hours of expected occupancy, the controls shall maintain system outdoor air ventilation rates no less than the rate listed in Table 120.1-A for DCV, times the conditioned floor area for spaces with CO_2 sensors, plus the rate required by Section 120.1(c)3 for other spaces served by the system, or the exhaust air rate whichever is greater.

F. CO_2 sensors shall be certified by the manufacturer to be accurate within plus or minus 75 ppm at a 600 and 1000 ppm concentration when measured at sea level and 25°C, factory calibrated, and certified by the manufacturer to require calibration no more frequently than once every 5 years. Upon detection of sensor failure, the system shall provide a signal which resets to supply the minimum quantity of outside air to levels required by Section 120.1(c)3 to the zone serviced by the sensor at all times that the zone is occupied.

G. The CO_2 sensor(s) reading for each zone shall be displayed continuously, and shall be recorded on systems with DDC to the zone level.

5. **Occupant Sensor Ventilation Control Devices.** ~~When occupancy sensor ventilation devices are required by Section 120.2(e)3,~~ Occupancy sensor ventilation controls are required for air conditioning zones that are both permitted to have their ventilation air reduced to zero while in occupied standby mode per Table 120.1-A and required to install occupant sensors to comply with Section 130.1. ~~Occupant sensors~~Occupant sensing ventilation control devices ~~shall be~~ used to reduce the rate of outdoor airflow when occupants are not present ~~in accordance~~shall comply with the following:

A. Occupant sensors shall ~~meet the requirements in Section 110.9(b)4 and shall~~ have suitable coverage and placement to detect occupants in the entire space ventilated. Within 20 minutes of no occupancy being detected by any sensors covering the room, occupant sensing controls shall indicate a room is vacant.

B. ~~If~~ When occupant sensors controlling lighting are also used for ventilation, the ventilation signal shall be independent of daylighting, manual lighting overrides or manual control of lighting.

C. When a single zone damper or a single zone system serves multiple rooms, there shall be an occupancy sensor in each room and the zone ~~is~~ shall not be considered vacant until all rooms in the zone are vacant.

~~B~~D. One hour prior to normal scheduled occupancy, the occupancy sensor ventilation control shall allow pre-occupancy purge as described in Section 120.1(d)2.

E. When the zone is scheduled to be occupied and occupancy sensing controls in all rooms and areas served by the zone indicate the spaces are unoccupied, the zone shall be placed in occupied standby mode.

F. Within 5 minutes of entering occupied-standby mode, mechanical ventilation to the zone shall be shut off until the space becomes occupied or until ventilation is needed to provide space heating or conditioning.

G. Where the system providing space conditioning also provides ventilation to the zone, within 5 minutes of entering occupied-standby mode, space conditioning zone setpoints shall be reset in accordance with Section 120.2(e)3.

(e) **Ducting for Zonal Heating and Cooling Units.** Where a return plenum is used to distribute outdoor air to a zonal heating or cooling unit which then supplies the air to a space in order to meet the requirements of Section 120.1(c)3, the outdoor air shall be ducted to discharge either:

1. Within 5 feet of the unit; or
2. Within 15 feet of the unit, substantially toward the unit, and at a velocity not less than 500 feet per minute.

(f) **Design and Control Requirements for Quantities of Outdoor Air.**

1. All mechanical ventilation and space-conditioning systems shall be designed with and have installed ductwork, dampers, and controls ~~to~~ that allow design minimum outside air rates to be operated at no less than the larger of (1) the minimum levels specified in Section 120.1(c)3 or (2) the rate required for make-up of exhaust systems that are required for an exempt or covered process, for control of odors, or for the removal of contaminants within the space.
2. All variable air volume mechanical ventilation and space-conditioning systems shall include dynamic controls that are capable of maintaining measured outside air ventilation rates within 10 percent of the ~~required~~design minimum outside air ventilation rate at both full and reduced supply airflow conditions. Fixed minimum damper position is not considered to be dynamic and is not an allowed control strategy.
3. ~~Measured outdoor air rates of constant volume~~All mechanical ventilation and space-conditioning systems shall be tested to confirm their ability to operate within 10 percent of the ~~required~~design minimum outside air rate.

(g) **Air Classification and Recirculation Limitations.** Air classification and recirculation limitations of air shall be based on the air classification as listed in Table 120.1-A or Table 120.1-C, and in accordance with the requirements of 120.1(g)1 through 4.

NOTE: Air class definitions are taken directly from ASHRAE 62.1 and are duplicated here for convenience.

1. **Class 1 Air** is air with low contaminant concentration, low sensory-irritation intensity, or inoffensive odor. Recirculation or transfer of Class 1 air to any space shall be permitted; [ASHRAE 62.1:5.16.3.1]
2. **Class 2 Air** is air with moderate contaminant concentration, mild sensory-irritation intensity, or mildly offensive odors (Class 2 air also includes air that is not necessarily harmful or objectionable but that is inappropriate for transfer or recirculation to spaces used for different purposes). Recirculation or transfer of Class 2 air shall be permitted in accordance with 120.1(g)2A through 120.1(g)2E:
   A. Recirculation of Class 2 air within the space of origin shall be permitted [ASHRAE 62.1:5.16.3.2.1]:
   B. Recirculation or transfer of Class 2 to other Class 2 or Class 3 spaces shall be permitted, provided that the other spaces are used for the same or similar purpose or task and involve the same or similar pollutant sources as the Class 2 space [ASHRAE 62.1:5.16.3.2.2]; or
   C. Transfer of Class 2 air to toilet rooms [ASHRAE 62.1:5.16.3.2.3]; or
   D. Recirculation or transfer of Class 2 air to Class 4 spaces [ASHRAE 62.1:5.16.3.2.4]; or
   E. Class 2 air shall not be recirculated or transferred to Class 1 spaces. [ASHRAE 62.1:5.16.3.2.5]

   EXCEPTION to Section 120.1(g)2E: When using any energy recovery device, recirculation from leakage, carryover, or transfer from the exhaust side of the energy recovery device is permitted. Recirculated Class 2 air shall not exceed 10% of the outdoor air intake flow.
3. **Class 3 Air** is air with significant contaminant concentration, significant sensory-irritation intensity, or offensive odor. Recirculation or transfer of Class 3 air shall be permitted in accordance with 120.1(g)3A and B:
   A. Recirculation of Class 3 air within the space of origin shall be permitted. [ASHRAE 62.1:5.16.3.3.1]

B. Class 3 air shall not be recirculated or transferred to any other space. [ASHRAE 62.1:5.16.3.3.2].

EXCEPTION to Section 120.1(g)3B: When using any energy recovery device, recirculation from leakage, carryover, or transfer from the exhaust side of the energy recovery device is permitted. Recirculated Class 3 air shall not exceed 5% of the outdoor air intake flow.

4. **Class 4 Air** is air with highly objectionable fumes or gases or with potentially dangerous particles, bioaerosols, or gases at concentrations high enough to be considered as harmful. Class 4 air shall not be recirculated or transferred to any space or recirculated within the space of origin. [ASHRAE 62.1:5.16.3.4]

5. **Ancillary spaces.** Redesignation of Class 1 air to Class 2 air shall be permitted for Class 1 spaces that are ancillary to Class 2 spaces. [ASHRAE 62.1:5.16.2.3]

6. **Transfer.** A mixture of air that has been transferred through or returned form spaces or locations with different air classes shall be redesignated with the highest classification among the air classes mixed. [ASHRAE 62.1:5.16.2.2]

7. **Classification.** Air leaving each space or location shall be designated at an expected air-quality classification not less than that shown in Tables 120.1-A, 120.1-B or 120.1-C. Air leaving spaces or locations that are not listed in Tables 120.1-A, 120.1-B or 120.1-C shall be designated with the same classification as air from the most similar space or location listed in terms of occupant activities and building construction.

(h) **Ventilation Only Mechanical Systems.** HVAC Systems without mechanical cooling or mechanical heating shall meet the requirements of Section 120.2(f).

Table 120.1-A – Minimum Ventilation Rates

Occupancy Category	~~Area Outdoor Air~~Total Outdoor Air Rate[1] R_t~~a~~ (cfm/ft²)	Min Ventilation Air Rate for DCV[2] R_a (cfm/ft²)	Air Class	Notes
Educational Facilities				
Daycare (through age 4)	0.21	0.15	2	
Daycare sickroom	0.15		3	
Classrooms (ages 5-8)	0.38	0.15	1	
Classrooms (age 9 -18)	0.38	0.15	1	
Lecture/postsecondary classroom	0.38	0.15	1	F
Lecture hall (fixed seats)	-	0.15	1	F
Art classroom	0.15		2	
Science laboratories	0.15		2	
University/college laboratories	0.15		2	
Wood/metal shop	0.15		2	
Computer lab	0.15		1	
Media center	0.15		1	A
Music/theater/dance	1.07	0.15	1	F
Multiuse assembly	0.5	0.15	1	F

Occupancy Category	Total Outdoor Airflow~~Area Outdoor Air~~ Rate[1] R_t~~a~~ cfm/ft^2	Min Ventilation Air Rate for DCV[2] R_a (cfm/ft^2)	Air Class	Notes
Food and Beverage Service				
Restaurant dining rooms	0.5	0.15	2	
Cafeteria/fast-food dining	0.5	0.15	2	
Bars, cocktail lounges	0.5	0.2	2	
Kitchen (cooking)	0.15		2	
General				
Break rooms	0.5	0.15	1	F
Coffee Stations	0.5	0.15	1	F
Conference/meeting	0.5	0.15	1	F
Corridors	0.15		1	F
Occupiable storage rooms for liquids or gels	0.15		2	B
Hotels, Motels, Resorts, Dormitories				
Bedroom/living room	0.15		1	F
Barracks sleeping areas	0.15		1	F
Laundry rooms, central	0.15		2	
Laundry rooms within dwelling units	0.15		1	
Lobbies/pre-function	0.5	0.15	1	F
Multipurpose assembly	0.5		1	F
Office Buildings				
Breakrooms	0.5	0.15	1	G
Main entry lobbies	0.5	0.15	1	F
Occupiable storage rooms for dry materials	0.15		1	
Office space	0.15		1	F
Reception areas	0.15		1	F
Telephone/data entry	0.15		1	F
Miscellaneous Spaces				
Bank vaults/safe deposit	0.15		2	F
Banks or bank lobbies	0.15		1	F
Computer (not printing)	0.15		1	F
Freezer and refrigerated spaces (<50oF)	-		2	E

Occupancy Category	Total Outdoor Airflow~~Area Outdoor Air~~ Rate[1] R_t~~a~~ cfm/ft^2	Min Ventilation Air Rate for DCV[2] R_a (cfm/ft^2)	Air Class	Notes
General manufacturing (excludes heavy industrial and process using chemicals)	0.15		3	
Pharmacy (prep. Area)	0.15		2	
Photo studios	0.15		1	
Shipping/receiving	0.15		2	B
Sorting, packing, light assembly	0.15		2	
Telephone closets	0.15		1	
Transportation waiting	0.5	0.15	1	F
Warehouses	0.15		2	B
All others	0.15		2	
Public Assembly Spaces				
Auditorium seating area	1.07	0.15	1	F
Places of religious worship	1.07	0.15	1	F
Courtrooms	0.19	0.15	1	F
Legislative chambers	0.19	0.15	1	F
Libraries (reading rooms and stack areas)	0.15		1	
Lobbies	0.5	0.15	1	F
Museums (children's)	0.25	0.15	1	
Museums/galleries	0.25	0.15	1	F
Residential				
Common corridors	0.15		1	F
Retail				
Sales (except as below)	0.25	0.2	2	H
Mall common areas	0.25	0.15	1	F
Barbershop	0.4		2	
Beauty and nail salons	0.4		2	
Pet shops (animal areas)	0.25	0.15	2	
Supermarket	0.25	0.2	1	F
Coin-operated laundries	0.3		2	
Sports and Entertainment				
Gym, sports arena (play area)	0.5	0.15	2	E

Occupancy Category	Total Outdoor Airflow~~Area Outdoor Air~~ Rate[1] R_{ta} cfm/ft^2	Min Ventilation Air Rate for DCV[2] R_a (cfm/ft^2)	Air Class	Notes
Spectator areas	0.5	0.15	1	F
Swimming (pool)	0.15		2	C
Swimming (deck)	0.5	0.15	2	C
Disco/dance floors	1.5	0.15	2	F
Health club/aerobics room	0.15		2	
Health club/weight rooms	0.15		2	
Bowling alley (seating)	1.07	0.15	1	
Gambling casinos	0.68	0.15	1	
Game arcades	0.68	0.15	1	
Stages, studios	0.5	0.15	1	D, F

General footnotes for Table 120.1-A:

[1] R_{ta} ~~was~~ is determined as being the larger of the area method and the default per person method. The occupant density used in the default per person method ~~was assumed to be~~is one half of the maximum occupant load assumed for egress purposes in the CBC.

~~[2] If this column specifies a minimum cfm/ft2 then it shall be used to comply with Section 120.1(d)4E.~~

Specific Notes:

A – For high-school and college libraries, the values shown for “Public Assembly Spaces – Libraries” shall be used.

B – Rate may not be sufficient where stored materials include those having potentially harmful emissions.

C – Rate does not allow for humidity control. “Deck area” refers to the area surrounding the pool that is capable of being wetted during pool use or when the pool is occupied. Deck area that is not expected to be wetted shall be designated as an occupancy category.

D – Rate does not include special exhaust for stage effects such as dry ice vapors and smoke.

E – Where combustion equipment is intended to be used on the playing surface or in the space, additional dilution ventilation, source control, or both shall be provided.

F – Ventilation air for this occupancy category shall be permitted to be reduced to zero when the space is in occupied-standby mode.

Table 120.1-B – Minimum Exhaust Rates
[ASHRAE 62.1: Table 6.5]

Occupancy Category	Exhaust Rate, cfm/unit	Exhaust Rate, cfm/ft^2	Air Class	Notes
Arenas	-	0.50	1	B
Art classrooms	-	0.70	2	
Auto repair rooms	-	1.5	2	A
Barber shops	-	0.50	2	
Beauty and nail salons	-	0.60	2	
Cells with toilet	-	1.00	2	
Copy, printing rooms	-	0.50	2	
Darkrooms	-	1.00	2	
Educational science laboratories	-	1.00	2	
Janitor closets, trash rooms, recycling	-	1.00	3	
Kitchenettes	-	0.30	2	
Kitchens – commercial	-	0.70	2	
Locker rooms for athletic or industrial facilities	-	0.50	2	
All other locker rooms	-	0.25	2	
Shower rooms	20/50	-	2	G,H
Paint spray booths	-	-	4	F
Parking garages	-	0.75	2	C
Pet shops (animal areas)	-	0.90	2	
Refrigerating machinery rooms	-	-	3	F
Soiled laundry storage rooms	-	1.00	3	F
Storage rooms, chemical	-	1.50	4	F
Toilets – private	25/50	-	2	E
Toilets – public	50/70	-	2	D
Woodwork shop/classrooms	-	0.50	2	

Notes:
A – Stands where engines are run shall have exhaust systems that directly connect to the engine exhaust and prevent escape of fumes.
B – Where combustion equipment is intended to be used on the playing surface, additional dilution ventilation, source control, or both shall be provided.
C – Exhaust shall not be required where two or more sides comprise walls that are at least 50% open to the outside.
D – Rate is per water closet, urinal, or both. Provide the higher rate where periods of heavy use are expected to occur. The lower rate shall be permitted to be used otherwise.
E – Rate is for a toilet room intended to be occupied by one person at a time. For continuous systems operation during hours of use, the lower rate shall be permitted to be used. Otherwise the higher rate shall be used.
F – See other applicable standards for exhaust rate.
G – For continuous system operation, the lower rate shall be permitted to be used. Otherwise the higher rate shall be used.
H – Rate is per showerhead

Table 120.1-C – Airstreams or Sources
[ASHRAE 62.1:Table 5.16.1]

Description	Air Class
Diazo printing equipment discharge	4
Commercial kitchen grease hoods	4
Commercial kitchen hoods other than grease	3
Laboratory hoods	4[a]
Hydraulic elevator machine room	2

a. Air Class 4 unless determined otherwise by the Environmental Health and Safety professional responsible to the owner or to the owner's designee.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, Public Resources Code.

SECTION 120.2 – REQUIRED CONTROLS FOR SPACE-CONDITIONING SYSTEMS

Nonresidential, high-rise residential, and hotel/motel buildings shall comply with the applicable requirements of Sections 120.2(a) through 120.2(k).

(a) **Thermostatic Controls for Each Zone.** The supply of heating and cooling energy to each space-conditioning zone or dwelling unit shall be controlled by an individual thermostatic control that responds to temperature within the zone and that meets the applicable requirements of Section 120.2(b). An Energy Management Control System (EMCS) may be installed to comply with the requirements of one or more thermostatic controls if it complies with all applicable requirements for each thermostatic control.

EXCEPTION to Section 120.2(a): An independent perimeter heating or cooling system may serve more than one zone without individual thermostatic controls if:

1. All zones are also served by an interior cooling system; and
2. The perimeter system is designed solely to offset envelope heat losses or gains; and
3. The perimeter system has at least one thermostatic control for each building orientation of 50 feet or more; and
4. The perimeter system is controlled by at least one thermostat located in one of the zones served by the system.

(b) **Criteria for Zonal Thermostatic Controls.** The individual thermostatic controls required by Section 120.2(a) shall meet the following requirements as applicable:

1. Where used to control comfort heating, the thermostatic controls shall be capable of being set, locally or remotely, down to 55°F or lower.
2. Where used to control comfort cooling, the thermostatic controls shall be capable of being set, locally or remotely, up to 85°F or higher.
3. Where used to control both comfort heating and comfort cooling, the thermostatic controls shall meet Items 1 and 2 and shall be capable of providing a temperature range or deadband of at least 5°F within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum.

   EXCEPTION 1 to Section 120.2(b)3: Systems with thermostats that require manual changeover between heating and cooling modes.

   EXCEPTION 2 to Section 120.2(b)3: Systems serving healthcare facilities.
4. Thermostatic controls for all single zone air conditioners and heat pumps, shall comply with the requirements of Sections 110.2(c) and 110.12(a) and, if equipped with DDC to the Zone level, with the Automatic Demand Shed Controls of Section 110.12(b).

   EXCEPTION 1 to Section 120.2(b)4: Systems serving exempt process loads that must have constant temperatures to prevent degradation of materials, a process, plants or animals.

   EXCEPTION 2 to Section 120.2(b)4: Package terminal air conditioners, package terminal heat pumps, room air conditioners, and room air-conditioner heat pumps.

   EXCEPTION 3 to Section 120.2(b)4: Systems serving healthcare facilities.

(c) **Hotel/Motel Guest Room ~~and High-rise Residential Dwelling Unit~~ Thermostats.**

1. Hotel/motel guest room thermostats shall:
   A. Have numeric temperature setpoints in °F and °C; and
   B. Have setpoint stops, which are accessible only to authorized personnel, such that guest room occupants cannot adjust the setpoint more than ±5°F (±3°C); and

C. Meet the requirements of Section 110.2(c).

EXCEPTION to Section 120.2(c)1: Thermostats that are integrated into the room heating and cooling equipment.

~~2. High-rise residential dwelling unit thermostats shall meet the requirements of Section 110.2(c).~~

(d) **Heat Pump Controls.** All heat pumps with supplementary electric resistance heaters shall be installed with controls that comply with Section 110.2(b).

(e) **Shut-off and Reset Controls for Space-conditioning Systems.** Each space-conditioning system shall be installed with controls that comply with the following:

1. The control shall be capable of automatically shutting off the system during periods of nonuse and shall have:

   A. An automatic time switch control device complying with Section 110.9, with an accessible manual override that allows operation of the system for up to 4 hours; or

   B. An occupancy sensor; or

   C. A 4-hour timer that can be manually operated.

   EXCEPTION to Section 120.2(e)1: Mechanical systems serving retail stores and associated malls, restaurants, grocery stores, churches, and theaters equipped with 7-day programmable timers.

2. The control shall automatically restart and temporarily operate the system as required to maintain:

   A. A setback heating thermostat setpoint if the system provides mechanical heating; and

   EXCEPTION to Section 120.2(e)2A: Thermostat setback controls are not required in nonresidential buildings in areas where the Winter Median of Extremes outdoor air temperature determined in accordance with Section 140.4(b)3 is greater than 32°F.

   B. A setup cooling thermostat setpoint if the system provides mechanical cooling.

   EXCEPTION to Section 120.2(e)2B: Thermostat setup controls are not required in nonresidential buildings in areas where the Summer Design Dry Bulb 0.5 percent temperature determined in accordance with Section 140.4(b)3 is less than 100°F.

3. **Occupancy Sensing Zone Controls.** ~~Space conditioning systems serving room(s) that are required to have occupant sensing controls in accordance with Section 130.1(c), and where the Table 120.1-A occupancy category permits ventilation air to be reduced to zero when the space is in occupied-standby mode, shall meet the following:~~Where the system providing space conditioning also provides the ventilation required by Section 120.1 and includes occupant sensor ventilation control as specified in Section 120.1(d)5, the occupant sensing zone controls shall additionally comply with the following:

   ~~A. The zone shall be placed in occupied standby mode when all room(s) served by the zone are unoccupied for more than 5 minutes; and~~

   ~~B~~A. ~~During~~ Within 5 minutes of entering occupied ~~-~~standby mode as described in Section 120.1(d).

      i. Automatically set up the operating cooling temperature set point by 2°F or more and set back the operating heating temperature set point by 2°F or more; or

      ii. For multiple zone systems with Direct Digital Controls (DDC) to the zone level, set up the operating cooling temperature setpoint by 0.5°F or more and set back the operating heating temperature setpoint by 0.5°F or more.

   ~~C~~B. ~~During~~ Within 5 minutes of entering occupied-standby mode, ~~all airflow~~mechanical ventilation to the zone shall ~~be shut~~remain off whenever the space temperature is between the active heating and cooling setpoints.

   EXCEPTION 1 to Sections 120.2(e)1, 2, and 3: Where it can be demonstrated to the satisfaction of the enforcing agency that the system serves an area that must operate continuously.

EXCEPTION 2 to Sections 120.2(e)1, 2, and 3: Systems with full load demands of 2 kW or less, if they have a readily accessible manual shut-off switch.

EXCEPTION 3 to Sections 120.2(e)1 and 2: Systems serving hotel/motel guest rooms, if they have a readily accessible manual shut-off switch.

4. Hotel and motel guest rooms shall have captive card key controls, occupancy sensing controls, or automatic controls such that, no longer than 30 minutes after the guest room has been vacated, setpoints are set up at least +5°F (+3°C) in cooling mode and set down at least -5°F (-3°C) in heating mode.

EXCEPTION to Section 120.2(e): Systems serving healthcare facilities.

(f) **Dampers for Air Supply and Exhaust Equipment.** Outdoor air supply and exhaust equipment shall be installed with dampers that automatically close upon fan shutdown.

EXCEPTION 1 to Section 120.2(f): Equipment that serves an area that must operate continuously.

EXCEPTION 2 to Section 120.2(f): Gravity and other nonelectrical equipment that has readily accessible manual damper controls.

EXCEPTION 3 to Section 120.2(f): At combustion air intakes and shaft vents.

EXCEPTION 4 to Section 120.2(f): Where prohibited by other provisions of law.

(g) **Isolation Area Devices.** Each space-conditioning system serving multiple zones with a combined conditioned floor area of more than 25,000 square feet shall be designed, installed, and controlled to serve isolation areas.

1. Each zone, or any combination of zones not exceeding 25,000 square feet, shall be a separate isolation area.
2. Each isolation area shall be provided with isolation devices, such as valves or dampers that allow the supply of heating or cooling to be reduced or shut-off independently of other isolation areas.
3. Each isolation area shall be controlled by a device meeting the requirements of Section 120.2(e)1.

EXCEPTION to Section 120.2(g): Zones designed to be conditioned continuously.

(h) **Automatic Demand Shed Controls.** See Section 110.12 for requirements for Automatic Demand Shed Controls.

(i) **Economizer Fault Detection and Diagnostics (FDD).** All newly installed air handlers with a mechanical cooling capacity ~~greater than 54,000 Btu/hr~~over 33,000 Btu/hr and an installed air economizer shall include a stand-alone or integrated Fault Detection and Diagnostics (FDD) system in accordance with Subsections 120.2(i)1 through 120.2(i)8.

1. The following temperature sensors shall be permanently installed to monitor system operation: outside air, supply air, and when required for differential economizer operation, a return air sensor; and
2. Temperature sensors shall have an accuracy of ±2°F over the range of 40°F to 80°F; and
3. The controller shall have the capability of displaying the value of each sensor; and
4. The controller shall provide system status by indicating the following conditions:
   A. Free cooling available;
   B. Economizer enabled;
   C. Compressor enabled;
   D. Heating enabled, if the system is capable of heating; and
   E. Mixed air low limit cycle active.
5. The unit controller shall allow manual initiation of each operating mode so that the operation of cooling systems, economizers, fans, and heating systems can be independently tested and verified; and
6. Faults shall be reported in one of the following ways:

A. Reported to an Energy Management Control System regularly monitored by facility personnel.

B. Annunciated locally on one or more zone thermostats, or a device within five (5) feet of zone thermostat(s), clearly visible, at eye level, and meeting the following requirements:

i. On the thermostat, device, or an adjacent written sign, display instructions to contact appropriate building personnel or an HVAC technician; and

ii. In buildings with multiple tenants, the annunciation shall either be within property management offices or in a common space accessible by the property or building manager.

C. Reported to a fault management application which automatically provides notification of the fault to remote HVAC service provider.

7. The FDD system shall detect the following faults:

A. Air temperature sensor failure/fault;

B. Not economizing when it should;

C. Economizing when it should not;

D. Damper not modulating; and

E. Excess outdoor air.

8. The FDD System shall be certified by the Energy Commission as meeting requirements of Sections 120.2(i)1 through 120.2(i)7 in accordance with Section 110.0 and JA6.3.

EXCEPTION to 120.2(i)8: FDD algorithms based in Direct Digital Control systems are not required to be certified to the Energy Commission.

(j) Direct Digital Controls (DDC). Direct Digital Controls to the zone shall be provided as specified by Table 120.2-A.

The provided DDC system shall meet the control logic requirements of Sections 120.1(d), 110.12(a) and 110.12(b)~~120.2(h)~~, and be capable of the following:

1. Monitoring zone and system demand for fan pressure, pump pressure, heating and cooling;
2. Transferring zone and system demand information from zones to air distribution system controllers and from air distribution systems to heating and cooling plant controllers;
3. Automatically detecting the zones and systems that may be excessively driving the reset logic and generate an alarm or other indication to the system operator;
4. Readily allow operator removal of zones(s) from the reset algorithm;
5. For new buildings, trending and graphically displaying input and output points; and
6. Resetting heating and cooling setpoints in all noncritical zones upon receipt of a signal from a centralized contact or software point as described in Section ~~120.2(h)~~110.12(b).

Table 120.2-A DDC Applications and Qualifications

Building Status	Applications	Qualifications
Newly Constructed Buildings	Air-handling system and all zones served by the system	Individual systems supplying more than three zones and with design heating or cooling capacity of 300 kBtu/h and larger
Newly Constructed Buildings	Chilled water plant and all coils and terminal units served by the system	Individual plants supplying more than three zones and with design cooling capacity of 300 kBtu/h (87.9 kW) and larger
Newly Constructed Buildings	Hot water plant and all coils and terminal units served by the system	Individual plants supplying more than three zones and with design heating capacity of 300 kBtu/h (87.9 kW) and larger
Additions or Alterations	Zone terminal unit such as VAV box	Where existing zones served by the same air-handling, chilled water, or hot water systems that have DDC
Additions or Alterations	Air-handling system or fan coil	Where existing air-handling system(s) and fan coil(s) served by the same chilled or hot water plant have DDC
Additions or Alterations	New air-handling system and all new zones served by the system	Individual systems with design heating or cooling capacity of 300 kBtu/h and larger and supplying more than three zones and more than 75 percent of zones are new
Additions or Alterations	New or upgraded chilled water plant	Where all chillers are new and plant design cooling capacity is 300 kBtu/h (87.9 kW) and larger
Additions or Alterations	New or upgraded hot water plant	Where all boilers are new and plant design heating capacity is 300 kBtu/h (87.9 kW) and larger

(k) **Optimum Start/Stop Controls.** Space conditioning systems with DDC to the zone level shall have optimum start/stop controls. The control algorithm shall, as a minimum, be a function of the difference between space temperature and occupied setpoint, the outdoor air temperature, and the amount of time prior to scheduled occupancy. Mass radiant floor slab systems shall incorporate floor temperature onto the optimum start algorithm.

EXCEPTION to Section 120.2(k): Systems that must operate continuously.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, Public Resources Code.

SECTION 120.3 – REQUIREMENTS FOR PIPE INSULATION

Nonresidential~~, high-rise residential,~~ and hotel/motel buildings shall comply with the applicable requirements of Sections 120.3(a) through 120.3(c).

(a) **General Requirements.** The piping conditions listed below for space-conditioning and service water-heating systems with fluid normal operating temperatures listed in Table 120.3-A, shall have at least the amount of insulation specified in Subsection (c):

1. **Space Cooling Systems.** All refrigerant suction, chilled water, and brine fluid distribution systems.
2. **Space Heating Systems.** All refrigerant, steam, steam condensate and hot water fluid distribution systems.
3. **Service water-heating systems.**
   A. Recirculating system piping, including the supply and return piping to the water heater.
   B. The first 8 feet of hot and cold outlet piping, including piping between a storage tank and a heat trap, for a nonrecirculating storage system.
   C. Pipes that are externally heated.

Insulation conductivity shall be determined in accordance with ASTM C335 at the mean temperature listed in Table 120.3-A, and shall be rounded to the nearest 1/100 Btu-inch per hour per square foot per °F. Fluid distribution systems include all elements that are in series with the fluid flow, such as pipes, pumps, valves, strainers, coil u-bends, and air separators, but not including elements that are not in series with the fluid flow, such as expansion tanks, fill lines, chemical feeders, and drains.

(b) **Insulation Protection.** Pipe Insulation shall be protected from damage due to sunlight, moisture, equipment maintenance, and wind. Protection shall, at minimum, include the following:

1. Pipe insulation exposed to weather shall be protected by a cover suitable for outdoor service. The cover shall be water retardant and provide shielding from solar radiation that can cause degradation of the material. Adhesive tape shall not be used to provide this protection.
2. Pipe insulation covering chilled water piping and refrigerant suction piping located outside the conditioned space shall include, or be protected by, a Class I or Class II vapor retarder. All penetrations and joints shall be sealed.
3. Pipe insulation buried below grade must be installed in a water proof and non-crushable casing or sleeve.

(c) **Insulation Thickness**

1. For insulation with a conductivity in the range shown in Table 120.3-A for the applicable fluid temperature range, the insulation shall have the applicable minimum thickness or R-value shown in Table 120.3-A.
2. For insulation with a conductivity outside the range shown in Table 120.3-A for the applicable fluid temperature range, the insulation shall have a minimum R-value shown in Table 120.3-A or thickness as calculated with:

MINIMUM INSULATION THICKNESS EQUATION

$$T = PR\left[\left(1+\frac{t}{PR}\right)^{\frac{K}{k}}-1\right]$$

WHERE:

T = Minimum insulation thickness for material with conductivity K, inches.

PR = Pipe actual outside radius, inches.

t = Insulation thickness from Table 120.3-A, inches.

K = Conductivity of alternate material at the mean rating temperature indicated in Table 120.3-A for the applicable fluid temperature range, in Btu-inch per hour per square foot per °F.

k = The lower value of the conductivity range listed in Table 120.3-A for the applicable fluid temperature range, Btu-inch per hour per square foot per °F.

Table 120.3-A PIPE INSULATION THICKNESS

Fluid Operating Temperature Range (°F)	Insulation Conductivity			Nominal Pipe Diameter (in inches)				
	Conductivity (in Btu·in/h·ft²·°F)	Mean Rating Temperature (°F)		< 1	1 to <1.5	1.5 to < 4	4 to < 8	8 and larger
Space heating and Service Water Heating Systems (Steam, Steam Condensate, Refrigerant, Space Heating, Service Hot Water)				**Minimum Pipe Insulation Required (Thickness in inches or R-value)**				
Above 350	0.32-0.34	250	Inches	4.5	5.0	5.0	5.0	5.0
			R-value	R 37	R 41	R 37	R 27	R 23
251-350	0.29-0.32	200	Inches	3.0	4.0	4.5	4.5	4.5
			R-value	R 24	R 34	R 35	R 26	R 22
201-250	0.27-0.30	150	Inches	2.5	2.5	2.5	3.0	3.0
			R-value	R 21	R 20	R 17.5	R 17	R 14.5
141-200	0.25-0.29	125	Inches	1.5	1.5	2.0	2.0	2.0
			R-value	R 11.5	R 11	R 14	R 11	R 10
105-140	0.22-0.28	100	Inches	1.0	1.5	1.5	1.5	1.5
			R-value	R 7.7	R 12.5	R 11	R 9	R 8
				Nominal Pipe Diameter (in inches)				
				< 1	**1 to <1.5**	**1.5 to < 4**	**4 to < 8**	**8 and larger**
Space cooling systems (chilled water, refrigerant and brine)				**Minimum Pipe Insulation Required (Thickness in inches or R-value)[1]**				
40-60	0.21-0.27	75	Inches	Nonres 0.5 / Res 0.75		Nonres 0.5 / Res 0.75		1.0	1.0	1.0
			R-value	Nonres R 3 / Res R 6		Nonres R 3 / Res R 5		R 7	R 6	R 5
Below 40	0.20-0.26	50	Inches	1.0		1.5		1.5	1.5	1.5
			R-value	R 8.5		R 14		R 12	R 10	R 9

Footnote to Table 120.3-A:

1. These thickness are based on energy efficiency considerations only. Issues such as water vapor permeability or surface condensation sometimes require vapor retarders or additional insulation.

EXCEPTION 1 to Section 120.3: Factory-installed piping within space-conditioning equipment certified under Section 110.1 or 110.2.

EXCEPTION 2 to Section 120.3: Piping that conveys fluids with a design operating temperature range between 60°F and 105°F.

EXCEPTION 3 to Section 120.3: Where the heat gain or heat loss to or from piping without insulation will not increase building source energy use.

EXCEPTION 4 to Section 120.3: Piping that penetrates framing members shall not be required to have pipe insulation for the distance of the framing penetration. Metal piping that penetrates metal framing shall use grommets, plugs, wrapping or other insulating material to assure that no contact is made with the metal framing.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 120.4 – REQUIREMENTS FOR AIR DISTRIBUTION SYSTEM DUCTS AND PLENUMS

Nonresidential~~, high-rise residential,~~ and hotel/motel buildings shall comply with the applicable requirements of Sections 120.4(a) through 120.4(~~f~~g).

EXCEPTION to Section 120.4: Systems serving healthcare facilities shall comply with the applicable requirements of the California Mechanical Code.

(a) **CMC Compliance.** All air distribution system ducts and plenums, including, but not limited to, building cavities, mechanical closets, air-handler boxes and support platforms used as ducts or plenums, shall meet the requirements of the CMC Sections 601.0, 602.0, 603.0, 604.0, 605.0, and ANSI/SMACNA-006-2006 HVAC Duct Construction Standards Metal and Flexible 3rd Edition, incorporated herein by reference. Connections of metal ducts and the inner core of flexible ducts shall be mechanically fastened. Openings shall be sealed with mastic, tape, aerosol sealant, or other duct-closure system that meets the applicable requirements of UL 181, UL 181A, or UL 181B. If mastic or tape is used to seal openings greater than 1/4 inch, the combination of mastic and either mesh or tape shall be used.

Portions of supply-air and return-air ducts conveying heated or cooled air located in one or more of the following spaces shall be insulated to a minimum installed level of R-8:

1. Outdoors; or
2. In a space between the roof and an insulated ceiling; or
3. In a space directly under a roof with fixed vents or openings to the outside or unconditioned spaces; or
4. In an unconditioned crawl space; or
5. In other unconditioned spaces.

Portions of supply-air ducts that are not in one of these spaces, including ducts buried in concrete slab, shall be insulated to a minimum installed level of R-4.2 or be enclosed in directly conditioned space.

(b) **Duct and Plenum Materials.**

1. **Factory-fabricated duct systems.**

   A. All factory-fabricated duct systems shall comply with UL 181 for ducts and closure systems, including collars, connections, and splices, and be labeled as complying with UL 181. UL 181 testing may be performed by UL laboratories or a laboratory approved by the Executive Director.

   B. All pressure-sensitive tapes, heat-activated tapes, and mastics used in the manufacture of rigid fiberglass ducts shall comply with UL 181 and UL 181A.

   C. All pressure-sensitive tapes and mastics used with flexible ducts shall comply with UL 181 and UL 181B.

   D. <u>All ductwork and plenums with pressure class ratings shall be constructed to Seal Class A, as specified by ASHRAE 90.1.</u> Joints and seams of duct systems and their components shall not be sealed with cloth-back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.

   <u>**EXCEPTION to Section 120.4(b)1D:** Ductwork located in occupied space and exposed to view is not required to meet Seal Class A.</u>

2. **Field-fabricated duct systems.**

   A. Factory-made rigid fiberglass and flexible ducts for field-fabricated duct systems shall comply with UL 181. All pressure-sensitive tapes, mastics, aerosol sealants, or other closure systems used for installing

field-fabricated duct systems shall meet the applicable requirements of UL 181, UL 181A, and UL 181B.

B. **Mastic sealants and mesh.**

i. Sealants shall comply with the applicable requirements of UL 181, UL 181A, and UL 181B, and be nontoxic and water resistant.

ii. Sealants for interior applications shall pass ASTM C731 (extrudability after aging) and D2202 (slump test on vertical surfaces), incorporated herein by reference.

iii. Sealants for exterior applications shall pass ASTM tests C731, C732 (artificial weathering test), and D2202, incorporated herein by reference.

iv. Sealants and meshes shall be rated for exterior use.

C. **Pressure-sensitive tape.** Pressure-sensitive tapes shall comply with the applicable requirements of UL 181, UL 181A, and UL 181B.

D. All ductwork and plenums with pressure class ratings shall be constructed to Seal Class A, as specified by ASHRAE 90.1. Joints and seams of duct systems and their components shall not be sealed with cloth-back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.

EXCEPTION to Section 120.4(b)2D: Ductwork located in occupied space and exposed to view is not required to meet Seal Class A.

E. **Drawbands used with flexible duct.**

i. Drawbands shall be either stainless-steel worm-drive hose clamps or UV-resistant nylon duct ties.

ii. Drawbands shall have a minimum tensile strength rating of 150 pounds.

iii. Drawbands shall be tightened as recommended by the manufacturer with an adjustable tensioning tool.

F. **Aerosol-sealant closures.**

i. Aerosol sealants shall meet the requirements of UL 723 and be applied according to manufacturer specifications.

ii. Tapes or mastics used in combination with aerosol sealing shall meet the requirements of this section.

(c) All duct insulation product R-values shall be based on insulation only (excluding air films, vapor retarders, or other duct components) and tested C-values at 75°F mean temperature at the installed thickness, in accordance with ASTM C518 or ASTM C177, incorporated herein by reference, and certified pursuant to Section 110.8.

(d) The installed thickness of duct insulation used to determine its R-value shall be determined as follows:

1. For duct board, duct liner, and factory-made rigid ducts not normally subjected to compression, the nominal insulation thickness shall be used.

2. For duct wrap, installed thickness shall be assumed to be 75 percent (25 percent compression) of nominal thickness.

3. For factory-made flexible air ducts, the installed thickness shall be determined by dividing the difference between the actual outside diameter and nominal inside diameter by two.

(e) Insulated flexible duct products installed to meet this requirement must include labels, in maximum intervals of 3 feet, showing the thermal performance R-value for the duct insulation itself (excluding air films, vapor retarder, or other duct components), based on the tests in Section 120.4(c) and the installed thickness determined by Section 120.4(d)3.

(f) **Protection of Insulation.** Insulation shall be protected from damage, including that due to sunlight, moisture, equipment maintenance, and wind but not limited to the following: insulation exposed to weather shall be suitable for outdoor service, e.g., protected by aluminum, sheet metal, painted canvas, or plastic cover. Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation that can cause degradation of the material.

(g) **Duct Sealing.** Duct systems shall comply with subsections 1 or 2 below:

1. New duct systems that meet the criteria in Subsections A, B, C, and D below shall be sealed to a leakage rate not to exceed 6 percent of the nominal air handler airflow rate as confirmed through HERS field verification and diagnostic testing, in accordance with the applicable procedures in Reference Nonresidential Appendices NA1 and NA2;

   A. The duct system does not serve a healthcare facility;

   B. The duct system provides conditioned air to an occupiable space for a constant volume, single zone, space-conditioning system;

   C. The space conditioning system serves less than 5,000 square feet of conditioned floor area; and

   D. The combined surface area of the ducts located outdoors or in unconditioned space is more than 25 percent of the total surface area of the entire duct system.

2. New duct systems that are not subject to testing under Section 120.4(g)1 shall instead meet the duct leakage testing requirements of CMC Section 603.10.1.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, Public Resources Code.

SECTION 120.5 – REQUIRED NONRESIDENTIAL MECHANICAL SYSTEM ACCEPTANCE

Nonresidential~~, high-rise residential,~~ and hotel/motel buildings shall comply with the applicable requirements of Sections 120.5(a) through 120.5(b).

EXCEPTION to Section 120.5: Systems serving healthcare facilities.

(a) Before an occupancy permit is granted the following equipment and systems shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified by the Reference Nonresidential Appendix NA7. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements:

1. Outdoor air ventilation systems shall be tested in accordance with NA7.5.1
2. Constant volume, single zone air conditioning and heat pump unit controls shall be tested in accordance with NA7.5.2.
3. Duct systems that are subject to testing under Section 120.4(g)1 or Section 141.0(b)2D shall be tested in accordance with NA7.5.3~~. where either:~~

~~A. They are new duct systems that meet the criteria of Sections 140.4(l)1a, 140.4(l)1b, and 140.4(l)1c; or~~

~~B. They are part of a system that meets the criteria of Section 141.0(b)2D.~~

4. Air economizers shall be tested in accordance with NA7.5.4.

   EXCEPTION to Section 120.5(a)4: Air economizers installed by the HVAC system manufacturer and certified to the Commission as being factory calibrated and tested are exempt from the Functional Testing section of the Air Economizer Controls acceptance test as described in NA7.5.4.2.

5. Demand control ventilation systems required by Section 120.1(c)3 shall be tested in accordance with NA7.5.5
6. Supply fan variable flow controls shall be tested in accordance with NA7.5.6
7. Hydronic system variable flow controls shall be tested in accordance with NA7.5.7 and NA7.5.9
8. Boiler or chillers that require isolation controls as specified by Section 140.4(k)2 or 140.4(k)3 shall be tested in accordance with NA7.5.7
9. Hydronic systems with supply water temperature reset controls shall be tested in accordance with NA7.5.8
10. Automatic demand shed controls shall be tested in accordance with NA7.5.10.
11. Fault Detection and Diagnostics (FDD) for Packaged Direct-Expansion Units shall be tested in accordance with NA7.5.11.
12. Automatic Fault Detection and Diagnostics (FDD) for air-handling units and zone terminal units shall be tested in accordance with NA7.5.12.
13. Distributed Energy Storage DX AC Systems shall be tested in accordance with NA7.5.13.
14. Thermal Energy Storage (TES) Systems shall be tested in accordance with NA7.5.14.
15. Supply air temperature reset controls shall be tested in accordance with NA7.5.15.
16. Water-cooled chillers served by cooling towers with condenser water reset controls shall be tested in accordance with NA7.5.16.
17. When an Energy Management Control System is installed, it shall functionally meet all of the applicable requirements of Part 6.

18. Occupant Sensing Zone Controls shall be tested in accordance with NA7.5.17.

(b) When certification is required by Title 24, Part 1, Section 10-103.2, the acceptance testing specified by Section 120.5(a) shall be performed by a Certified Mechanical Acceptance Test Technician (CMATT). If the CMATT is operating as an employee, the CMATT shall be employed by a Certified Mechanical Acceptance Test Employer. The CMATT shall disclose on the Certificate of Acceptance a valid CMATT certification identification number issued by an approved Acceptance Test Technician Certification Provider. The CMATT shall complete all Certificate of Acceptance documentation in accordance with the applicable requirements in Section 10-103(a)4.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402, and 25402.1~~, and 25213~~, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, ~~,~~25402.8, 25943, Public Resources Code.

SECTION 120.6 – MANDATORY REQUIREMENTS FOR COVERED PROCESSES

Nonresidential~~, high-rise residential,~~ and hotel/motel buildings shall comply with the applicable requirements of Sections 120.6(a) through 120.6(g).

(a) **Mandatory Requirements for Refrigerated Warehouses**

Refrigerated warehouses that are greater than or equal to 3,000 square feet and refrigerated spaces with a sum total of 3,000 square feet or more that are served by the same refrigeration system shall meet the requirements of Section 120.6(a).

Refrigerated spaces that are less than 3,000 square feet shall meet the requirements of the Appliance Efficiency Regulations for walk-in coolers or freezers contained in the Appliance Efficiency Regulations (California Code of Regulations, Title 20, Sections 1601 through 1608).

1. **Insulation Requirements.** Exterior surfaces of refrigerated warehouses shall be insulated at least to the R-values in Table 120.6-A.

Table 120.6-A REFRIGERATED WAREHOUSE INSULATION

SPACE	SURFACE	MINIMUM R-VALUE (°F·hr·sf/Btu)
Freezers	Roof/Ceiling	R-40
	Wall	R-36
	Floor	R-35
	Floor with all heating from productive refrigeration capacity[1]	R-20
Coolers	Roof/Ceiling	R-28
	Wall	R-28

[1]All underslab heating is provided by a heat exchanger that provides refrigerant subcooling or other means that result in productive refrigeration capacity on the associated refrigerated system.

2. **Underslab heating.** Electric resistance heat shall not be used for the purposes of underslab heating.

EXCEPTION to Section 120.6(a)2: Underslab heating systems controlled such that the electric resistance heat is thermostatically controlled and disabled during the summer on-peak period defined by the local electric utility.

3. **Evaporators.** New fan-powered evaporators used in coolers and freezers shall conform to the following:

A. Single phase fan motors less than 1 hp and less than 460 Volts in newly installed evaporators shall be electronically commutated motors or shall have a minimum motor efficiency of 70 percent when rated in accordance with NEMA Standard MG 1-2006 at full load rating conditions.

B. Evaporator fans served either by a suction group with multiple compressors, or by a single compressor with variable capacity capability shall be variable speed and the speed shall be controlled in response to space temperature or humidity.

EXCEPTION 1 to Section 120.6(a)3B: Addition, alteration or replacement of less than all of the evaporators in an existing refrigerated space that does not have speed-controlled evaporators.

EXCEPTION 2 to Section 120.6(a)3B: Coolers within refrigerated warehouses that maintain a Controlled Atmosphere for which a licensed engineer has certified that the types of products stored will require constant operation at 100 percent of the design airflow.

EXCEPTION 3 to Section 120.6(a)3B: Areas within refrigerated warehouses that are designed solely for the purpose of quick chilling/freezing of products, including but not limited to spaces with design cooling capacities of greater than 240 Btu/hr-ft² (2 tons per 100 ft²).

C. Evaporator fans served by a single compressor that does not have variable capacity shall utilize controls to reduce airflow by at least 40 percent for at least 75 percent of the time when the compressor is not running.

EXCEPTION to Section 120.6(a)3C: Areas within refrigerated warehouses that are designed solely for the purpose of quick chilling/freezing of products (space with design cooling capacities of greater than 240 Btu/hr-ft² (2 tons per 100 ft²)).

4. **Condensers.** New fan-powered condensers on new refrigeration systems shall conform to the following:

A. Design saturated condensing temperatures for evaporative-cooled condensers and water-cooled condensers served by fluid coolers or cooling towers shall be less than or equal to:

i. The design wetbulb temperature plus 20°F in locations where the design wetbulb temperature is less than or equal to 76°F;

ii. The design wetbulb temperature plus 19°F in locations where the design wetbulb temperature is between 76°F and 78°F; or

iii. The design wetbulb temperature plus 18°F in locations were the design wetbulb temperature is greater than or equal to 78°F.

EXCEPTION 1 to Section 120.6(a)4A: Compressors and condensers on a refrigeration system for which more than 20 percent of the total design refrigeration cooling load is for quick chilling/ ~~or~~ freezing of products (space with design cooling capacities of greater than 240 Btu/hr-ft^2), or process refrigeration cooling for other than a refrigerated space.

B. Design saturated condensing temperatures for air-cooled condensers shall be less than or equal to:

i. The design drybulb temperature plus 10°F for systems serving freezers;

ii. The design drybulb temperature plus 15°F for systems serving coolers.

EXCEPTION 1 to Section 120.6(a)4B: Condensing units with a total compressor horsepower less than 100 HP.

EXCEPTION 2 to Section 120.6(a)4B: Compressors and condensers on a refrigeration system for which more than 20 percent of the total design refrigeration cooling load is for quick chilling/ ~~or~~ freezing of products (space with design cooling capacities of greater than 240 Btu/hr-ft^2), or process refrigeration cooling for other than a refrigerated space.

C. The saturated condensing temperature necessary for adiabatic condensers to reject the design total heat of rejection of a refrigeration system assuming dry mode performance shall be less than or equal to:

i. The design drybulb temperature plus 20°F for systems serving freezers;

ii. The design drybulb temperature plus 30°F for systems serving coolers.

EXCEPTION 1 to Section 120.6(a)4C: Compressors and condensers on a refrigeration system for which more than 20 percent of the total design refrigeration cooling load is for quick chilling/ ~~or~~ freezing of products (space with design cooling capacities of greater than 240 Btu/hr-ft^2 (2 tons per 100 ft^2)), or process refrigeration cooling for other than a refrigerated space.

D. All condenser fans for air-cooled condensers, evaporative-cooled condensers, adiabatic condensers, gas coolers, air or water fluid coolers or cooling towers shall be continuously variable speed, with the speed of all fans serving a common condenser high side controlled in unison.

E. The minimum condensing temperature setpoint shall be less than or equal to 70°F for systems utilizing air-cooled condensers, evaporative-cooled condensers, adiabatic condensers, gas coolers, air or water-cooled fluid coolers or cooling towers for heat rejection.

F. Condensing temperature reset. The condensing temperature set point of systems served by air-cooled condensers shall be reset in response to ambient drybulb temperature. The condensing temperature

set point of systems served by evaporative-cooled condensers or water-cooled condensers (via cooling towers or fluid coolers) shall be reset in response to ambient wetbulb temperatures. The condensing temperature set point for systems served by adiabatic condensers shall be reset in response to ambient drybulb temperature while operating in dry mode.

EXCEPTION 1 to Section 120.6(a)4F: Condensing temperature control strategies approved by the Executive Director that have been demonstrated to provide at least equal energy savings.

EXCEPTION 2 to Section 120.6(a)4F: Systems served by adiabatic condensers in Climate Zones 1, 3, 5, 12, 14 and 16.

G. Fan-powered condensers shall meet the condenser efficiency requirements listed in Table 120.6-B. Condenser efficiency is defined as the Total Heat of Rejection (THR) capacity divided by all electrical input power including fan power at 100 percent fan speed, and power of spray pumps for evaporative condensers.

EXCEPTION to Section 120.6(a)4G: Adiabatic condensers with ammonia as refrigerant.

H. Air-cooled condensers shall have a fin density no greater than 10 fins per inch.

EXCEPTION to Section 120.6(a)4H: Micro-channel condensers.

EXCEPTION to Section 120.6(a)4~~A, 4B, 4C, 4E, 4F and 4G~~: Transcritical CO_2 refrigeration systems.

Table 120.6-B FAN-POWERED CONDENSERS – MINIMUM EFFICIENCY REQUIREMENTS

CONDENSER TYPE	REFRIGERANT TYPE	MINIMUM EFFICIENCY	RATING CONDITION
Outdoor Evaporative-Cooled with THR Capacity > 8,000 MBH	All	350 Btuh/watt	100°F Saturated Condensing Temperature (SCT), 70°F Outdoor Wetbulb Temperature
Outdoor Evaporative-Cooled with THR Capacity < 8,000 MBH and Indoor Evaporative-Cooled	All	160 Btuh/watt	
Outdoor Air-Cooled	Ammonia	75 Btuh/watt	105°F Saturated Condensing Temperature (SCT), 95°F Outdoor Drybulb Temperature
	Halocarbon	65 Btuh/watt	
Adiabatic Dry Mode	Halocarbon	45 Btuh/watt	105°F Saturated Condensing Temperature (SCT), 95°F Outdoor Drybulb Temperature
Indoor Air-Cooled	All	Exempt	

5. **Compressors.** Compressor systems utilized in refrigerated warehouses shall conform to the following:

A. Compressors <u>serving refrigeration systems that are not transcritical CO_2,</u> shall be designed to operate at a minimum condensing temperature of 70°F or less.

<u>B. Compressors for transcritical CO_2 refrigeration systems shall be designed to operate at a minimum condensing temperature of 60°F or less.</u>

<u>**EXCEPTION to Section 120.6(a)5B:** Compressors with a design saturated suction temperature greater than or equal to 30°F shall be designed to operate at a minimum condensing temperature of 70°F or less.</u>

C.~~B.~~ New open-drive screw compressors in new refrigeration systems with a design saturated suction temperature (SST) of 28°F or lower that discharges to the system condenser pressure shall control compressor speed in response to the refrigeration load.

EXCEPTION 1 to Section 120.6(a)5C~~B~~: Refrigeration plants with more than one dedicated compressor per suction group.

EXCEPTION 2 to Section 120.6(a)5C~~B~~: Compressors and condensers on a refrigeration system for which more than 20 percent of the total design refrigeration cooling load is for quick chilling~~ or~~ freezing of products (space with design cooling capacities of greater than 240 Btu/hr-ft^2 (2 tons per 100 ft^2)), or process refrigeration cooling for other than a refrigerated space.

D~~C~~. New screw compressors with nominal electric motor power greater than 150 HP shall include the ability to automatically vary the compressor volume ratio (Vi) in response to operating pressures.

6. **Infiltration Barriers.** Passageways between freezers and higher-temperature spaces, and passageways between coolers and nonrefrigerated spaces, shall have an infiltration barrier consisting of strip curtains, an automatically-closing door, or an air curtain designed by the manufacturer for use in the passageway and temperature for which it is applied.

EXCEPTION 1 to Section 120.6(a)6: Openings with less than 16 square feet of opening area.

EXCEPTION 2 to Section 120.6(a)6: Dock doorways for trailers.

~~7~~7. **Refrigerated~~ion System~~ Warehouse Acceptance.** Before an occupancy permit is granted for a new refrigerated warehouse, or before a new refrigeration system serving a refrigerated warehouse is operated for normal use, the following equipment and systems shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified by the Reference Nonresidential Appendix NA7. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements:

A. Electric resistance underslab heating systems shall be tested in accordance with NA7.10.1.

B. Evaporators fan motor controls shall be tested in accordance with NA7.10.2.

C. Evaporative condensers shall be tested in accordance with NA7.10.3.1.

D. Air-cooled condensers shall be tested in accordance with NA7.10.3.2.

E. Adiabatic condensers shall be tested in accordance with NA7.10.3.3.

F. Variable speed compressors shall be tested in accordance with NA7.10.4.

G. Transcritical CO_2 refrigeration systems shall be tested in accordance with NA7.20.1

8. **Transcritical CO_2 Gas Coolers.** New fan-powered gas coolers on all new transcritical CO_2 refrigeration systems shall conform to the following:

A. Air-cooled gas coolers are prohibited in Climate Zones 9 through 15.

B. Design leaving gas temperature for air-cooled gas coolers shall be less than or equal to the design dry bulb temperature plus 6°F.

EXCEPTION to Section 120.6(a)8B: Design leaving gas temperature for air-cooled gas coolers in Climate Zone 2, 4, and 8 shall be less than or equal to the design dry bulb temperature plus 8°F.

C. Design leaving gas temperature for adiabatic gas coolers necessary to reject the design total heat of rejection of a refrigeration system assuming dry mode performance shall be less than or equal to the design dry bulb temperature plus 15°F.

D. All gas cooler fans shall be continuously variable speed, with the speed of all fans serving a common condenser high side controlled in unison.

E. While operating below the critical point, the gas cooler pressure shall be controlled in accordance to 120.6(a)4F.

F. While operating above the critical point, the gas cooler pressure setpoint shall be reset based on ambient conditions such that the system efficiency is maximized.

G. The minimum condensing temperature setpoint shall be less than or equal to 60°F for systems utilizing air-cooled gas coolers, evaporative-cooled gas coolers, adiabatic gas coolers, air or water-cooled fluid coolers or cooling towers for heat rejection.

EXCEPTION to Section 120.6(a)8G: Transcritical CO_2 refrigeration systems with a design intermediate saturated suction temperature greater than or equal to 30°F shall have a minimum condensing temperature setpoint of 70°F or less.

H. Fan-powered gas coolers shall meet the gas cooler efficiency requirements listed in Table 120.6-C. Gas cooler efficiency is defined as the Total Heat of Rejection (THR) capacity divided by all electrical input power (fan power at 100 percent fan speed).

Table 120.6-C TRANSCRITICAL CO_2 FAN-POWERED GAS COOLERS – MINIMUM EFFICIENCY REQUIREMENTS

CONDENSER TYPE	REFRIGERANT TYPE	MINIMUM EFFICIENCY	RATING CONDITION
Outdoor Air-Cooled	Transcritical CO_2	160 Btuh/watt	1400 psig, 100°F Outlet Gas Temperature, 90°F Outdoor Dry bulb Temperature
Adiabatic Dry Mode	Transcritical CO_2	90 Btuh/watt	1100 psig, 100°F Outlet Gas Temperature, 90°F Outdoor Dry bulb Temperature

9. Automatic Door Closers. Doors designed for the passage of people that are between freezers and higher-temperature spaces, or between coolers and nonrefrigerated spaces, shall have automatic door closers.

(b) **Mandatory Requirements for Commercial Refrigeration.**

Retail food ~~stores~~ or beverage stores with 8,000 square feet or more of conditioned floor area, and that utilize either refrigerated display cases, or walk-in coolers or freezers, shall meet all applicable State and federal appliance and equipment standards consistent with Section 110.0 and 110.1 or, for equipment not subject to such standards, the requirements of Subsections 1 through 4.

1. **Condensers serving refrigeration systems.** Fan-powered condensers shall conform to the following requirements:

A. All condenser fans for air-cooled condensers, evaporative-cooled condensers, adiabatic condensers, gas coolers, air- or water-cooled fluid coolers or cooling towers shall be continuously variable speed, with the speed of all fans serving a common condenser high side controlled in unison.

B. The refrigeration system condenser controls for systems with air-cooled condensers shall use variable-setpoint control logic to reset the condensing temperature setpoint in response to ambient drybulb temperature.

C. The refrigeration system condenser controls for systems with evaporative-cooled condensers shall use variable-setpoint control logic to reset the condensing temperature setpoint in response to ambient wetbulb temperature.

D. The refrigeration system condenser controls for systems with adiabatic condensers shall use variable setpoint control logic to reset the condensing temperature setpoint in response to ambient drybulb temperature while operating in dry mode.

EXCEPTION 1 to Section 120.6(b)1B, C and D: Condensing temperature control strategies approved by the executive director that have been demonstrated to provide equal energy savings.

EXCEPTION 2 to Section 120.6(b)1D: Systems served by adiabatic condensers in Climate Zone 16.

E. The saturated condensing temperature necessary for adiabatic condensers to reject the design total heat of rejection of a refrigeration system assuming dry mode performance shall be less than or equal to:

   i. The design drybulb temperature plus 20°F for systems serving freezers;

   ii. The design drybulb temperature plus 30°F for systems serving coolers.

F. The minimum condensing temperature setpoint shall be less than or equal to 70°F.

G. Fan-powered condensers shall meet the specific efficiency requirements listed in Table 120.6-D~~C~~.

Table 120.6-D~~C~~ FAN-POWERED CONDENSERS –SPECIFIC EFFICIENCY REQUIREMENTS

CONDENSER TYPE	MINIMUM SPECIFIC EFFICIENCY[a]	RATING CONDITION
Evaporative-Cooled	160 Btuh/watt	100°F Saturated Condensing Temperature (SCT), 70°F Entering Wetbulb Temperature
Air-Cooled	65 Btuh/watt	105°F Saturated Condensing Temperature (SCT), 95°F Entering Drybulb Temperature
Adiabatic Dry Mode	45 Btu/watt (halocarbon)	105°F Saturated Condensing Temperature (SCT), 95°F Entering Drybulb Temperature
[a]See Section 100.1 for definition of condenser specific efficiency.		

EXCEPTION 1 to Section 120.6(b)1G: Condensers with a Total Heat Rejection capacity of less than 150,000 Btuh at the specific efficiency rating condition.

EXCEPTION 2 to Section 120.6(b)1G: Stores located in Climate Zone 1.

EXCEPTION 3 to Section 120.6(b)1G: Existing condensers that are reused for an addition or alteration.

H. Air-cooled condensers shall have a fin density no greater than 10 fins per inch.

EXCEPTION 1 to Section 120.6(b)1H: Microchannel condensers.

EXCEPTION 2 to Section 120.6(b)1H: Existing condensers that are reused for an addition or alteration.

EXCEPTION to Section 120.6(b)1B, 1C, 1D, 1E, 1F, 1G: Transcritical CO_2 refrigeration systems.

EXCEPTION to Section 120.6(b)1: New condensers replacing existing condensers when the attached compressor system Total Heat of Rejection does not increase and less than 25 percent of both the attached compressors and the attached display cases are new.

2. **Compressor Systems.** Refrigeration compressor systems and condensing units shall conform to the following requirements:

A. Compressors and multiple-compressor suction groups shall include control systems that use floating suction pressure logic to reset the target saturated suction temperature based on the temperature requirements of the attached refrigeration display cases or walk-ins.

EXCEPTION 1 to Section 120.6(b)2A: Single compressor systems that do not have continuously variable capacity capability.

EXCEPTION 2 to Section 120.6(b)2A: Suction groups that have a design saturated suction temperature of 30°F or higher, or suction groups that comprise the high stage of a two-stage or cascade system or that primarily serve chillers for secondary cooling fluids.

B. Liquid subcooling shall be provided for all low temperature compressor systems with a design cooling capacity equal or greater than 100,000 Btu/hr with a design saturated suction temperature of -10°F or lower, with the subcooled liquid temperature maintained continuously at 50°F or less at the exit of the subcooler, using compressor economizer port(s) or a separate medium or high temperature suction group operating at a saturated suction temperature of 18°F or higher.

EXCEPTION 1 to Section 120.6(b)2B: Low temperature cascade systems that condense into another refrigeration system rather than condensing to ambient temperature.

EXCEPTION 2 to Section 120.6(b)2B: Transcritical CO_2 refrigeration systems.

C. Compressors for transcritical CO_2 refrigeration systems shall be designed to operate at a minimum condensing temperature of 60°F or less.

EXCEPTION to Section 120.6(b)2C: Compressors with a design saturated suction temperature greater than or equal to 30°F shall be designed to operate at a minimum condensing temperature of 70°F or less.

EXCEPTION to Section 120.6(b)2: Existing compressor systems that are reused for an addition or alteration.

3. **Refrigerated Display Cases.** Lighting in refrigerated display cases, and lights on glass doors installed on walk-in coolers and freezers shall be controlled by one of the following:

   A. Automatic time switch controls to turn off lights during nonbusiness hours. Timed overrides for any line-up or walk-in case may only be used to turn the lights on for up to one hour. Manual overrides shall time-out automatically to turn the lights off after one hour.

   B. Motion sensor controls on each case that reduce display case lighting power by at least 50 percent within 30 minutes after the area near the case is vacated.

4. **Refrigeration Heat Recovery.**

   A. HVAC systems shall utilize heat recovery from refrigeration system(s) for space heating, using no less than 25 percent of the sum of the design Total Heat of Rejection of all refrigeration systems that have individual Total Heat of Rejection values of 150,000 Btu/h or greater at design conditions.

   EXCEPTION 1 to Section 120.6(b)4A: Stores located in Climate Zone 15.

   EXCEPTION 2 to Section 120.6(b)4A: HVAC systems or refrigeration systems that are reused for an addition or alteration.

   EXCEPTION 3 to Section 120.6(b)4A: Stores where the design Total Heat of Rejection of all refrigeration systems is less than or equal to 500,000 Btu/h.

   B. The increase in hydrofluorocarbon refrigerant charge associated with refrigeration heat recovery equipment and piping shall be no greater than 0.35 lbs per 1,000 Btu/h of heat recovery heating capacity.

5. **Transcritical CO_2 Gas Coolers.** New fan-powered gas coolers on all new transcritical CO_2 refrigeration systems shall conform to the following:

   A. Air-cooled gas coolers are prohibited in Climate Zones 10 through 15.

   B. Design leaving gas temperature for air-cooled gas coolers shall be less than or equal to the design dry bulb temperature plus 6°F.

   C. Design leaving gas temperature for adiabatic gas coolers necessary to reject the design total heat of rejection of a refrigeration system assuming dry mode performance shall be less than or equal to the design dry bulb temperature plus 15°F.

   D. All gas cooler fans shall be continuously variable speed, with the speed of all fans serving a common condenser high side controlled in unison.

   E. While operating below the critical point, the gas cooler pressure shall be controlled in accordance to 120.6(b)1A.

   F. While operating above the critical point, the gas cooler pressure setpoint shall be reset based on ambient conditions such that the system efficiency is maximized.

   G. The minimum condensing temperature setpoint shall be less than or equal to 60°F for air-cooled gas coolers, evaporative-cooled gas coolers, adiabatic gas coolers, air or water-cooled fluid coolers or cooling towers.

   EXCEPTION to Section 120.6(b)5G: Transcritical CO_2 refrigeration systems with a design intermediate saturated suction temperature greater than or equal to 30°F shall have a minimum condensing temperature setpoint of 70°F or less.

H. Fan-powered gas coolers shall meet the condenser efficiency requirements listed in Table 120.6-E. Gas cooler efficiency is defined as the Total Heat of Rejection (THR) capacity divided by all electrical input power (fan power at 100 percent fan speed).

Table 120.6-E TRANSCRITICAL CO_2 FAN-POWERED GAS COOLERS – MINIMUM EFFICIENCY REQUIREMENTS

CONDENSER TYPE	REFRIGERANT TYPE	MINIMUM EFFICIENCY	RATING CONDITION
Outdoor Air-Cooled	Transcritical CO_2	160 Btuh/watt	1400 psig, 100°F Outlet Gas Temperature, 90°F Outdoor Dry bulb Temperature
Adiabatic Dry Mode	Transcritical CO_2	90 Btuh/watt	1100 psig, 100°F Outlet Gas Temperature, 90°F Outdoor Dry bulb Temperature

6. **Commercial Refrigeration Acceptance.** Before an occupancy permit is granted for a new retail food or beverage store, or before a new refrigeration system serving a retail food or beverage store is operated for normal use, the following equipment and systems shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified by the Reference Nonresidential Appendix NA7. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements. ~~A.~~ Transcritical CO_2 refrigeration systems shall be tested in accordance with NA7.20.1.

(c) **Mandatory Requirements for Enclosed Parking Garages.** Mechanical ventilation systems for enclosed parking garages where the total design exhaust rate for the garage is greater than or equal to 10,000 cfm shall conform to all of the following:

1. Automatically detect contaminant levels and stage fans or modulate fan airflow rates to 50 percent or less of design capacity provided acceptable contaminant levels are maintained.
2. Have controls and/or devices that will result in fan motor demand of no more than 30 percent of design wattage at 50 percent of design airflow.
3. CO shall be monitored with at least one sensor per 5,000 square feet, with the sensor located in the highest expected concentration locations, with at least two sensors per proximity zone. A proximity zone is defined as an area that is isolated from other areas either by floor or other impenetrable obstruction.
4. CO concentration at all sensors is maintained at 25 ppm or less at all times.
5. The ventilation rate shall be at least 0.15 cfm/ft^2 when the garage is scheduled to be occupied.
6. The system shall maintain the garage at negative or neutral pressure relative to other occupiable spaces when the garage is scheduled to be occupied.
7. CO sensors shall be:
   A. Certified by the manufacturer to be accurate within plus or minus 5 percent of measurement.
   B. Factory calibrated.
   C. Certified by the manufacturer to drift no more than 5 percent per year.
   D. Certified by the manufacturer to require calibration no more frequently than once a year.
   E. Monitored by a control system. The system shall have logic that automatically checks for sensor failure by the following means. Upon detection of a failure, the system shall reset to design ventilation rates and transmit an alarm to the facility operators.

i. If any sensor has not been calibrated according to the manufacturer's recommendations within the specified calibration period, the sensor has failed.

ii. During unoccupied periods the system compares the readings of all sensors, e.g., if any sensor is more than 15 ppm above or below the average of all sensors for longer than four hours, the sensor has failed.

iii. During occupied periods the system compares the readings of sensors in the same proximity zone, e.g., if the 30 minute rolling average for any sensor in a proximity zone is more than 15 ppm above or below the 30 minute rolling average for other sensor(s) in that proximity zone, the sensor has failed.

8. **Parking Garage Ventilation System Acceptance.** Before an occupancy permit is granted for a parking garage system subject to Section 120.6(c), the following equipment and systems shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified by the Reference Nonresidential Appendix NA7. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in NA7.12.

EXCEPTION 1 to Section 120.6(c): Any garage, or portion of a garage, where more than 20 percent of the vehicles expected to be stored have non-gasoline combustion engines.

EXCEPTION 2 to Section 120.6(c): Additions and alterations to existing garages where less than 10,000 cfm of new exhaust capacity is being added.

(d) **Mandatory Requirements for Process Boilers**

1. Combustion air positive shut-off shall be provided on all newly installed process boilers as follows:

   A. All process boilers with an input capacity of 2.5 MMBtu/h (2,500,000 Btu/h) and above, in which the boiler is designed to operate with a non-positive vent static pressure.

   B. All process boilers where one stack serves two or more boilers with a total combined input capacity per stack of 2.5 MMBtu/h (2,500,000 Btu/h).

2. Process boiler combustion air fans with motors 10 horsepower or larger shall meet one of the following for newly installed boilers:

   A. The fan motor shall be driven by a variable speed drive; or

   B. The fan motor shall include controls that limit the fan motor demand to no more than 30 percent of the total design wattage at 50 percent of design air volume.

~~3. Newly installed process boilers with an input capacity of 5 MMBtu/h (5,000,000 Btu/h) to 10 MMBtu/h (10,000,000 Btu/h) shall maintain excess (stack-gas) oxygen concentrations at less than or equal to 5.0 percent by volume on a dry basis over firing rates of 20 percent to 100 percent. Combustion air volume shall be controlled with respect to firing rate or measured flue gas oxygen concentration. Use of a common gas and combustion air control linkage or jack shaft is prohibited.~~

~~4~~3. Newly installed process boilers with an input capacity greater than ~~10~~ 5 MMBtu/h (~~10~~5,000,000 Btu/h) shall maintain ~~excess (~~stack-gas~~)~~ oxygen concentrations at less than or equal to 3.0 percent by volume on a dry basis over firing rates of 20 to 100 percent. Combustion air volume shall be controlled with respect to measured flue gas oxygen concentration. Use of a common gas and combustion air control linkage or jack shaft is prohibited.

EXCEPTION to Section 120.6(d)3: Boilers with steady state full-load combustion efficiency 90 percent or higher.

(e) **Mandatory Requirements for Compressed Air Systems.** All new compressed air systems, and all additions or alterations of compressed air systems where the total combined ~~online~~ horsepower (hp) of the compressor(s) is 25 ~~horsepower~~ hp or more shall meet the requirements of Subsections 1 through ~~5~~3. These requirements apply to the compressors, related piping systems, and related controls that provide compressed air and do not apply to any equipment or controls that use or process the compressed air.

~~**EXCEPTION 1 to Section 120.6(e):** Alterations of existing compressed air systems that include one or more centrifugal compressors.~~

EXCEPTION ~~2~~1 to Section 120.6(e): ~~Compressed Air Systems, including~~ Medical gas compressed air systems~~,~~ serving healthcare facilities.

1. **Trim Compressor and Storage.** The compressed air system shall be equipped with an appropriately sized trim compressor and primary storage to provide acceptable performance across the range of the system and to avoid control gaps. The compressed air system shall comply with Subsection A or B below:

   A. The compressed air system shall include one or more variable speed drive (VSD) compressors. For systems with more than one compressor, the total combined capacity of the VSD compressor(s) acting as trim compressors must be at least 1.25 times the largest net capacity increment between combinations of compressors. The compressed air system shall include primary storage of at least one gallon per actual cubic feet per minute (acfm) of the largest trim compressor; or,

   B. The compressed air system shall include a compressor or set of compressors with total effective trim capacity at least the size of the largest net capacity increment between combinations of compressors, or the size of the smallest compressor, whichever is larger. The total effective trim capacity of single compressor systems shall cover at least the range from 70 percent to 100 percent of rated capacity. The effective trim capacity of a compressor is the size of the continuous operational range where the specific power of the compressor (kW/100 acfm) is within 15 percent of the specific power at its most efficient operating point. The total effective trim capacity of the system is the sum of the effective trim capacity of the trim compressors. The system shall include primary storage of at least 2 gallons per acfm of the largest trim compressor.

   EXCEPTION 1 to Section 120.6(e)1: ~~Compressed air systems in existing facilities that are adding or replacing less than 50 percent of the online capacity of the system~~Alterations where the total combined added or replaced compressor horsepower is less than the average per-compressor horsepower of all compressors in the system.

   EXCEPTION 2 to Section 120.6(e)1: Alterations where all added or replaced compressors are variable speed drive (VSD) compressors and compressed air system includes primary storage of at least one gallon per actual cubic feet per minute (acfm) of the largest trim compressor.

   EXCEPTION ~~3~~2 to Section 120.6(e)1: Compressed air systems that have been approved by the Energy Commission Executive Director as having demonstrated that the system serves loads for which typical air demand fluctuates less than 10 percent.

   EXCEPTION 4 to Section 120.6(e)1: Alterations of existing compressed air systems that include one or more centrifugal compressors.

2. **Controls.** Compressed air systems with three or more ~~than one~~ compressors ~~online, having~~and a combined horsepower rating of more than 100 hp~~, must~~shall operate with ~~a controller that is~~controls that are able to choose the most energy efficient combination and loading of compressors within the system based on the current compressed air demand ~~as measured by a sensor~~.

3. **Monitoring.** Compressed air systems having a combined horsepower rating equal to or greater than 100 hp shall have an energy and air demand monitoring system with the following minimum requirements:

   A. Measurement of system pressure.

   B. Measurement of amps or power of each compressor.

   C. Measurement or determination of total airflow from compressors in cfm.

   D. Data logging of pressure, power in kW, airflow in cfm, and compressed air system specific efficiency in kW/100 cfm at intervals of 5 minutes or less.

   E. Maintained data storage of at least the most recent 24 months.

   F. Visual trending display of each recorded point, load, and specific energy.

4. **Leak Testing of Compressed Air Piping.** Compressed air system piping greater than 50 adjoining feet in length shall be pressure tested after being isolated from the compressed air supply and end uses. The piping shall be pressurized to the design pressure and test pressures shall be held for a length of time at the discretion of the authority having jurisdiction, but in no case for less than 30 minutes, with no perceptible drop in pressure.

   If dial gauges are used for conducting this test, these gauges must conform with California Plumbing Code section 318.3, 318.4, and 318.5.

   Piping less than or equal to 50 adjoining feet in length shall be pressurized and inspected. Connections shall be tested with a noncorrosive leak-detecting fluid or other leak detecting methods at the discretion of the Authority Having Jurisdiction.

5. **Pipe Sizing.** Compressed air piping greater than 50 adjoining feet in length shall be designed and installed to minimize frictional losses in the distribution network. These piping installations shall meet the requirements of Section 120.6(e)5A and either Section 120.6(e)5B or 120.6(e)5C:

   A. Service line piping shall have inner diameters greater than or equal to ¾ inch. Service line piping are pipes that deliver compressed air from distribution piping to end uses.

   B. Piping section average velocity. Compressor room interconnection and main header piping shall be sized so that at coincident peak flow conditions, the average velocity in the segment of pipe is no greater than 20 ft/sec. Compressor room interconnection and main header piping are the pipes that deliver compressed air from the compressor outlets to the inlet to the distribution piping. Each segment of distribution and service piping shall be sized so that at coincident peak flow conditions, the average velocity in the segment of pipe is no greater than 30 ft/sec. Distribution piping are pipes that deliver compressed air from the compressor room interconnection piping or main header piping to the service line piping.

   C. Piping total pressure drop. Piping shall be designed such that piping frictional pressure loss at coincident peak loads are less than 5 percent of operating pressure between the compressor and end use or end use regulator.

6~~3~~. **Compressed Air System Acceptance.** Before an occupancy permit is granted for a compressed air system subject to Section 120.6(e), the ~~following~~ equipment and systems shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified by the Reference Nonresidential Appendix NA7. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in NA 7.13.

(f) **Mandatory Requirements for Elevators.** Elevators shall meet the following requirements:

1. The light power density for the luminaires inside the elevator cab shall be no greater than 0.6 watts per square foot.

   EXCEPTION to Section 120.6(f)1: Interior signal lighting and interior display lighting are not included in the calculation of lighting power density.

2. Elevator cab ventilation fans for cabs without space conditioning shall not exceed 0.33 watts per cfm as measured at maximum speed.

3. When the elevator cab is stopped and unoccupied with doors closed for over 15 minutes, the cab interior lighting and ventilation fans shall be switched off until elevator cab operation resumes.

4. Lighting and ventilation shall remain operational in the event that the elevator cabin gets stuck when passengers are in the cabin.

5. Elevator Lighting and Ventilation Control Acceptance. Before an occupancy permit is granted for elevators subject to 120.6(f), the following equipment and systems shall be certified as meeting the Acceptance Requirement for Code Compliance, as specified by the Reference Nonresidential Appendix NA7. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in NA7.14.

EXCEPTION to Section 120.6(f): Elevators located in healthcare facilities.

(g) **Mandatory Requirements for Escalators and Moving Walkways**

1. Escalators and moving walkways located in airports, hotels, and transportation function areas shall automatically slow to the minimum permitted speed in accordance with ASME A17.1/CSA B44 when not conveying passengers.
2. Escalators and Moving Walkways Acceptance. Before an occupancy permit is granted for escalators and moving walkways subject to 120.6(g), the following equipment and systems shall be certified as meeting the Acceptance Requirement for Code Compliance, as specified by the Reference Nonresidential Appendix NA7. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in NA7.15.

(h) **Mandatory Requirements for Controlled Environment Horticulture (CEH) Spaces**

1. **Indoor Growing, Dehumidification.** Dehumidification equipment shall be one of the following:
   A. Stand-alone dehumidifiers that meet the following minimum integrated energy factors as measured by the test conditions in Appendix X1 to Subpart B of 10 CFR Part 430:
      i. Minimum integrated energy factor of 1.77 L/kWh for product case volumes of 8.0 cubic feet or less;
      ii. Minimum integrated energy factor of 2.41 L/kWh for product case volumes greater than 8.0 cubic feet;
   B. Integrated HVAC system with on-site heat recovery designed to fulfill at least 75 percent of the annual energy for dehumidification reheat;
   C. Chilled water system with on-site heat recovery designed to fulfill at least 75 percent of the annual energy for dehumidification reheat; or
   D. Solid or liquid desiccant dehumidification system for system designs that require dewpoint of 50°F or less.
2. **Indoor Growing, Horticultural Lighting.** In a building with CEH spaces and with more than 40 kW of aggregate horticultural lighting load, the electric lighting systems used for plant growth and plant maintenance shall meet the all of the following requirements:
   A. The horticultural lighting systems shall have a photosynthetic photon efficacy (PPE) rated in accordance with ANSI/ASABE S640 for wavelengths from 400 to 700 nanometers and meet one of the following requirements:
      i. Integrated, non-serviceable luminaires shall have a rated PPE of at least 1.9 micromoles per joule; or
      ii. Luminaires with removable or serviceable lamps shall have lamps with a rated PPE of at least 1.9 micromoles per joule.
   B. Time-switch lighting controls shall be installed and comply with Section 110.9(b)1, Section 130.4(a)4, and applicable sections of NA7.6.2.
   C. Multilevel lighting controls shall be installed and comply with Section 130.1(b).
3. **Indoor Growing, Electrical Power Distribution Systems.** Electrical power distribution system serving CEH spaces shall be designed so that a measurement device is capable of monitoring the electrical energy usage of aggregate horticultural lighting load.
4. **Conditioned Greenhouses, Building Envelope.** Conditioned greenhouses shall meet the following requirements:
   A. Opaque wall and opaque roof assembly shall meet the requirements of Section 120.7; and
   B. Fenestration products used for greenhouse glazing shall have a U-factor of 0.7 or less.

5. **Conditioned Greenhouses, Space-Conditioning Systems.** Space-conditioning systems used for plant production shall comply with all applicable requirements.

6. **Greenhouses, Horticultural Lighting.** In a greenhouse with more than 40 kW of aggregate horticultural lighting load, the electric lighting system used for plant growth and plant maintenance shall meet the following requirements:

   A. The horticultural lighting systems shall have a photosynthetic photon efficacy (PPE) rated in accordance with ANSI/ASABE S640 for wavelengths from 400 to 700 nanometers and meet one of the following requirements:

      i. Integrated, non-serviceable luminaires shall have a rated PPE of at least 1.7 micromoles per joule; or

      ii. Luminaires with removable or serviceable lamps shall have lamps with a rated PPE of at least 1.7 micromoles per joule.

   B. Time-switch lighting controls shall be installed and comply with Section 110.9(b)1, Section 130.4(a)4, applicable sections of Reference Nonresidential Appendix NA7.6.2.

   C. Multilevel lighting controls shall be installed and comply with Section 130.1(b).

(i) **Mandatory Requirements for Steam Traps.** Steam traps in new industrial facilities and new steam traps added to support new, non-replacement, process equipment in existing industrial facilities where the installed steam trap operating pressure, which is the steam pressure entering the steam trap during normal design operating conditions, is greater than 15 psig and the total combined connected boiler input rating is greater than 5 Million Btu/hr, shall meet the following requirements:

1. **Central Steam Trap Fault Detection and Diagnostics Monitoring.** Steam trap systems shall be equipped with a central steam trap monitoring system that:

   A. Provides a status update of all steam trap fault detection sensors at no greater than 8 hour intervals.

   B. Automatically display an alarm that identifies which steam trap has fault once the system has detected a fault.

2. **Steam Trap Fault Detection.** Steam traps shall be equipped with automatic fault detection sensors that shall communicate their operational state to the central steam trap monitoring system as described in Section 120.6(i)1.

3. **Steam Trap Strainer Installation.** Steam traps shall either:

   A. Be equipped with an integral strainer and blow-off valve; or

   B. Be installed downstream with 3 feet of a strainer and blow-off valve.

4. **Steam Trap System Acceptance.** Before an occupancy permit is granted for steam trap systems subject to Section 120.6(i), the equipment and systems shall be certified as meeting the Acceptance Requirement for Code Compliance, as specified by the Reference Nonresidential Appendix NA7.19. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in NA7.19.

EXCEPTION 1 to Section 120.6(i): Steam traps where steam is diverted to a steam system of lower pressure for use when the steam trap fails open.

(j) **Mandatory Requirements for Computer Rooms.** Space conditioning systems serving a computer room shall meet the following requirements:

1. **Reheat.** Each computer room zone shall have controls that prevent reheating, recooling and simultaneous provisions of heating and cooling to the same zone, such as mixing or simultaneous supply of air that has been previously mechanically heated and air that has been previously cooled, either by cooling equipment or by economizer systems.

2. **Humidification.** Humidification shall be adiabatic. Nonadiabatic humidification, including but not limited to steam and infrared, is prohibited.

3. **Fan Control.** Each unitary air conditioner with mechanical cooling capacity exceeding 60,000 Btu/hr and each chilled water fan system shall be designed to vary the airflow rate as a function of actual load. Fan motor demand shall not exceed 50 percent of design wattage at 66 percent of design fan speed.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, Public Resources Code.

SECTION 120.7 – MANDATORY INSULATION REQUIREMENTS

Nonresidential~~, high-rise residential,~~ and hotel/motel buildings shall comply with the applicable requirements in Sections 120.7(a) through 120.7(c).

(a) **Roof/Ceiling Insulation.** The opaque portions of the roof/ceiling that separates conditioned spaces from unconditioned spaces or ambient air shall meet the applicable requirements of Items 1 through 3 below:

1. **Metal Building-** The weighted average U-factor of the roof assembly shall not exceed 0.098.
2. **Wood Framed and Others-** The weighted average U-factor of the roof assembly shall not exceed 0.075.
3. **Insulation Placement-** Insulation installed to limit heat loss and gain from conditioned spaces to unconditioned spaces shall comply with all of the following:

   A. Insulation shall be installed in direct contact with a ~~continuous~~ roof or ceiling that is sealed to limit infiltration and exfiltration as specified in Section 110.7. This may include, but is not limited to, placing insulation either above or below the roof deck or on top of the finished ceiling.

   B. When insulation is installed at the roof in nonresidential buildings, fixed vents or openings to the outdoors or to unconditioned spaces shall not be installed. When the space between the ceiling and the roof is either directly or indirectly conditioned space, it shall not be considered an attic for the purposes of complying with CBC attic ventilation requirements.

   C. Insulation placed on top of a suspended ceiling with removable ceiling panels shall not be used to meet the Roof/Ceiling requirement of Sections 140.3 and 141.0.

   EXCEPTION to Section 120.7(a)3: When there are conditioned spaces with a combined floor area no greater than 2,000 square feet in an otherwise unconditioned building, and when the average height of the space between the ceiling and the roof over these spaces is greater than 12 feet, insulation placed in direct contact with a suspended ceiling with removable ceiling panels shall be an acceptable method of reducing heat loss from a conditioned space and shall be accounted for in heat loss calculations.

NOTE: Vents that do not penetrate the roof deck and are instead designed for wind resistance for roof membranes are not within the scope of Section 120.7(a)3B.

(b) **Wall Insulation.** The opaque portions of walls that separate conditioned spaces from unconditioned spaces or ambient air shall meet the applicable requirements of Items 1 through 7 below:

1. **Metal Building.** The weighted average U-factor of the wall assembly shall not exceed 0.113.
2. **Metal Framed.** The weighted average U-factor of the wall assembly shall not exceed 0.151.
3. **Light Mass Walls.** A 6 inch or greater Hollow Core Concrete Masonry Unit shall have a U-factor not to exceed 0.440.
4. **Heavy Mass Walls.** An 8 inch or greater Hollow Core Concrete Masonry Unit shall have a U-factor not to exceed 0.690.
5. **Wood Framed and Others.** The weighted average U-factor of the wall assembly shall not exceed 0.110.
6. **Spandrel Panels and Curtain Wall.** The weighted average U-factor of the spandrel panels and curtain wall assembly shall not exceed 0.280.
7. **Demising Walls.** The opaque portions of framed demising walls shall meet the requirements of Item A or B below:

   A. Wood framed walls shall be insulated to meet a U-factor not greater than 0.099.

   B. Metal Framed walls shall be insulated to meet a U-factor not greater than 0.151.

(c) **Floor and Soffit Insulation**. The opaque portions of floors and soffits that separate conditioned spaces from unconditioned spaces or ambient air shall meet the applicable requirements of Items 1 and 2 below:

1. **Raised Mass Floors.** Shall have a minimum of 3 inches of lightweight concrete over a metal deck or the weighted average U-factor of the floor assembly shall not exceed 0.269.
2. **Other Floors.** The weighted average U-factor of the floor assembly shall not exceed 0.071.
3. **Heated Slab On Grade Floor.** A heated slab on grade floor shall be insulated to meet the requirements of Section 110.8(g)

EXCEPTION to Section 120.7: A dedicated building used solely as a data center that has a total covered process load exceeding 750 kW.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, Public Resources Code.

SECTION 120.8 – NONRESIDENTIAL BUILDING COMMISSIONING

Nonresidential buildings other than healthcare facilities, with conditioned space of 10,000 square feet or more, shall comply with the applicable requirements of Sections 120.8(a) through 120.8(i) in the building design and construction processes. All building systems and components covered by Sections 110.0, 120.0, 130.0, and 140.0 shall be included in the scope of the commissioning requirements in this Section, excluding those related solely to covered processes.

Nonresidential buildings other than healthcare facilities, with conditioned space of less than 10,000 square feet, shall comply with the design review requirements specified in Sections 120.8(d) and shall include any measures or requirements necessary for completing this review in the construction documents in a manner consistent with Section 120.8(e).

Healthcare facilities shall instead comply with the applicable requirements of Chapter 7 of the California Administrative Code (Title 24, Part 1).

NOTE: Nonresidential buildings include nonresidential spaces such as nonresidential function areas within hotel/motel and high-rise residential buildings. The requirements of Section 120.8 apply based on the square footage of the nonresidential spaces.

The commissioning described in this Section is in addition to any commissioning required by Title 24, Part 11, Section 5.410.2, 5.410.4, and subsections.

(a) **Summary of Commissioning Requirements.** Commissioning shall include completion of the following items:

1. Owner's or owner representative's project requirements;
2. Basis of design;
3. Design phase design review;
4. Commissioning measures shown in the construction documents;
5. Commissioning plan;
6. Functional performance testing;
7. Documentation and training; and
8. Commissioning report.

(b) **Owner's or Owner Representative's Project Requirements (OPR).** The energy-related expectations and requirements of the building shall be documented before the design phase of the project begins. This documentation shall include the following:

1. Energy efficiency goals;
2. Ventilation requirements;
3. Project documentation requirements, including facility functions, ~~and~~ hours of operation, ~~and~~ need for after-hours operation;
4. Equipment and systems expectations; and
5. Building envelope performance expectations.

(c) **Basis of Design (BOD).** A written explanation of how the design of the building systems and components meets the OPR shall be completed at the design phase of the building project, and updated as necessary during the design and construction phases. The Basis of Design document shall cover the following systems and components:

1. Heating, ventilation, air conditioning (HVAC) systems and controls;
2. Indoor lighting system and controls;
3. Water heating systems and controls; ~~and~~

4. Any other building equipment or system listed in the OPR; and

5. Any building envelope component considered in the OPR.

(d) **Design Phase Design Review.**

1. **Design Reviewer Requirements.** The design reviewer shall be the signer of the Design Review Kickoff Certificate(s) of Compliance and Construction Document Design Review Checklist Certificate(s) of Compliance as specified in Part 1 Section 10-103(a)1.

2. **Design Review Kickoff.** During the schematic design phase of the building project, the owner or owner's representative, design team and design reviewer must meet to discuss the project scope, schedule and how the design reviewer will coordinate with the project team. The building owner or owner's representative shall include the Design Review Kickoff Certificate of Compliance form in the Certificate of Compliance documentation as specified in Part 1 Section 10-103.

3. **Construction Documents Design Review.** The Construction Document Design Review Checklist Certificate of Compliance shall list the items checked by the design reviewer during the construction document review. The completed form shall be returned to the owner and design team for review and sign-off. The building owner or owner's representative shall include this form in the Certificate of Compliance documentation as specified in Part 1 Section 10-103.

(e) **Commissioning measures shown in the construction documents.** Complete descriptions of all measures or requirements necessary for commissioning shall be included in the construction documents (plans and specifications). Commissioning measures or requirements shall be clear, detailed and complete to clarify the commissioning process.

(f) **Commissioning Plan.** Prior to permit issuance a commissioning plan shall be completed to document how the project will be commissioned and shall be started during the design phase of the building project. The Commissioning Plan shall include the following:

1. General project information; ~~and~~

2. Commissioning goals; ~~and~~

3 Systems to be commissioned; and

4. Plans to test systems and components, which shall include:

A. An explanation of the original design intent; ~~and~~

B. Equipment and systems to be tested, including the extent of tests; ~~and~~

C. Functions to be tested; ~~and~~

D. Conditions under which the test shall be performed; ~~and~~

E. Measurable criteria for acceptable performance; ~~and~~

F. Commissioning team information; and

G. Commissioning process activities, schedules and responsibilities. Plans for the completion of commissioning requirements listed in Sections 120.8(g) through 120.8(i) shall be included.

(g) **Functional performance testing.** Functional performance tests shall demonstrate the correct installation and operation of each component, system and system-to-system interface in accordance with the acceptance test requirements in Sections 120.5, 130.4 and 140.9. Functional performance testing reports shall contain information addressing each of the building components tested, the testing methods utilized, and include any readings and adjustments made.

EXCEPTION to Section 120.8(g): Healthcare facilities.

(h) **Documentation and training.** A Systems Manual and Systems Operations Training shall be completed.

1. **Systems manual.** Documentation of the operational aspects of the building shall be completed within the Systems Manual and delivered to the building owner or representative and facilities operator. The Systems Manual shall include the following:
   A. Site information, including facility description, history and current requirements; ~~and~~
   B. Site contact information; ~~and~~
   C. Instructions for basic operations and maintenance, including general site operating procedures, basic troubleshooting, recommended maintenance requirements, and a site events log; ~~and~~
   D. Description of major systems; ~~and~~
   E. Site equipment inventory and maintenance notes; and
   F. A copy of all special inspection verifications required by the enforcing agency or the Standards.
2. **Systems operations training**. The training of the appropriate maintenance staff for each equipment type or system shall be documented in the commissioning report. Training materials shall include the following:
   A. System and equipment overview (i.e., what the equipment is, what it does and with what other systems or equipment it interfaces)<u>;</u>
   B. Review and demonstration of operation, servicing and preventive maintenance procedures<u>;</u>
   C. Review of the information in the Systems Manual<u>; and</u>
   D. Review of the record drawings on the systems and equipment

(i) **Commissioning report.** A complete report of commissioning process activities undertaken through the design, construction and reporting recommendations for post-construction phases of the building project shall be completed and provided to the owner or owner's representative.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 120.9 – MANDATORY REQUIREMENTS FOR COMMERCIAL BOILERS~~.~~

(a) Combustion air positive shut-off shall be provided on all newly installed boilers as follows:

1. All boilers with an input capacity of 2.5 MMBtu/h (2,500,000 Btu/h) and above, in which the boiler is designed to operate with a nonpositive vent static pressure.
2. All boilers where one stack serves two or more boilers with a total combined input capacity per stack of 2.5 MMBtu/h (2,500,000 Btu/h).

(b) Boiler combustion air fans with motors 10 horsepower or larger shall meet one of the following for newly installed boilers:

1. The fan motor shall be driven by a variable speed drive, or
2. The fan motor shall include controls that limit the fan motor demand to no more than 30 percent of the total design wattage at 50 percent of design air volume.

(c) Newly installed boilers with an input capacity 5 MMBtu/h (5,000,000 Btu/h) and greater shall maintain ~~excess (~~stack-gas~~)~~ oxygen concentrations at less than or equal to 5.0 percent by volume on a dry basis over firing rates of 20 to 100 percent. Combustion air volume shall be controlled with respect to firing rate or flue gas oxygen concentration. Use of a common gas and combustion air control linkage or jack shaft is prohibited.

EXCEPTION to Section 120.9(c): Boilers with steady state full-load thermal efficiency ~~85~~ 90 percent or higher.

NOTE: Authority: Sections 25213, 2521<u>8, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, Public Resources Code.</u>

SECTION 120.10 – MANDATORY REQUIREMENTS FOR FANS

a) Each fan or fan array with a combined motor nameplate horsepower greater than 1.00 hp or with a combined fan nameplate electrical input power greater than 0.89 kW shall have a fan energy index (FEI) of 1.00 or higher at fan system design conditions. Each fan and fan array used for a variable-air-volume system that meets the requirements of Section 140.4(c)(2) shall have an FEI of 0.95 or higher at fan system design conditions.

1. The FEI for fan arrays shall be calculated in accordance with ANSI/AMCA 208-18 Annex C.
2. All FEI values shall be provided by a manufacturer, where fan selection software and/or fan catalogs display third party verified FEI values in accordance with ANSI/AMCA 208-18.

   EXCEPTION to Section 120.10(a)2: FEI values for embedded fans do not need to be third party verified.

EXCEPTION 1 to Section 120.10(a): Embedded fans that are part of equipment listed under Section 110.2, Section 110.1, or equipment that has an energy conservation standard under 10 CFR 431, including any equipment with new energy conservation standards with effective dates prior to January 1, 2026.

EXCEPTION 2 to Section 120.10(a): Embedded fans and fan arrays with a combined motor nameplate horsepower of 5 hp or less or with a fan system electrical input power of 4.1 kW or less.

EXCEPTION 3 to Section 120.10(a): Circulation fans, ceiling fans and air curtains.

EXCEPTION 4 to Section 120.10(a): Fans that are intended to only operate during emergency conditions.

~~8, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, Public Resources Code.~~

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, Public Resources Code.

SUBCHAPTER 4
NONRESIDENTIAL~~, HIGH-RISE RESIDENTIAL,~~ AND HOTEL/MOTEL OCCUPANCIES—MANDATORY REQUIREMENTS FOR LIGHTING SYSTEMS AND EQUIPMENT, AND ELECTRICAL POWER DISTRIBUTION SYSTEMS

SECTION 130.0 – LIGHTING SYSTEMS AND EQUIPMENT, AND ELECTRICAL POWER DISTRIBUTION SYSTEMS —GENERAL

(a) The design and installation of all lighting systems and equipment in nonresidential and~~, high-rise residential,~~ hotel/motel buildings, outdoor lighting, and electrical power distribution systems within the scope of Section 100.0(a) shall comply with the applicable provisions of Sections 130.0 through 130.5.

NOTE: The requirements of Sections 130.0 through 130.5 apply to newly constructed buildings. Section 141.0 specifies which requirements of Sections 130.0 through 130.5 also apply to additions and alterations to existing buildings.

(b) **Functional areas where compliance with the residential lighting standards is required.** The design and installation of all lighting systems, lighting controls, and equipment in the following functional areas shall comply with the applicable residential lighting requirements of Section 150.0(k). In buildings containing these functional areas, all other functional areas, such as common areas, shall comply with the applicable nonresidential lighting and controlled receptacle requirements.

1. **RESERVED**~~High-rise residential dwelling units.~~
2. Outdoor lighting attached to a ~~high-rise residential or~~ hotel/motel building and separately controlled from the inside of a ~~dwelling unit or~~ guest room.
3. Fire station dwelling accommodations.
4. Hotel and motel guest rooms. Additionally, hotel and motel guest rooms shall meet the requirements of Section 130.1(c)8 and Section 130.5(d)4.
5. RESERVED

~~Dormitory and Senior housing dwelling accommodations.~~

NOTE: The requirements of Section 130.0(b) also apply to additions and alterations to functional areas of existing buildings as specified in Section 130.0(b).

(c) **Luminaire classification and power.** Luminaires shall be classified and their wattage shall be determined as follows:

1. Luminaire wattage shall be labeled as follows:
   A. The maximum rated wattage or relamping rated wattage of a luminaire shall be listed on a permanent, preprinted, factory-installed label, as specified by UL 1574, 1598, 2108, or 8750, as applicable; and
   B. The factory-installed maximum rated wattage or relamping rated wattage label shall not consist of peel-off or peel-down layers or other methods that allow the rated wattage to be changed after the luminaire has been shipped from the manufacturer.

EXCEPTION to Section 130.0(c)1B: Peel-down labels may be used only for the following luminaires when they can accommodate a range of lamp wattages without changing the luminaire housing, ballast, transformer or wiring. Qualifying luminaires shall have a single lamp, and shall have integrated ballasts or transformers. Peel-down labels must be layered such that the rated wattage reduces as successive layers are removed.

i. High intensity discharge luminaires, having an integral electronic ballast, with a maximum relamping rated wattage of 150 watts.

ii. Low-voltage luminaires (except low voltage track systems), ≤ 24 volts, with a maximum relamping rated wattage of 50 watts.

iii. Compact fluorescent luminaires, having an integral electronic ballast, with a maximum relamping rated wattage of 42 watts.

2. For luminaires with line voltage lamp holders not ~~containing permanently installed~~served by drivers, ballasts, or transformers, the wattage of such luminaires shall be determined as ~~follows:~~

~~A. The~~the maximum rated wattage ~~of the luminaire; and~~

~~B. For recessed luminaires with line-voltage medium screw base sockets, wattage shall not be less than 50 watts per socket, or the rated wattage of the installed JA8 compliant lamps~~as labeled in accordance with Section 130.0(c)1.

3. For luminaires with permanently installed or remotely installed ballasts, the wattage of such luminaires shall be the operating input wattage of the rated lamp/ballast combination published in the ballast manufacturer's catalogs based on independent testing lab reports as specified by UL 1598.

4. For inseparable SSL luminaires and SSL luminaires with remotely mounted drivers, the maximum rated wattage shall be the maximum rated input wattage of the SSL luminaire as specified in Section 130.0(c)1 when tested in accordance with UL 1598, 2108, 8750, or IES LM-79.

5. For LED tape lighting and LED linear lighting with LED tape lighting components, the maximum rated wattage shall be the sum of the installed length of the tape lighting times its rated linear power density in watts per linear feet, or the maximum rated input wattage of the driver or power supply providing power to the lighting system, with tape lighting tested in accordance with UL 2108, 8750, or IES LM-79.

6. ~~—~~For modular lighting systems that allow the addition or relocation of luminaires without altering the wiring of the system, shall be determined as follows:

A. The wattage shall be the greater of:

i. 30 watts per linear foot of track or plug-in busway; or

ii. the rated wattage of all of the luminaires included in the system, where the luminaire wattage is determined as specified in Section 130.0(c)1.~~; or~~

B. For line-voltage lighting track and plug-in busway served by a track lighting integral current limiter or a dedicated track lighting supplementary overcurrent protection panel, the wattage shall be determined as follows:

i. The volt-ampere rating of the current limiter as specified by UL 1077; or

ii. The sum of the ampere (A) rating of all of the current protection devices times the branch circuit voltages for track lighting supplementary overcurrent protection panel. ~~; or~~

C. For other modular lighting systems with power supplied by a driver, power supply or transformer, including but not limited to low-voltage lighting systems, the wattage of the system shall be the maximum rated input wattage of the driver, power supply or transformer published in the manufacturer's catalogs, as specified by UL 2108 or 8750.

EXCEPTION to Section 130.0(c)6: For power-over-Ethernet lighting systems, power provided to installed non-lighting devices may be subtracted from the total power rating of the power-over-Ethernet system.

7. For all other lighting equipment not addressed by Sections 130.0(c)2 through 6, the wattage of the lighting equipment shall be the maximum rated wattage of the lighting equipment, or operating input wattage of the system, labeled in accordance with Section 130.0(c)1, or published in manufacturer's catalogs, based on independent testing lab reports as specified by UL 1574, 1598, 2108, 8750, or IES LM-79.

(d) **Lighting Controls**. All lighting controls and equipment shall comply with the applicable requirements in Sections 110.9, 130.1 and 130.2, and shall be installed in accordance with any applicable manufacturer instructions.

(e) **Energy Management Control System (EMCS)**. An EMCS may be installed to comply with the requirements of one or more lighting controls if it meets the following minimum requirements:

1. Provides all applicable functionality for each specific lighting control or system for which it is installed in accordance with Sections 110.9, 130.1 and 130.2; and
2. Complies with all applicable Lighting Control Installation Requirements in accordance with Section 130.4 for each specific lighting control or system for which it is installed; and
3. Complies with all applicable application requirements for each specific lighting control or system for which it is installed, in accordance with Part 6.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 130.1 – MANDATORY INDOOR LIGHTING CONTROLS

Nonresidential~~, high-rise residential,~~ and hotel/motel buildings shall comply with the applicable requirements of Sections 130.1(a) through 130.1(f), in addition to the applicable requirements of Sections 110.9 and 130.0.

(a) **Manual Area Controls.** Each area enclosed by ceiling-height partitions shall provide lighting controls that allow the lighting in that area to be manually turned on and off. The manual control shall:

1. Be readily accessible; and

   EXCEPTION to Section 130.1(a)1: ~~Public r~~Restrooms having two or more stalls, parking areas, stairwells, ~~and~~ corridors, and areas of the building intended for access or use by the public may use a manual control not accessible to unauthorized personnel.

2. Be located in the same enclosed area with the lighting it controls; and

   EXCEPTION 1 to Section 130.1(a)2: For malls and atria, main entry lobbies, auditorium areas, dining areas, retail merchandise sales areas, wholesale showroom areas, commercial and industrial storage areas, general commercial and industrial work areas, convention centers, arenas, psychiatric and secure areas in healthcare facilities, and other areas where placement of a manual area control poses a health and safety hazard, the manual area control may instead be located so that a person using the control can see the lights or area controlled by that control, or visually signal or display showing the current state of the controlled lighting.

   EXCEPTION 2 to Section 130.1(a)2: In healthcare facilities, for restrooms and bathing rooms intended for a single occupant, the lighting control may be located outside the enclosed area but directly adjacent to the door.

3. Provide separate control of general, floor display, wall display, window display, case display, ornamental, and special effects lighting, such that each type of lighting can be turned on or off without turning on or off other types of lighting., ~~and without turning on or off any other equipment.~~Scene controllers may comply with this requirement provided that at least one scene turns on general lighting only, and the control provides a means to manually turn off all lighting.

EXCEPTION to Section 130.1(a): Up to ~~0.2~~0.1 watts per square foot of indoor lighting may be continuously illuminated to allow for means of egress illumination consistent with California Building Code Section 1008. Egress lighting complying with this wattage limitation is not required to comply with manual area control requirements if:

1. The area is designated for means of egress on the plans and specifications submitted to the enforcement agency under Section 10-103(a)2 of Part 1; and
2. The controls for the egress lighting are not accessible to unauthorized personnel.

(b) **Multilevel Lighting Controls.** The general lighting of any enclosed area 100 square feet or larger with a connected lighting load that exceeds 0.5 watts per square foot shall provide multilevel lighting controls that allow the level of lighting to be adjusted up and down. The multilevel controls shall:

1. P~~p~~rovide the number of control steps specified in TABLE 130.1-A; and

~~meet the uniformity requirements specified in TABLE 130.1-A.~~

~~**EXCEPTION 1 to Section 130.1(b):** An area enclosed by ceiling height partitions that has only one luminaire with no more than two lamps.~~

~~**EXCEPTION 2 to Section 130.1(b):** Restrooms.~~

~~**EXCEPTION 3 to Section 130.1(b):** Healthcare facilities.~~**EXCEPTION 1 to Section 130.1(b)1:** Classrooms with a connected general lighting load of 0.6 watts per square feet or less shall have a minimum of one control step between 30-70 percent of full rated power, regardless of luminaire type.

2. Meet the uniformity requirements specified in TABLE 130.1-A.

EXCEPTION 1 to Section 130.1(b): An area enclosed by ceiling height partitions that has only one luminaire with no more than two lamps or has only one inseparable SSL luminaire.

EXCEPTION 2 to Section 130.1(b): Restrooms.

EXCEPTION 3 to Section 130.1(b): Healthcare facilities.

(c) **Shut-OFF Controls.** All installed indoor lighting shall be equipped with controls able to automatically reduce lighting power when the space is typically unoccupied.

EXCEPTION 1 to Section 130.1(c): Healthcare facilities.

EXCEPTION 2 to Section 130.1(c): Lighting providing means of egress illumination, as the term is used in the California Building Code, shall be configured to provide no less than the amount of light required by California Building Code Section 1008 while in the partial-off mode.

1. In addition to lighting controls installed to comply with Sections 130.1(a) and (b), all installed indoor lighting shall be equipped with controls that meet the following requirements:

   A. Shall be controlled with an occupant sensing control, automatic time-switch control, or other control capable of automatically shutting OFF all of the lighting when the space is typically unoccupied; and

   B. Separate controls for the lighting on each floor, other than lighting in stairwells; and

   C. Separate controls for a space enclosed by ceiling height partitions not exceeding 5,000 square feet; and

      EXCEPTION to Section 130.1(c)1C: ~~In the following function areas T~~the area controlled may not exceed 20,000 square feet in the following function areas : Malls, auditoriums, single tenant retail, industrial, convention centers, and arenas;

   D. Separate controls for general, display, ornamental, and display case lighting~~; and~~.

   ~~E. For automatic time-switch controls, may include a manual-on mode.~~

   EXCEPTION 1 to Section 130.1(c)1: Where the lighting is serving an area that is in continuous use, 24 hours per day/365 days per year.

   EXCEPTION 2 to Section 130.1(c)1: Lighting complying with Section 130.1(c)5 or 7.

   EXCEPTION 3 to Section 130.1(c)1: Up to 0.1 watts per square foot of lighting in any area within a building may be continuously illuminated, provided that the area is designated for means of egress on the plans and specifications submitted to the enforcement agency under Section 10-103(a)2 of Part 1.

   EXCEPTION 4 to Section 130.1(c)1: Electrical equipment rooms subject to Article 110.26(D) of the California Electrical Code.

   EXCEPTION 5 to Section 130.1(c)1: Illumination provided by lighting equipment that is designated for emergency lighting, connected to an emergency power source or battery supply, and is intended to function in emergency mode only when normal power is absent.

   EXCEPTION 6 to Section 130.1(c)1: Lighting in stairways provided that the stairway is designated for means of egress on the plans and specifications submitted to the enforcement agency under Section 10-103(a)2 of Part 1.

2. Countdown timer switches may be used to comply with the automatic shut-OFF control requirements in Section 130.1(c)1 only in closets less than 70 square feet, and server aisles in server rooms. The maximum timer setting shall be 10 minutes for closets, and 30 minutes for server aisles.

3. If an automatic time-switch control, other than an occupant sensing control, is installed to comply with Section 130.1(c)1, it shall incorporate a manual override lighting control that:

   A. Complies with Section 130.1(a); and

   B. Allows the lighting to remain ON for no more than 2 hours when an override is initiated.

      EXCEPTION to Section 130.1(c)3B: In the following function areas, the override time may exceed 2 hours: Malls, auditoriums, single tenant retail, industrial, and arenas where captive-key override is utilized.

4. If an automatic time-switch control, other than an occupant sensing control, is installed to comply with Section 130.1(c)1, it shall incorporate an automatic holiday "shut-OFF" feature that turns OFF all loads for at least 24 hours, and then resumes the normally scheduled operation.

   EXCEPTION to Section 130.1(c)4: In retail stores and associated malls, restaurants, grocery stores, churches, and theaters, the automatic time-switch control is not required to incorporate an automatic holiday shut-OFF feature.

5. **~~Areas where~~ Occupant Sensing Controls are required ~~to shut OFF All Lighting~~for specified offices, multipurpose rooms, classrooms, conference rooms and restrooms**. In offices 250 square feet or smaller, multipurpose rooms of less than 1,000 square feet, classrooms of any size, conference rooms of any size, and restrooms of any size, lighting shall be controlled with occupant sensing controls to automatically shut OFF all of the lighting ~~when the room is unoccupied~~within 20 minutes of the control zone being unoccupied.

~~In areas required by Section 130.1(b) to have multilevel lighting controls, the occupant sensing controls shall function either as a:~~

~~Partial ON Occupant Sensor capable of automatically activating between 50-70 percent of controlled lighting power, or~~

~~Vacancy Sensor, where all lighting responds to a manual ON input only.~~

~~In areas not required by Section 130.1(b) to have multilevel lighting controls, the occupant sensing controls shall function either as a:~~

The general lighting in the following areas are required to be controlled by Occupant Sensing Controls or partial-on occupant sensing controls or vacancy sensing controls: (the areas are not required to have multilevel lighting controls)

A. An area enclosed by ceiling height partitions that has only one luminaire with no more than two lamps~~Occupant Sensor~~; or

~~B.~~ Restrooms~~Partial ON Occupant Sensor, or~~

C. ~~Vacancy Sensor, where all lighting responds to a manual ON input only~~.

The general lighting in the following areas are required to be controlled by partial-on occupant sensing controls capable of automatically activating between 50-70 percent of controlled lighting power: Classrooms with a connected lighting load of 0.6 watts per square feet or less.

In addition, controls shall be provided that allow the lights to be manually shut-OFF in accordance with Section 130.1(a) regardless of the sensor status.

6. **~~Areas where full or partial~~ Partial OFF occupant sensing controls are required for aisle ways and open area in warehouses, library book stack aisles, corridors and stairwells, and offices greater than 300**

square feet. General ~~Lighting~~ lighting installed in the following areas shall meet the ~~following~~ requirements below in addition to complying with Section 130.1(c)1.

A. In aisle ways and open areas in warehouses, lighting shall be controlled with occupant sensing controls that automatically reduce lighting power by at least 50 percent when the areas are unoccupied. The occupant sensing controls shall independently control lighting in each aisle way, and shall not control lighting beyond the aisle way being controlled by the sensor.

EXCEPTION 1 to Section 130.1(c)6A: In aisle ways and open areas in warehouses in which the installed lighting power is 80 percent or less of the value allowed under the Area Category Method, occupant sensing controls shall reduce lighting power by at least 40 percent.

EXCEPTION 2 to Section 130.1(c)6A: When metal halide lighting or high pressure sodium lighting is installed in warehouses, occupant sensing controls shall reduce lighting power by at least 40 percent.

B. In library book stack aisles 10 feet or longer that are accessible from only one end, and library book stack aisles 20 feet or longer that are accessible from both ends, lighting shall be controlled with occupant sensing controls that automatically reduce lighting power by at least 50 percent when the areas are unoccupied. The occupant sensing controls shall independently control lighting in each aisle way, and shall not control lighting beyond the aisle way being controlled by the sensor.

C. ~~Lighting installed l~~In corridors and stairwells, lighting shall be controlled by occupant sensing controls that separately reduce the lighting power in each space by at least 50 percent when the space is unoccupied. The occupant sensing controls shall be capable of automatically turning the lighting fully ON only in the separately controlled space, and shall be automatically activated from all designed paths of egress.

D. In office spaces greater than 250 square feet, general lighting shall be controlled with occupant sensing controls that meet all of the following:

i. The occupant sensing controls shall be configured so that lighting shall be controlled separately in control zones not greater than 600 square feet. For luminaires with an embedded occupant sensor that are capable of reducing power independently from other luminaires, each luminaire can be considered its own control zone; and

ii. Within 20 minutes of the control zone being unoccupied, the occupant sensing controls shall uniformly reduce lighting power in the control zone to by at least 80 percent of full power. Control functions that switch control zone lights completely off when the zone is vacant meet this requirement; and

iii. Within 20 minutes of the entire office space being unoccupied, the occupant sensing controls shall automatically turn off lighting in all control zones in the space; and

iv. In each control zone, lighting shall be allowed to automatically turn on to full power upon occupancy within the control zone. When occupancy is detected in any control zone in the space, the lighting in other control zones that are unoccupied shall operate at no more than 20 percent of full power.

EXCEPTION to Section 130.1(c)6D: Under-shelf or furniture-mounted task lighting controlled by a local switch and either a time switch or an occupancy sensor.

7. **~~Areas where p~~Partial OFF occupant sensing controls.** Partial OFF occupant sensing controls are required for specified stairwells and common area corridors, parking garages, parking areas and loading and unloading areas**.** ~~L~~General lighting installed in the following areas shall meet the ~~following~~ requirements below instead of complying with Section 130.1(c)1.

A. Lighting in stairwells and common area corridors that provide access to guest rooms ~~and dwelling units~~ of ~~high-rise residential buildings and~~ hotel/motels shall be controlled with occupant sensing controls that automatically reduce lighting power by at least 50 percent when the areas are unoccupied. The occupant sensing controls shall be capable of automatically turning the lighting fully

ON only in the separately controlled space, and shall be automatically activated from all designed paths of egress.

EXCEPTION to Section 130.1(c)7A: In corridors and stairwells in which the installed lighting power is 80 percent or less of the value allowed under the Area Category Method, occupant sensing controls shall reduce power by at least 40 percent.

B. In parking garages, parking areas and loading and unloading areas, general lighting shall be controlled by occupant sensing controls having at least one control step between 20 percent and 50 percent of design lighting power. No more than 500 watts of rated lighting power shall be controlled together as a single zone. A reasonably uniform level of illuminance shall be achieved in accordance with the applicable requirements in TABLE 130.1-A. The occupant sensing controls shall be capable of automatically turning the lighting fully ON only in the separately controlled space, and shall be automatically activated from all designed paths of egress.

Interior areas of parking garages are classified as indoor lighting for compliance with Section 130.1(c)7B. Parking areas on the roof of a parking structure are classified as outdoor hardscape and shall comply with the applicable provisions in Section 130.2.

EXCEPTION to Section 130.1(c)7B: Metal halide luminaires with a lamp plus ballast mean system efficacy of greater than 75 lumens per watt, used for general lighting in parking garages, parking areas and loading and unloading areas, shall be controlled by occupant sensing controls having at least one control step between 20 percent and 60 percent of design lighting power.

8. Hotel motel guest rooms shall be controlled with one of the following ~~have captive card key controls, occupancy sensing controls, or automatic controls~~ such that, no longer than 20 minutes after the guest room has been vacated, lighting power is switched off

i. captive card key controls; or

ii. occupant sensing controls; or

iii. automatic controls.

EXCEPTION to Section 130.1(c)8: One high efficacy luminaire as defined in TABLE 150.0-A that is switched separately and where the switch is located within 6 feet of the entry door.

~~**EXCEPTION 2 to Section 130.1(c):** Lighting providing means of egress illumination, as the term is used in the California Building Code, shall be configured to provide no less than the amount of light required by California Building Code Section 1008 while in the partial-off mode.~~

(d) **Automatic Daylighting Controls.** The general lighting in skylit daylit zones, ~~and~~ primary sidelit daylit zones, and secondary sidelit daylit zones, as well as the general lighting in the combined primary and secondary sidelit daylit zones in parking garages, shall be provided with controls that automatically adjust the power of the installed lighting up and down to keep the total light level stable as the amount of incoming daylight changes. For skylights located in an atrium, the skylit daylit zone definition shall apply to the floor area directly under the atrium and the top floor area directly adjacent to the atrium.

1. All skylit daylit zones, ~~and~~ primary sidelit daylit zones, secondary sidelit daylit zones, and the combined primary and secondary sidelit daylit zones in parking garages shall be shown on the plans.

NOTE: Parking areas on the roof of a parking structure are outdoor hardscape, not skylit daylit areas.

2. The automatic daylighting controls shall provide separate control for ~~luminaires~~ general lighting in each type of daylit zone. ~~Luminaires~~ General lighting ~~that fall~~ in ~~both~~ overlapping ~~a~~ skylit daylit zone and sidelit daylit zone shall be controlled as part of the skylit daylit zone. General lighting in overlapping primary and secondary sidelit daylit zones shall be controlled as part of the primary sidelit daylit zone. Linear LED and other solid state lighting (SSL) light sources in linear form may be treated as linear lamps in increments of 4 feet segments or smaller, and each segment is separately controlled based on the type of the daylit zone the segment is primarily located.

3. The automatic daylighting controls shall:

A. For spaces required to install multilevel controls under Section 130.1(b), adjust lighting via continuous dimming or the number of control steps provided by the multilevel controls;

B. For each space, ensure the combined illuminance from the controlled lighting and daylight is not less than the illuminance from controlled lighting when no daylight is available;

C. For areas other than parking garages, ensure that when the daylight illuminance is greater than 150 percent of the ~~design~~ illuminance ~~received from~~provided by the ~~general~~controlled lighting ~~system at full power~~when no daylight is available, the ~~general~~controlled lighting power in that daylight zone shall be reduced by a minimum of ~~65~~ 90 percent; and

D. For parking garages, ensure that when daylight illuminance levels measured at the farthest edge of the secondary sidelit zone away from the glazing or opening are greater than 150 percent of the illuminance provided by the controlled lighting when no daylight is available, the controlled lighting power in the combined primary and secondary sidelit daylit zones shall be reduced by 100 percent~~consumption is zero~~.

4. ~~When photosensors are located within the daylit zone, at least one p~~Photosensor shall be located so that they are not readily accessible to unauthorized personnel.

5. The location where calibration adjustments are made to the automatic daylighting controls shall be readily accessible to authorized personnel but may be inside a locked case or under a cover which requires a tool for access.

EXCEPTION 1 to Section 130.1(d): Areas under skylights where it is documented that existing adjacent structures or natural objects block direct sunlight for more than 1,500 daytime hours per year between 8 a.m. and 4 p.m.

EXCEPTION 2 to Section 130.1(d): Areas adjacent to vertical glazing below an overhang, where the overhang covers the entire width of the vertical glazing, no vertical glazing is above the overhang, and the ratio of the overhang projection to the overhang rise is greater than 1.5 for South, East and West orientations or greater than 1 for North orientations.

EXCEPTION 3 to Section 130.1(d): ~~Rooms in which the combined total installed general lighting power in the Skylit Daylit Zone and Primary Sidelit Daylit Zone is less than 120 Watts, or parking garage areas where the total combined general lighting power in the sidelit daylight zones is less than 60 watts.~~Rooms in which the total installed general lighting power in the Skylit Daylit Zone and Primary Sidelit Daylit Zone is less than 120 watts do not require automatic daylighting controls in the daylit zones.

EXCEPTION 4 to Section 130.1(d): Rooms in which the total installed general lighting power in the Secondary Sidelit Daylit Zone is less than 120 watts do not require automatic daylighting controls in the daylit zones.

EXCEPTION 5 to Section 130.1(d): Rooms in which the total installed wattage of the general lighting in the primary and the secondary sidelit daylit zones is less than 240 watts do not require automatic daylighting controls in the sidelit daylit zones.

EXCEPTION 6 to Section 130.1(d): Parking garage areas where the total installed wattage of the general lighting in the primary and the secondary sidelit daylit zones is less than 60 watts do not require automatic daylighting controls in the daylit zones.

EXCEPTION ~~4~~ 7 to Section 130.1(d): Rooms that have a total glazing area of less than 24 square feet, or parking garage areas with a combined total of less than 36 square feet of glazing or opening.

EXCEPTION ~~5~~ 8 to Section 130.1(d): For parking garages, luminaires located in the daylight adaptation zone ~~and luminaires for only dedicated ramps. Daylight adaptation zone and dedicated ramps are defined in Section 100.1~~.

EXCEPTION ~~6~~ 9 to Section 130.1(d): Luminaires in sidelit daylit zones in retail merchandise sales and wholesale showroom areas.

(e) **Demand Responsive Controls.** See Section 110.12 for requirements for demand responsive lighting controls.

(f) **Control Interactions.** Each lighting control installed to comply with Section 130.1(a) through(e) shall permit or incorporate the functions of the other lighting controls ~~required by this Section~~.

1. For general lighting, the manual area control shall permit the level or amount of light provided while the lighting is on to be set or adjusted by the controls specified in Section 130.1(b), (c), (d), and (e).
2. The manual area control shall permit the shutoff control to turn the lighting down or off.
3. The multilevel lighting control shall permit the automatic daylighting control to adjust the electric lighting level in response to changes in the amount of daylight in the daylit zone.
4. The multilevel lighting control shall permit the demand responsive control to adjust the lighting during a demand response event and to return it to the level set by the multilevel control after the event.
5. The shutoff control shall permit the manual area control to turn the lighting on. If the on request occurs while an automatic time switch control would turn the lighting off, then the on request shall be treated as an override request consistent with Section 130.1(c)3.
6. The automatic daylighting control shall permit the multilevel lighting control to adjust the level of lighting.
7. For lighting controlled by multilevel lighting controls and by occupant sensing controls that provide an automatic-on function, the controls shall provide a partial-on function that is capable of automatically activating between 50-70 percent of controlled lighting power.
8. (RESERVED)
9. For space conditioning system zones serving only spaces that are required to have occupant sensing controls as specified in Section 130.1(c), and where Table 120.1-A allows the ventilation air to be reduced to zero when the space is in occupied-standby mode, the space conditioning system shall be controlled by occupancy sensing controls as specified in Section 120.2(e)3.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

TABLE 130.1-A MULTILEVEL LIGHTING CONTROLS AND UNIFORMITY REQUIREMENTS

<table>
<tr><th>Luminaire Type</th><th colspan="4">Minimum Required Control Steps (percent of full rated power[1])</th><th>Uniform level of illuminance shall be achieved by:</th></tr>
<tr><td>LED luminaires and LED light source systems~~Line-voltage sockets except GU-24~~</td><td colspan="4" rowspan="4">Continuous dimming 10-100 percent</td><td rowspan="4"></td></tr>
<tr><td>Line-voltage sockets except GU-24 ~~Low-voltage incandescent systems~~</td></tr>
<tr><td>Low-voltage incandescent systems~~LED luminaires and LED source systems~~</td></tr>
<tr><td>~~GU-24 rated for LED~~</td></tr>
<tr><td>~~GU-24 sockets rated for fluorescent > 20 watts~~Fluorescent luminaires</td><td colspan="4" rowspan="2">Continuous dimming 20-100 percent</td><td rowspan="2"></td></tr>
<tr><td>~~Pin-based compact fluorescent > 20 watts[2]~~</td></tr>
<tr><td>GU-24 sockets rated for fluorescent ≤ 20 watts;
Pin-based compact fluorescent ≤ 20 watts[2]
Linear fluorescent and U-bent fluorescent ≤ 13 watts ~~GU-24 sockets rated for fluorescent ≤ 20 watts~~</td><td colspan="4" rowspan="3">Minimum one step between 30-70 percent</td><td rowspan="3">~~Stepped~~ Continuous dimming; or
~~Continuous~~ Stepped dimming; or
Switching alternate lamps in a luminaire; or
Separately switching circuits in multi-circuit track with a minimum of two circuits.</td></tr>
<tr><td>Track Lighting~~Pin-based compact fluorescent ≤ 20 watts[2]~~</td></tr>
<tr><td>~~Linear fluorescent and U-bent fluorescent ≤ 13 watts~~</td></tr>
<tr><td rowspan="2">Linear fluorescent and U-bent fluorescent > 13 watts
~~Linear fluorescent and U-bent fluorescent > 13 watts~~</td><td colspan="4">Minimum one step in each range:~~Minimum one step in each range:~~</td><td rowspan="2">Stepped dimming; or
Continuous dimming; or
Switching alternate lamps in each luminaire, having a minimum of 4 lamps per luminaire illuminating the same area and in the same manner~~Stepped dimming; or~~
~~Continuous dimming; or~~
~~Switching alternate lamps in each luminaire, having a minimum of 4 lamps per luminaire illuminating the same area and in the same manner~~</td></tr>
<tr><td>20-40 %~~20-40 %~~</td><td>50-70 %~~50-70 %~~</td><td>75-85 %~~75-85 %~~</td><td>100 %~~100 %~~</td></tr>
<tr><td>~~Track Lighting~~</td><td colspan="4">~~Minimum one step between 30 – 70 percent~~</td><td>~~Step dimming; or~~
~~Continuous dimming; or~~
~~Separately switching circuits in multi-circuit track with a minimum of two circuits.~~</td></tr>
<tr><td>~~HID > 20 watts~~</td><td colspan="4" rowspan="2">Minimum one step between 50 - 70 percent</td><td rowspan="2">Stepped dimming; or
Continuous dimming; or</td></tr>
<tr><td>~~Induction > 25 watts~~</td></tr>
</table>

Other light sources, including HID and Induction		Switching alternate lamps in each luminaire, having a minimum of 2 lamps per luminaire, illuminating the same area and in the same manner.
1. Full rated input power of driver, ballast and lamp, corresponding to maximum ballast factor 2. Includes only pin based lamps: twin tube, multiple twin tube, and spiral lamps ~~2. Includes only pin based lamps: twin tube, multiple twin tube, and spiral lamps~~		
~~**EXCEPTION 1 to Table 130.1-A Minimum Required Control Steps:** Classrooms with a connected general lighting load of 0.7 watts per square feet or less shall have a minimum of one control step between 30-70 percent of full rated power, regardless of luminaire type.~~ ~~**EXCEPTION 2 to Table 130.1-A Minimum Required Control Steps:** Library stack aisles, aisle ways and open areas in warehouses, parking garages, parking areas, loading and unloading areas, stairwells, and corridors shall have a minimum of one control step between 20-60 percent of full rated power, regardless of luminaire type.~~		

SECTION 130.2 – OUTDOOR LIGHTING CONTROLS AND EQUIPMENT

Nonresidential~~, high-rise residential~~ and hotel/motel buildings shall comply with the applicable requirements of Sections 130.2(a) through 130.2(c).

(a) **RESERVED**

(b) **Luminaire ~~Cutoff~~ Shielding Requirements.** All outdoor luminaires of 6,200 initial luminaire lumens or greater, shall comply with Backlight, Uplight, and Glare (BUG) (~~collectively referred to as "BUG"~~ in accordance with ANSI/IES TM-15-~~11~~20, ~~Addendum~~ Annex A~~)~~ requirements~~ as follows:~~

~~1. Maximum zonal lumens for Backlight, Uplight, and Glare shall be~~ in accordance with Title 24, Part 11, Section 5.106.8.

EXCEPTION 1 to Section 130.2(b): Signs.

EXCEPTION 2 to Section 130.2(b): Lighting for building facades, public monuments, public art, statues, and vertical surfaces of bridges.

EXCEPTION 3 to Section 130.2(b): Lighting not permitted by a health or life safety statute, ordinance, or regulation to be a cutoff luminaire.

EXCEPTION 4 to Section 130.2(b): Temporary outdoor lighting**.**

EXCEPTION 5 to Section 130.2(b): Replacement of existing pole mounted luminaires in hardscape areas meeting all of the following conditions:

A. Where the existing luminaire does not meet the luminaire BUG requirements in Section 130.2(b); and

B. Spacing between existing poles is greater than six times the mounting height of the existing luminaires; and

C. Where no additional poles are being added to the site; and

D. Where new wiring to the luminaires is not being installed; and

E. Provided that the connected lighting power wattage is not increased.

EXCEPTION 6 to Section 130.2(b): Luminaires that illuminate the public right of way ~~on~~ including publicly-maintained or utility-maintained roadways, sidewalks, and bikeways.

EXCEPTION 7 to Section 130.2(b): Outdoor lighting attached to a ~~high-rise residential or~~ hotel/motel building and separately controlled from the inside of a ~~dwelling unit or~~ guest room.

(c) **Controls for Outdoor Lighting.** Outdoor lighting shall be independently controlled from other electrical loads, and the controls for outdoor lighting shall meet the following functional requirements:

EXCEPTION 1 to Section 130.2(c): Outdoor lighting not permitted by a health or life safety statute, ordinance, or regulation to be turned OFF or reduced.

EXCEPTION 2 to Section 130.2(c): Lighting in tunnels required to be illuminated 24 hours per day and 365 days per year.

1. **Daylight Availability.** All installed outdoor lighting shall be controlled by a photo control, astronomical time-switch control, or other control capable of automatically shutting OFF the outdoor lighting when daylight is available.

2. **Automatic Scheduling Controls.**

A. Automatic scheduling controls shall be installed for all outdoor lighting. Automatic Scheduling Controls may be installed in combination with motion sensing controls or other outdoor lighting controls.

B. Automatic scheduling controls shall be capable of reducing the outdoor lighting power by at least 50 percent and no more than 90 percent, and separately capable of turning the lighting OFF, during scheduled unoccupied periods.

C~~B~~. Automatic scheduling controls shall allow scheduling of a minimum of two nighttime periods with independent lighting levels, and may include an override function that turns lighting ON during its scheduled dim or OFF state for no more than two hours when an override is initiated.

~~C. Acceptance tests of outdoor lighting controls shall verify the scheduled occupied and unoccupied periods, as specified in Section 130.4(a)6.~~

~~D. Automatic scheduling controls shall be installed for all outdoor lighting, and may be installed in combination with motion sensing controls or other outdoor lighting controls.~~

3. **Motion Sensing Controls.**

A. Motion sensing controls shall be installed for the following luminaires. Motion sensing controls may be installed for other outdoor lighting and in combination with other outdoor lighting controls.

i. Outdoor luminaires other than Building Façade, Ornamental Hardscape, Outdoor Dining, or Outdoor Sales Frontage lighting, where the bottom of luminaire is mounted 24 feet above grade or lower; and,

ii. Outdoor wall mounted luminaires installed for Building Façade, Ornamental Hardscape or Outdoor Dining lighting that have a bilaterally symmetric distribution such as Type II, III, and IV light distributions, as described in the IES Lighting Library™ and mounted 24 feet above grade or lower.

B. Motion sensing controls shall be capable of reducing the outdoor lighting power of each controlled luminaire by at least 50 percent and no more than 90 percent, and separately capable of turning the luminaire OFF, during unoccupied periods.

C~~B~~. Motion sensing controls shall be capable of reducing the lighting to its dim or OFF state no longer than 15 minutes after the area has been vacated, and of returning the lighting to its ON state when the area becomes occupied.

D~~C~~. No more than 1,500 watts of lighting power shall be controlled by a single sensor or as a single zone.

~~D. Motion sensing controls shall be installed for the following luminaires, and may be installed for other outdoor lighting and in combination with other outdoor lighting controls:~~

~~i. Outdoor luminaires other than Building Façade, Ornamental Hardscape, Outdoor Dining, or Outdoor Sales Frontage lighting, where the bottom of luminaire is mounted 24 feet or less above grade; and,~~

~~ii. Outdoor wall mounted luminaires installed for Building Façade, Ornamental Hardscape or Outdoor Dining lighting that have a bilaterally symmetric distribution as described in the IES Handbook (typically referred to as "wall packs") mounted 24 feet above grade or lower.~~

EXCEPTION 1 to Section 130.2(c)3: Luminaires with a maximum rated wattage of 40 watts each are not required to have motion sensing controls.

EXCEPTION 2 to Section 130.2(c)3: Applications listed as Exceptions to Section 140.7(a) are not required to have motion sensing controls.

EXCEPTION 3 to Section 130.2(c)3: Lighting subject to a health or life safety statute, ordinance, or regulation may have a minimum time-out period longer than 15 minutes or a minimum dimming level above 50 percent when necessary to comply with the applicable law.

EXCEPTION 4 to Section 130.2(c)3: For parking lots, luminaires with a maximum rated wattage of 78 watts each are not required to have motion sensing controls.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 130.3 – SIGN LIGHTING CONTROLS

Nonresidential buildings other than healthcare facilities, ~~high-rise residential buildings,~~ and hotel/motel buildings shall comply with the applicable requirements of Sections 130.3(a)1 through 130.3(a)3.

(a) **Controls for Sign Lighting.** All sign lighting shall meet the requirements below as applicable:

1. **Indoor Signs.** All indoor sign lighting other than exit sign lighting shall be controlled with an automatic time-switch control or astronomical time-switch control.
2. **Outdoor Signs.** Outdoor sign lighting shall meet the following requirements as applicable:

   A. All outdoor sign lighting shall be controlled with a photocontrol in addition to an automatic time-switch control, or an astronomical time-switch control.

   EXCEPTION to Section 130.3(a)2A: Outdoor signs in tunnels, and signs in large permanently covered outdoor areas that are intended to be continuously lit, 24 hours per day and 365 days per year.

   B. All outdoor sign lighting that is ON both day and night shall be controlled with a dimmer that provides the ability to automatically reduce sign lighting power by a minimum of 65 percent during nighttime hours. Signs that are illuminated at night and for more than 1 hour during daylight hours shall be considered ON both day and night.

   EXCEPTION to Section 130.3(a)2B: Outdoor signs in tunnels and large covered areas that are intended to be illuminated both day and night.
3. **Demand Responsive Electronic Message Center (EMC) Control.** See Section 110.12 for requirements for demand responsive EMC controls.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 130.4 –LIGHTING CONTROL ACCEPTANCE AND INSTALLATION CERTIFICATE REQUIREMENTS

Nonresidential buildings other than healthcare facilities~~, high-rise residential buildings,~~ and hotel/motel buildings shall comply with the applicable requirements of Sections 130.4(a) through 130.4(c). Healthcare facilities shall comply with the applicable acceptance and installation documentation requirements of OSHPD.

(a) **Lighting and Receptacle Control Acceptance Requirements.** Before an occupancy permit is granted, indoor and outdoor lighting and receptacle controls serving the building, area, or site and installed to comply with Sections 110.12, 130.1, 130.2, 130.5 or 140.6 shall be certified as meeting the Acceptance Requirements for Code Compliance, ~~in accordance with Section 130.4(a).~~as specified by the Reference Nonresidential Appendix NA7.6 and NA7.8. A Certificate of Acceptance shall be submitted to the enforcement agency under Section 10-103(a) of Part 1, that the equipment and systems meet the acceptance requirements:

1. ~~**Certifies that all of the lighting acceptance testing necessary to meet the requirements of Part 6 is completed**~~**RESERVED**
2. ~~Certifies that the applicable procedures in Reference Nonresidential Appendix NA7.6 and NA7.8 have been followed~~RESERVED
3. ~~Certifies that a~~Automatic daylight controls ~~comply with Section 130.1(d) and~~ shall be tested in accordance with Reference ~~Reference~~ Nonresidential Appendix NA7.6.1;
4. ~~Certifies that l~~Lighting shut-OFF controls ~~comply with Section 130.1(c) and~~ shall be tested in accordance with Reference ~~Reference~~ Nonresidential Appendix NA7.6.2;
5. D~~Certifies that d~~emand responsive lighting controls ~~comply with Section 130.1(e) and~~ shall be tested in accordance with Reference ~~Reference~~ Nonresidential Appendix NA7.6.3; and
6. ~~Certifies that o~~Outdoor lighting controls ~~comply with the applicable requirements of Section 130.2(c)~~ shall be tested in accordance with Reference ~~and Reference~~ Nonresidential Appendix NA7.8; and
7. ~~Certifies that l~~Lighting systems receiving the Institutional Tuning Power Adjustment Factor ~~comply with Section 140.6(a)2J~~ shall be tested in accordance with Reference ~~and Reference~~ Nonresidential -Appendix NA7.6.4~~7.6.2~~.
8. Demand responsive controls required to control controlled receptacles shall be tested in accordance with Reference Nonresidential Appendix NA7.6.5.

(b) **Lighting Control Installation Certificate Requirements.** To be recognized for compliance with Part 6, an Installation Certificate shall be submitted in accordance with Section 10-103(a) for any lighting control system, Energy Management Control System, ~~track lighting integral current limiter, track lighting supplementary overcurrent protection panel,~~ interlocked lighting system, lighting Power Adjustment Factor, or additional wattage available for a videoconference studio, in accordance with the following requirements, as applicable:

1. Certification that when a lighting control system is installed to comply with lighting control requirements in Part 6 it complies with the applicable requirements of Section 110.9; and complies with Reference Nonresidential Appendix NA7.7.1.
2. Certification that when an Energy Management Control System is installed to function as a lighting control required by Part 6 it functionally meets all applicable requirements for each application for which it is installed, in accordance with Sections 110.9, 130.0 through 130.5, 140.6 through 150.0, and 150.2; and complies with Reference Nonresidential Appendix NA7.7.2.
3. **RESERVED**
4. **RESERVED**
5. Certification that interlocked lighting systems used to serve an approved area comply with Section 140.6(a)1; and comply with Reference Nonresidential Appendix NA7.7.4.

6. Certification that lighting controls installed to earn a lighting Power Adjustment Factor (PAF) comply with Section 140.6(a)2; and comply with Reference Nonresidential Appendix NA7.7.5.

7. Certification that additional lighting wattage installed for a videoconference studio complies with Section 140.6(c)2Gvii; and complies with Reference Nonresidential Appendix NA7.7.6.

(c) When certification is required by Title 24, Part 1, Section 10-103.1, the acceptance testing specified by Section 130.4 shall be performed by a Certified Lighting Controls Acceptance Test Technician (CLCATT). If the CLCATT is operating as an employee, the CLCATT shall be employed by a Certified Lighting Controls Acceptance Test Employer. The CLCATT shall disclose on the Certificate of Acceptance a valid CLCATT certification identification number issued by an approved Acceptance Test Technician Certification Provider. The CLCATT shall complete all Certificate of Acceptance documentation in accordance with the applicable requirements in Section 10-103(a)4.

NOTE: Authority: Sections 25402, 25402.1, 25213, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 130.5 –ELECTRICAL POWER DISTRIBUTION SYSTEMS

Nonresidential~~, high-rise residential~~ and hotel/motel buildings shall comply with the applicable requirements of Sections 130.5(a) through 130.5(e).

(a) **Service Electrical Metering.** Each electrical service or feeder shall have a permanently installed metering system which measures electrical energy use in accordance with TABLE 130.5-A.

EXCEPTION 1 to Section 130.5(a): Service or feeder for which the utility company provides a metering system that indicates instantaneous kW demand and kWh for a utility-defined period.

EXCEPTION 2 to Section 130.5(a): Electrical power distribution systems subject to California Electrical Code Article 517.

(b) **Separation of Electrical Circuits for Electrical Energy Monitoring**. Electrical power distribution systems shall be designed so that measurement devices can monitor the electrical energy usage of load types according to TABLE 130.5-B.

EXCEPTION 1 to Section 130.5(b): For each separate load type, up to 10 percent of the connected load may be of any type.

EXCEPTION 2 to Section 130.5(b): Electrical power distribution systems subject to California Electrical Code Article 517.

(c) **Voltage Drop.** The maximum combined voltage drop on both installed feeder conductors and branch circuit conductors to the farthest connected load or outlet shall not exceed 5 percent.

EXCEPTION to Section 130.5(c): Voltage drop permitted by California Electrical Code Sections 647.4, 695.6 and 695.7.

(d) **Circuit Controls for 120-Volt Receptacles and Controlled Receptacles**. In all buildings, both controlled and uncontrolled 120 volt receptacles shall be provided in office areas, lobbies, conference rooms, kitchen areas in office spaces, and copy rooms. Additionally, hotel/motel guest rooms shall comply with Section 130.5(d)4. Controlled receptacles shall meet the following requirements, as applicable:

1. Install a control capable of automatically shutting OFF the controlled receptacles when the space is typically unoccupied, either at the receptacle or circuit level. When an automatic time switch control is installed it shall incorporate an override control that allows the controlled receptacle to remain ON for no more than 2 hours when an override is initiated and an automatic holiday “shut-OFF” feature that turns OFF all loads for at least 24 hours and then resumes the normally scheduled operation. Countdown timer switches shall not be used to comply with the automatic time switch control requirements; and
2. Install at least one controlled receptacle within 6 feet from each uncontrolled receptacle or install a splitwired receptacle with at least one controlled and one uncontrolled receptacle. Where receptacles are installed in modular furniture in open office areas, at least one controlled receptacle shall be installed at each workstation; and
3. Provide a permanent and durable marking for controlled receptacles or circuits to differentiate them from uncontrolled receptacles or circuits; and
4. For hotel and motel guest rooms, install controlled receptacles for at least one-half of the 120-volt receptacles in each guest room. Electric circuits serving controlled receptacles in guest rooms shall have captive card key controls, ~~occupancy~~ occupant sensing controls, or automatic controls so the power is switched off no longer than 30 minutes after the guest room has been vacated.

NOTE: A hardwired power strip controlled by an occupant sensing control may be used to comply with Section 130.5(d). Plug-in strips and other plug-in devices shall not be used to comply with the requirements of ~~this Section~~Section 130.5(d).

EXCEPTION 1 to Section 130.5(d): Receptacles that are only for the following purposes:

i. Receptacles specifically for refrigerators and water dispensers in kitchen areas. ~~Receptacles specifically for refrigerators and water dispensers in kitchen areas.~~

ii. Receptacles located a minimum of six feet above the floor that are specifically for clocks.

iii. Receptacles for network copiers, fax machines, A/V and data equipment other than personal computers in copy rooms.

iv. Receptacles on circuits rated more than 20 amperes.

v. Receptacles connected to an uninterruptible power supply (UPS) that are intended to be in continuous use, 24 hours per day/365 days per year, and are marked to differentiate them from other uncontrolled receptacles or circuits.

EXCEPTION 2 to Section 130.5(d): Receptacles in healthcare facilities.

(e) ~~-~~**Demand responsive controls and equipment.** See Section 110.12 for requirements for demand responsive controls and equipment including demand responsive controls for controlled receptacles.

NOTE: Definitions of terms and phrases in Section 130.5 are determined as specified in Section 100.1(b). Terms and phrases not found in Section 100.1(b) shall be defined as specified in Title 24, Part 3, Article 100 of the California Electrical Code.

TABLE 130.5-A MINIMUM REQUIREMENTS FOR METERING OF ELECTRICAL LOAD

Metering Functionality	**Electrical Services rated 50 kVA or less**	**Electrical Services rated more than 50kVA and less than or equal to 250 kVA**	**Electrical Services rated more than 250 kVA and less than or equal to 1000kVA**	**Electrical Services rated more than 1000kVA**
Instantaneous (at the time) kW demand	Required	Required	Required	Required
Historical peak demand (kW)	Not required	Not required	Required	Required
Tracking kWh for a user-definable period.	Required	Required	Required	Required
kWh per rate period	Not required	Not required	Not required	Required

TABLE 130.5-B MINIMUM REQUIREMENTS FOR SEPARATION OF ELECTRICAL LOAD

Electrical Load Type	Electrical Services rated 50 kVA or less	Electrical Services rated more than 50kVA and less than or equal to 250 kVA	Electrical Services rated more than 250 kVA and less than or equal to 1000kVA	Electrical Services rated more than 1000kVA
Lighting including exit and egress lighting and exterior lighting	Not required	All lighting in aggregate	All lighting disaggregated by floor, type or area	All lighting disaggregated by floor, type or area
HVAC systems and components including chillers, fans, heaters, furnaces, package units, cooling towers, and circulation pumps associated with HVAC	Not required	All HVAC in aggregate	All HVAC in aggregate and each HVAC load rated at least 50 kVA	All HVAC in aggregate and each HVAC load rated at least 50kVA
Domestic and service water system pumps and related systems and components	Not required	All loads in aggregate	All loads in aggregate	All loads in aggregate
Plug load including appliances rated less than 25 kVA	Not required	All plug load in aggregate Groups of plug loads exceeding 25 kVA connected load in an area less than 5000 sf	All plug load separated by floor, type or area Groups of plug loads exceeding 25 kVA connected load in an area less than 5000 sf	All plug load separated by floor, type or area All groups of plug loads exceeding 25 kVA connected load in an area less than 5000 sf
Elevators, escalators, moving walks, and transit systems	Not required	All loads in aggregate	All loads in aggregate	All loads in aggregate
Other individual non-HVAC loads or appliances rated 25kVA or greater	Not required	All loads in aggregate	All loads in aggregate	All loads in aggregate
Industrial and commercial load centers 25 kVA or greater including theatrical lighting installations and commercial kitchens	Not required	All loads in aggregate	All loads in aggregate	All loads in aggregate
Renewable power source (net or total)	Each group	Each group	Each group	Each group
Loads associated with renewable power source	Not required	All loads in aggregate	All loads in aggregate	All loads in aggregate
Charging stations for electric vehicles	All loads in aggregate	All loads in aggregate	All loads in aggregate	All loads in aggregate

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SUBCHAPTER 5
NONRESIDENTIAL~~, HIGH-RISE RESIDENTIAL,~~ AND HOTEL/MOTEL OCCUPANCIES—PERFORMANCE AND PRESCRIPTIVE COMPLIANCE APPROACHES FOR ACHIEVING ENERGY EFFICIENCY

SECTION 140.0 – PERFORMANCE AND PRESCRIPTIVE COMPLIANCE APPROACHES

Nonresidential~~, high-rise residential~~ and hotel/motel buildings shall comply with all of the following:

(a) The requirements of Sections 100.0 through 110.12 applicable to the building project (mandatory measures for all buildings).

(b) The requirements of Sections 120.0 through 130.5 (mandatory measures for nonresidential~~, high-rise residential~~ and hotel/motel buildings).

(c) Either the performance compliance approach (energy budgets) specified in Section 140.1 or the prescriptive compliance approach specified in Section 140.2 for the Climate Zone in which the building will be located. Climate zones are shown in FIGURE 100.1-A.

NOTE to Section 140.0(c): The Commission periodically updates, publishes, and makes available to interested persons and local enforcement agencies precise descriptions of the Climate Zones, which is available by zip code boundaries depicted in the Reference Joint Appendices along with a list of the communities in each zone.

NOTE to Section 140.0: The requirements of Sections 140.1 through 140.9 apply to newly constructed buildings. Section 141.0 specifies which requirements of Sections 140.1 through 140.9 also apply to additions or alterations to existing buildings.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 140.1 – PERFORMANCE APPROACH: ENERGY BUDGETS

A building complies with the performance approach if the energy budget calculated for the Proposed Design Building under Subsection (b) is no greater than the energy budget calculated for the Standard Design Building under Subsection (a).

(a) **Energy Budget for the Standard Design Building.** The energy budget for the Standard Design Building is determined by applying the mandatory and prescriptive requirements to the Proposed Design Building. The energy budget is the sum of the TDV energy for space-conditioning, indoor lighting, mechanical ventilation, photovoltaic (PV) and battery storage systems, service water heating, and covered process loads.

(b) **Energy Budget for the Proposed Design Building.** The energy budget for a Proposed Design Building is determined by calculating the TDV energy for the Proposed Design Building. The energy budget is the sum of the TDV energy for space-conditioning, indoor lighting, mechanical ventilation, photovoltaic (PV) and battery storage systems, and service water heating and covered process loads.

EXCEPTION to Section 140.1(b). A community shared solar electric generation system, or other renewable electric generation system, and/or community shared battery storage system, which provides dedicated power, utility energy reduction credits, or payments for energy bill reductions, to the permitted building and is approved by the Energy Commission as specified in Title 24, Part 1, Section 10-115, may offset part or all of the solar electric generation system TDV energy required to comply with the Standards, as calculated according to methods established by the Commission in the Nonresidential ACM Reference Manual.

(c) **Calculation of Energy Budget.** The TDV energy for both the Standard Design Building and the Proposed Design Building shall be computed by Compliance Software certified for this use by the Commission. The processes for Compliance Software approval by the Commission are documented in the ACM Approval Manual.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 140.2 – PRESCRIPTIVE APPROACH

To comply using the prescriptive approach, a building shall be designed with and shall have constructed and installed systems and components meeting the applicable requirements of Sections 140.3 through 140.9.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 140.3 – PRESCRIPTIVE REQUIREMENTS FOR BUILDING ENVELOPES

A building complies with this section by being designed with and having constructed to meet all prescriptive requirements in Subsection (a) and the requirements of Subsection (c) and (d) where they apply.

(a) **Envelope Component Requirements.**

1. **Exterior roofs and ceilings.** Exterior roofs and ceilings shall comply with each of the applicable requirements in this subsection:

   A. **Roofing Products.** Shall meet the requirements of Section 110.8 and the applicable requirements of Subsections i through ii:

      i. Nonresidential buildings:

         a. Low-sloped roofs in Climate Zones 1 through 16 shall have:

            1. A minimum aged solar reflectance of 0.63 and a minimum thermal emittance of 0.75; or

            2. A minimum Solar Reflectance Index (SRI) of 75.

            EXCEPTION 1 to Section 140.3(a)1Aia: Wood-framed roofs in Climate Zones 3 and 5 are exempt from the requirements of Section 140.3(a)1Aia if the roof assembly has a U-factor of 0.034 or lower.

            EXCEPTION 2 to Section 140.3(a)1Aia: Roof constructions with a weight of at least 25 lb/ft² over the roof membrane are exempt from the requirements of Section 140.3(a)1Aia.

            EXCEPTION 3 to SECTION 140.3(a)1Aia: An aged solar reflectance less than 0.63 is allowed provided the maximum roof/ceiling U-factor in TABLE 140.3 is not exceeded.

         b. Steep-sloped roofs

            1. ~~i~~In Climate Zones 1 ~~through 16~~and 3 shall have a minimum aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16.

            2. In Climate Zones 2 and 4 through 16 shall have a minimum aged solar reflectance of 0.25 and a minimum thermal emittance of 0.80, or a minimum SRI of 23.

~~ii. High-rise residential buildings and hotels and motels:~~

~~a. Low-sloped roofs in Climate Zones 9, 10, 11, 13, 14 and 15 shall have a minimum aged solar reflectance of 0.55 and a minimum thermal emittance of 0.75, or a minimum SRI of 64.~~

~~**EXCEPTION to Section 140.3(a)1Aiia:** Roof constructions with a weight of at least 25 lb/ft² over the roof membrane.~~

~~b. Steep-sloped roofs in Climate Zones 2 through 15 shall have a minimum aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16.~~

TABLE 140.3 ROOF/CEILING INSULATION TRADEOFF FOR AGED SOLAR REFLECTANCE – NONRESIDENTIAL BUILDINGS

~~Nonresidential~~			
Aged Solar Reflectance	**Metal Building Climate Zone 1-16 U-factor**	**Wood framed and Other Climate Zone ~~6 & 7~~ 8 U-factor**	**Wood Framed and Other All Other Climate Zones U-factor**
0.62-0.56	0.038	0.045	0.032
0.55-0.46	0.035	0.042	0.030
0.45-0.36	0.033	0.039	0.029
0.35-0.25	0.031	0.037	0.028

EXCEPTION to Section 140.3(a)1A: Roof area covered by building integrated photovoltaic panels and building integrated solar thermal panels are not required to meet the minimum requirements for solar reflectance, thermal emittance, or SRI.

B. **Roof Insulation.** Roofs shall have an overall assembly U-factor no greater than the applicable value in Table 140.3- B, C or D, and where required by Section 110.8 and 120.7(a)3, insulation shall be placed in direct contact with a ~~continuous~~ roof or drywall ceiling.

2. **Exterior Walls.** Exterior walls shall have an overall assembly U-factor no greater than the applicable value in TABLE 140.3-B, C or D.

3. **Demising Walls.** Demising walls shall meet the requirements of Section 120.7(b)7. Vertical windows in demising walls between conditioned and unconditioned spaces shall have an area-weighted average U-factor no greater than the applicable value in TABLE140.3-B, C or D.

4. **Exterior Floors and Soffits.** Exterior floors and soffits shall have an overall assembly U-factor no greater than the applicable value in TABLE 140.3-B, C or D.

5. **Exterior Windows.** Vertical windows in exterior walls shall:

   A. Percent window area shall be limited in accordance with the applicable requirements of i and ii below:

      i. a west-facing area no greater than 40 percent of the gross west-facing exterior wall area, or 6 feet times the west-facing display perimeter, whichever is greater; and

      ii. a total area no greater than 40 percent of the gross exterior wall area, or 6 feet times the display perimeter, whichever is greater; and

   NOTE: Demising walls are not exterior walls, and therefore demising wall area is not part of the gross exterior wall area or display perimeter, and windows in demising walls are not part of the window area.

   EXCEPTION to Section 140.3(a)5A: Conditioned greenhouses. The requirements of Section 120.6(h)4 apply.

   B. Have an area-weighted average U-factor no greater than the applicable value in TABLE 140.3-B, C or D.

   EXCEPTION 1 to Section 140.3(a)5B: For school buildings less than 25,000 square feet and 3 stories or less in climate zones 1 and 16 shall have a U-factor of 0.26 or less.

EXCEPTION 2 to Section 140.3(a)5B: Conditioned greenhouses. The requirements of Section 120.6(h)4 apply.

EXCEPTION 3 to Section 140.3(a)5B: For vertical windows containing chromogenic type glazing:

i. The lower-rated labeled U-factor shall be used with automatic controls to modulate the amount of heat flow into the space in multiple steps in response to daylight levels or solar intensity; and

ii. Chromogenic glazing shall be considered separately from other glazing; and

iii. Area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

C. Have an area-weighted average Relative Solar Heat Gain Coefficient, RSHGC, excluding the effects of interior shading, no greater than the applicable value in TABLE 140.3-B, C or D.

For purposes of this paragraph, the Relative Solar Heat Gain Coefficient, RSHGC, of a vertical window is:

i. The Solar Heat Gain Coefficient of the window; or

ii. Relative Solar Heat Gain Coefficient is calculated using EQUATION 140.3-A, if the window has an overhang or exterior horizontal slats that extends beyond each side of the window jamb by a distance equal to the overhang's horizontal projection.

EXCEPTION 1 to Section 140.3(a)5C: An area-weighted average Relative Solar Heat Gain Coefficient of 0.56 or less shall be used for windows:

a. That are in the first story of exterior walls that form a display perimeter; and
b. For which codes restrict the use of overhangs to shade the windows.

EXCEPTION 2 to Section 140.3(a)5C: For vertical glazing containing chromogenic type glazing:

i. the lower-rate labeled RSHGC shall be used with automatic controls to modulate the amount of heat flow into the space in multiple steps in response to daylight levels or solar intensity; and

ii. chromogenic glazing shall be considered separately from other glazing; and

iii. area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

EXCEPTION 3 to Section 140.3(a)5C: Conditioned greenhouses. The requirements of Section 120.6(h)4 apply.

NOTE: Demising walls are not exterior walls, and therefore windows in demising walls are not subject to SHGC requirements.

D. Have an area-weighted average Visible Transmittance (VT) no less than the applicable value in TABLE 140.3-B and C, or EQUATION 140.3-B, as applicable.

EXCEPTION 1 to Section 140.3(a)5D: When the window's primary and secondary sidelit daylit zones are completely overlapped by one or more skylit daylit zones, then the window need not comply with Section 140.3(a)5D.

EXCEPTION 2 to Section 140.3(a)5D: If the window's VT is not within the scope of NFRC 200, or ASTM E972, then the VT shall be calculated according to Reference Nonresidential Appendix NA6.

EXCEPTION 3 to Section 140.3(a)5D: For vertical glazing containing chromogenic type glazing:

i. The higher-rate labeled VT shall be used with automatic controls to modulate the amount of light transmitted into the space in multiple steps in response to daylight levels or solar intensity; and

ii. Chromogenic glazing shall be considered separately from other glazing; and

iii. Area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

EXCEPTION 4 to Section 140.3(a)5D: Conditioned greenhouses. The requirements of Section 120.6(h)4

apply.

NOTE: Demising walls are not exterior walls, and therefore windows in demising walls are not subject to VT requirements.

EQUATION 140.3-A RELATIVE SOLAR HEAT GAIN COEFFICIENT, RSHGC

$$RSHGC = SHGC_{win} \times \left[1 + \frac{aH}{V} + b\left(\frac{H}{V}\right)^2\right]$$

RSHGC = SHGC × [1 + a × (2.72^{-PF} – 1) × (sin(b × Az) – c]

WHERE:

	a	b	c
Overhang	0.150	0.130	5.67
Exterior Horizontal Slat	0.144	0.133	5.13

RSHGC = Relative Solar Heat Gain Coefficient.

$SHGC_{win}$ = Solar Heat Gain Coefficient of the ~~window~~vertical fenestration.

~~H = Horizontal projection of the overhang from the surface of the window in feet, but no greater than V.~~

~~V = Vertical distance from the window sill to the bottom of the overhang in feet.~~

~~a = -0.41 for north-facing windows, -1.22 for south-facing windows, and -0.92 for east and west-facing windows.~~

~~b = 0.20 for north-facing windows, 0.66 for south-facing windows, and 0.35 for east and west-facing windows.~~

Az = Azimuth of the vertical fenestration in degrees.

PF = Projection factor as calculated by Equation 140.3-C.

EQUATION 140.3-B VERTICAL FENESTRATION MINIMUM VT

VT ≥ 0.11/ WWR

WHERE:

WWR = Window Wall Ratio, the ratio of (i) the total window area of the entire building to (ii) the total gross exterior wall area of the entire building. If the WWR is greater than 0.40, then 0.40 shall be used as the value for WWR in EQUATION 140.3-B.

VT = Visible Transmittance of framed window.

6. **Skylights.** Skylights shall:

   A. Have an area no greater than 5 percent of the gross exterior roof area Skylight Roof Ratio (SRR); and

EXCEPTION 1 to Section 140.3(a)6A: Buildings with an atria over 55 feet high shall have a skylight area no greater than 10 percent of the gross exterior roof area.

EXCEPTION 2 to Section 140.3(a)6A: Conditioned greenhouses. The requirements of Section 120.6(h)4 apply.

B. Have an Area-Weighted Performance Rating U-factor no greater than the applicable value in TABLE 140.3-B, C or D.

EXCEPTION 1 to Section 140.3(a)6B: For skylights containing chromogenic type glazing:

i. the lower-rate labeled U-factor shall be used with automatic controls to modulate the amount of heat flow into the space in multiple steps in response to daylight levels or solar intensity; and

ii. chromogenic glazing shall be considered separately from other glazing; and

iii. area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

EXCEPTION 2 to Section 140.3(a)6B: Conditioned greenhouses. The requirements of Section 120.6(h)4 apply.

C. Have an area-weighted performance rating Solar Heat Gain Coefficient no greater than the applicable value in TABLE 140.3-B, C or D.

EXCEPTION 1 to Section 140.3(a)6C: For skylights containing chromogenic type glazing:

i. the lower-rated labeled SHGC shall be used with automatic controls to modulate the amount of heat flow into the space in multiple steps in response to daylight levels or solar intensity; and

ii. chromogenic glazing shall be considered separately from other glazing; and

iii. area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

EXCEPTION 2 to Section 140.3(a)6C: Conditioned greenhouses. The requirements of Section 120.6(h)4 apply.

D. Have an Area-Weighted Performance Rating VT no less than the applicable value in TABLE 140.3-B or C; and

EXCEPTION 1 to Section 140.3(a)6D: For skylights containing chromogenic type glazing:

i. the higher-rated labeled VT shall be used with automatic controls to modulate the amount of light transmitted into the space in multiple steps in response to daylight levels or solar intensity and;

ii. chromogenic glazing shall be considered separately from other glazing; and

iii. area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

EXCEPTION 2 to Section 140.3(a)6D: Conditioned greenhouses. The requirements of Section 120.6(h)4 apply.

E. Have a glazing material or diffuser that has a measured haze value greater than 90 percent, determined according to ASTM D1003, or other test method approved by the Energy Commission.

EXCEPTION 1 to Section 140.3(a)6E: Skylights designed and installed to exclude direct sunlight entering the occupied space by the use of fixed or automated baffles or the geometry of the skylight and light well.

EXCEPTION 2 to Section 140.3(a)6E: Conditioned greenhouses. The requirements of Section 120.6(h)4 apply.

7. **Exterior doors.** All exterior doors that separate conditioned space from unconditioned space or from ambient air shall have a U-factor not greater than the applicable value in TABLE 140.3-B, C or D. Doors that are more than one ~~half~~ quarter glass in area are considered Glazed Doors.

8. **Relocatable Public School Buildings.** In complying with Sections 140.3(a)1 to 7 shall meet the following:

   A. Relocatable public school buildings shall comply with TABLE 140.3-B for a specific Climate Zone when the manufacturer or builder of the relocatable public school building certifies that the building is intended for use only in a specific Climate Zone; or

   B. Relocatable public school buildings shall comply with TABLE 140.3-D for any Climate Zone when the manufacturer or builder of the relocatable public school building certifies that the building is intended for use in any Climate Zone; and

   C. The manufacturer or builder of a relocatable public school building shall certify that components of the building comply with requirements of this section by:

      i. The placement of two (2) metal identification labels on the building, one mechanically fastened and visible from the exterior and the other mechanically fastened to the interior frame above the ceiling at the end of the module, both labels stating (in addition to any other information by the Division of the State Architect or other law) "Complies with Title 24, Part 6 for all Climate Zones"; and

      ii. Identification of the location of the 2 labels on the plans submitted to the enforcing agency.

9. **Air Barrier**. To meet the requirement of TABLE 140.3-B, all buildings shall have a continuous air barrier that is designed and constructed to control air leakage into, and out of, the building's conditioned space.

   EXCEPTION to Section 140.3(a)9: Relocatable Public School Buildings.

   A. Design. Construction documents shall include air barrier boundaries, interconnections and penetrations, and associated square foot calculations for all sides of the air barrier.

   B. Acceptable Materials and Assemblies, The air barrier shall be sealed at all joints for its entire length and shall be composed of:

   ~~A~~i ~~.~~Materials that have an air permeance not exceeding 0.004 cfm/ft^2, under a pressure differential of 0.3 in. of water (1.57 psf) (0.02 L/(sec-m^2) at 75 pa), when tested in accordance with ASTM E2178; or

   ~~**EXCEPTION to Section 140.3(a)9A**: Materials in TABLE 140.3-A shall be deemed to comply with Section 140.3(a)9A provided if all joints are sealed and all of the materials are installed as air barriers in accordance with the manufacturer's instructions.~~

~~TABLE 140.3-A MATERIALS DEEMED TO COMPLY WITH SECTION 140.3(a)9A~~

	~~MATERIALS AND THICKNESS~~		~~MATERIALS AND THICKNESS~~
~~1~~	~~Plywood – min. 3/8 inches thickness~~	~~9~~	~~Built up roofing membrane~~
~~2~~	~~Oriented strand board – min. 3/8 inches thickness~~	~~10~~	~~Modified bituminous roof membrane~~
~~3~~	~~Extruded polystyrene insulation board – min. ½ inches thickness~~	~~11~~	~~Fully adhered single-ply roof membrane~~
~~4~~	~~Foil-back polyisocyanurate insulation board – min. ½ inches thickness~~	~~12~~	~~A Portland cement or Portland sand parge, or a gypsum plaster, each with min. 5/8 inches thickness~~
~~5~~	~~Closed cell spray foam with a minimum density of 2.0 pcf and a min. 2.0 inches thickness~~	~~13~~	~~Cast-in-place concrete, or precast concrete~~
~~6~~	~~Open cell spray foam with a density no less than 0.4 pcf and no greater than 1.5 pcf, and a min. 5½ inches thickness~~	~~14~~	~~Fully grouted concrete block masonry~~
~~7~~	~~Exterior or interior gypsum board min. 1/2 inches thickness~~	~~15~~	~~Sheet steel or sheet aluminum~~
~~8~~	~~Cement board – min. 1/2 inches thickness~~	~~---~~	~~----------~~

~~B~~ii. Assemblies of materials and components that have an average air leakage not exceeding 0.04 cfm/ft^2, under a pressure differential of 0.3 in. of water (1.57 psf) (0.2 L/m^2 at 75 pa), when tested in accordance with ASTM E2357, ASTM E1677, ASTM E1680, or ASTM E283; ~~or~~

EXCEPTION to Section 140.3(a)9 Bi: Materials in TABLE 140.3-B shall be deemed to comply with Section 140.3(a)9B provided if all joints are sealed and all of the materials are installed as air barriers in accordance with the manufacturer's instructions.

EXCEPTION to Section 140.3(a)9Bii: The following materials shall be deemed to comply with Section 140.3(a)9B if all joints are sealed and all of the materials are installed as air barriers in accordance with the manufacturer's instructions:

a. ~~i.~~ Concrete masonry walls that have at least two coatings of paint or at least two coatings of sealer coating.

b. ~~ii.~~ Concrete masonry walls with integral rigid board insulation.

c. ~~iii.~~ Structurally Insulated Panels.

d. ~~iv.~~ Portland cement or Portland sand parge, or stucco, or a gypsum plaster, each with minimum 1/2 inch thickness

C. Verification. If verification is conducted the entire building shall meet one of the following requirements:

i.~~The entire building has a~~ An air leakage rate not exceeding 0.40 cfm/ft^2 at a pressure differential of 0.3 in of water (1.57 psf) (2.0 L/ m^2 at 75 pa), when the entire building is tested, after

completion of construction, in accordance with ~~ASTM E779~~ NA 2.4, or another test method approved by the Commission; or.

ii. For buildings that have more than 50,000ft^2 of conditioned floor area, a sectional test method of co-pressurizing representative test floors and taking data from the specific floors to achieve the requirement in Section 140.3(a)9Ci. when following the procedures in Sections NA2.4.2 to NA2.4.7. Representative test floors must meet the following conditions:

a. The entire floor area of all stories that have any spaces directly under a roof.

b. The entire floor area of all stories that have a building entrance or loading dock.

c. Representative above-grade wall sections of the building totaling at least 25% of the wall area enclosing the remaining conditioned space. Floor areas in parts a. and b. above shall not be included in the 25%.

iii. If the air leakage requirements of either Section 140.3(a)9Ci or 140.3(a)9Cii are not met, a Visual Inspection and Diagnostic Evaluation shall been completed in accordance with NA2.4.7, all observed leaks shall be sealed where such sealing can be made without destruction of existing building components, and buildings where the tested leakage rate exceeded 0.6 cfm/ft^2 of building shell area at 75 pa have been re-tested to confirm leakage is below 0.6 cfm/ft^2 of building shell at 75 pa.

iv. Verification of the design and installation of the continuous air barrier conducted by an independent third party in accordance with NA 2.5.

TABLE 140.3-A MATERIALS DEEMED TO COMPLY WITH SECTION 140.3(a)9B

	MATERIALS AND THICKNESS		**MATERIALS AND THICKNESS**
1	Plywood – min. 3/8 inches thickness	9	Built up roofing membrane
2	Oriented strand board – min. 3/8 inches thickness	10	Modified bituminous roof membrane
3	Extruded polystyrene insulation board – min. ½ inches thickness	11	Fully adhered single-ply roof membrane
4	Foil-back polyisocyanurate insulation board – min. ½ inches thickness	12	A Portland cement or Portland sand parge, or a gypsum plaster, each with min. 5/8 inches thickness
5	Closed cell spray foam with a minimum density of 2.0 pcf and a min. 2.0 inches thickness	13	Cast-in-place concrete, or precast concrete
6	Open cell spray foam with a density no less than 0.4 pcf and no greater than 1.5 pcf, and a min. 5½ inches thickness	14	Fully grouted concrete block masonry
7	Exterior or interior gypsum board min. 1/2 inches thickness	15	Sheet steel or sheet aluminum
8	Cement board – min. 1/2 inches thickness	---	----------

~~**EXCEPTION to Section 140.3(a)9:** Relocatable Public School Buildings.~~

TABLE 140.3-B – PRESCRIPTIVE ENVELOPE CRITERIA FOR NONRESIDENTIAL BUILDINGS (INCLUDING RELOCATABLE PUBLIC SCHOOL BUILDINGS (WHERE MANUFACTURER CERTIFIES USE ONLY IN SPECIFIC CLIMATE ZONE; NOT INCLUDING HIGH-RISE RESIDENTIAL BUILDINGS AND GUEST ROOMS OF HOTEL/MOTEL BUILDINGS)

				Climate Zone															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Envelope	**Maximum U-factor**	**Roofs/ Ceilings**	Metal Building	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041
			Wood Framed and Other	0.034	0.034	0.034	0.034	0.034	0.049	0.049	0.049	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034
		Walls	Metal Building	0.113	0.061	0.113	0.061	0.061	0.113	0.113	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.057	0.061
			Metal-framed	~~0.069~~ 0.060	~~0.062~~ 0.055	~~0.082~~ 0.071	~~0.062~~ 0.055	~~0.062~~ 0.055	~~0.069~~ 0.060	~~0.069~~ 0.060	~~0.062~~ 0.055	~~0.062~~ 0.055	~~0.062~~ 0.055	~~0.062~~ 0.055	~~0.062~~ 0.055	~~0.062~~ 0.055	~~0.062~~ 0.055	~~0.062~~ 0.055	~~0.062~~ 0.055
			Mass Light[1]	0.196	0.170	0.278	0.227	0.440	0.440	0.440	0.440	0.440	0.170	0.170	0.170	0.170	0.170	0.170	0.170
			Mass Heavy[1]	0.253	0.650	0.650	0.650	0.650	0.690	0.690	0.690	0.690	0.650	0.184	0.253	0.211	0.184	0.184	0.160
			Wood-framed and Other	0.095	0.059	0.110	0.059	0.102	0.110	0.110	0.102	0.059	0.059	0.045	0.059	0.059	0.059	0.042	0.059
		Floors/ Soffits	Raised Mass	0.092	0.092	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.269	0.092	0.092	0.092	0.092	0.092	0.058
			Other	0.048	0.039	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.039	0.071	0.071	0.039	0.039	0.039
	Roofing Products	**Low-sloped**	Aged Solar Reflectance	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
			Thermal Emittance	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
		Steep- Sloped	Aged Solar Reflectance	0.20	~~0.20~~ 0.25	0.20	~~0.20~~ 0.25	~~0.20~~ 0.25	~~0.20~~ 0.25	~~0.20~~ 0.25	~~0.20~~ 0.25	~~0.20~~ 0.25	~~0.20~~ 0.25	~~0.20~~ 0.25	~~0.20~~ 0.25	~~0.20~~ 0.25	~~0.20~~ 0.25	~~0.20~~ 0.25	~~0.20~~ 0.25
			Thermal Emittance	0.75	~~0.75~~ 0.80	0.75	~~0.75~~ 0.80	~~0.75~~ 0.80	~~0.75~~ 0.80	~~0.75~~	~~0.75~~ 0.80	~~0.75~~ 0.80	~~0. 75~~ 0.80	~~0.75~~ 0.80	~~0.75~~ 0.80	~~0.75~~ 0.80	~~0.75~~ 0.80	~~0.75~~ 0.80	~~0.75~~ 0.80
	Air Barrier			REQ~~NR~~	REQ~~NR~~	REQ~~NR~~	REQ~~NR~~	REQ ~~NR~~	REQ ~~NR~~	~~NR~~ NR	~~NR~~ REQ	REQ ~~NR~~	REQ	REQ	REQ	REQ	REQ	REQ	REQ
	Exterior Doors, Maximum U-factor		Non-Swinging	0.50	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	0.50
			Swinging	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70

CONTINUED: TABLE 140.3-B – PRESCRIPTIVE ENVELOPE CRITERIA FOR NONRESIDENTIAL BUILDINGS (INCLUDING RELOCATABLE PUBLIC SCHOOL BUILDINGS WHERE MANUFACTURER CERTIFIES USE ONLY IN SPECIFIC CLIMATE ZONE; NOT INCLUDING HIGH-RISE RESIDENTIAL BUILDINGS AND GUEST ROOMS OF HOTEL/MOTEL BUILDINGS)

				All Climate Zones				
				Fixed Window	Operable Window	Curtainwall or Storefront	Glazed Doors[2]
Envelope	Fenestration	Vertical	Area-Weighted Performance Rating	Max U-factor	0.36	0.46	0.41	0.45
				Max RSHGC	0.25	0.22	0.26	0.23
			Area-Weighted Performance Rating	Min VT	0.42	0.32	0.46	0.17
			Maximum WWR%	40%				
		Skylights			Glass, Curb Mounted	Glass, Deck Mounted	Plastic, Curb Mounted	Tubular Daylighting Devices (TDDs)
			Area-Weighted Performance Rating	Max U-factor	0.58	0.46	0.88	0.88
				Max SHGC	0.25	0.25	NR	NR
			Area-Weighted Performance Rating	Min VT (Min VT_{annual} for TDDs)	0.49	0.49	0.64	0.38
			Maximum SRR%	5%				

				Climate Zone														
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Envelope	Fenestration	Vertical	Area-weighted Performance Rating	**Fixed Window**															
				Max U-factor	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.34	0.36	0.34	0.34	0.34	0.34	0.34	0.36
				Max RSHGC	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.22	0.25	0.22	0.22	0.22	0.22	0.22	0.25
				Min VT	0.42															
				Curtainwall or Storefront															
				Max U-factor	0.38	0.41	0.41	0.41	0.41	0.41	0.38	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
				Max RSHGC	0.25	0.26	0.26	0.26	0.26	0.26	0.25	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
				Min VT	0.46															
				Operable Window															
				Max U-factor	0.46															
				Max RSHGC	0.22															

				Min VT	0.32			
				Glazed Doors				
				Max U-factor	0.45			
				Max RSHGC	0.23			
				Min VT	0.17			
			Max WWR%		40%			
		All Climate Zones						
		Skylights			Glass, Curb Mounted	Glass, Deck Mounted	Plastic, Curb Mounted	Tubular Daylighting Devices (TDDs)
			Area-Weighted Performance Rating	Max U-factor	0.58	0.46	0.88	0.88
				Max SHGC	0.25	0.25	NR	NR
				Min VT (Min VT_{annual} for TDDs)	0.49	0.49	0.64	0.38
			Maximum SRR%		5%			

TABLE 140.3-C – PRESCRIPTIVE ENVELOPE CRITERIA FOR ~~HIGH-RISE RESIDENTIAL BUILDINGS AND~~ GUEST ROOMS OF HOTEL/MOTEL BUILDINGS

				Climate Zone															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Envelope	**Maximum U-factor**	**Roofs / Ceilings**	Metal Building	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041
			Wood Framed and Other	0.028	0.028	0.034	0.028	0.034	0.034	0.039	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028
		Walls	Metal Building	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.057	0.057	0.057	0.057	0.057	0.057
			Metal-framed	0.069	0.069	0.069	0.069	0.069	0.069	0.105	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.048	0.069
			Mass, Light[1]	0.170	0.170	0.170	0.170	0.170	0.227	0.227	0.227	0.196	0.170	0.170	0.170	0.170	0.170	0.170	0.170
			Mass, Heavy[1]	0.160	0.160	0.160	0.184	0.211	0.690	0.690	0.690	0.690	0.690	0.184	0.253	0.211	0.184	0.184	0.160
			Wood-framed and Other	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.042	0.059	0.059	0.042	0.042	0.042
		Floors / Soffits	Raised Mass[1]	0.045	0.045	0.058	0.058	0.058	0.069	0.092	0.092	0.092	0.069	0.058	0.058	0.058	0.045	0.058	0.037
			Other	0.034	0.034	0.039	0.039	0.039	0.039	0.071	0.039	0.039	0.039	0.039	0.039	0.039	0.034	0.039	0.034
	Roofing Products	**Low-sloped**	Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	0.55	0.55	0.55	NR	0.55	0.55	0.55	NR
			Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	0.75	0.75	0.75	NR	0.75	0.75	0.75	NR
		Steep-Sloped	Aged Solar Reflectance	NR	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	NR
			Thermal Emittance	NR	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0. 75	0.75	0.75	0.75	0.75	0.75	NR
	Air Barrier			REQ	REQ	REQ	REQ	REQ	REQ	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
	Exterior Doors, Maximum U-factor		Non-Swinging	0.50	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	0.50
			Swinging	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70

CONTINUED: TABLE 140.3-C – PRESCRIPTIVE ENVELOPE CRITERIA FOR ~~HIGH-RISE RESIDENTIAL BUILDINGS AND~~ GUEST ROOMS OF HOTEL/MOTEL BUILDINGS

				All Climate Zones			
				Fixed Window	Operable Window	Curtainwall/ Storefront	Glazed Doors[2]
Envelope	**Fenestration**	**Vertical**	Area-Weighted Performance Rating	Max U-factor	0.36	0.46	0.41	0.45
				Max RSHGC	0.25	0.22	0.26	0.23
			Area-Weighted Performance Rating	Min VT	0.42	0.32	0.46	0.17
			Maximum WWR%	40%			
		Skylights			Glass, Curb Mounted	Glass, Deck Mounted	Plastic, Curb Mounted	
			Area-Weighted Performance Rating	Max U-factor	0.58	0.46	0.88	
				Max SHGC	0.25	0.25	NR	
			Area-Weighted Performance Rating	Min VT	0.49	0.49	0.64	
			Maximum SRR%	5%			

Notes:

1. As defined in Section 100.1, light mass walls are walls with a heat capacity of at least 7.0 Btu/ft²-oF and less than 15.0 Btu/ft²-oF. Heavy mass walls are walls with a heat capacity of at least 15.0 Btu/ft²-oF.

2. Glazed Doors applies to both site-built and to factory-assembled glazed doors.

TABLE 140.3-D PRESCRIPTIVE ENVELOPE CRITERIA FOR RELOCATABLE PUBLIC SCHOOL BUILDINGS FOR USE IN ALL CLIMATE ZONES

Roofs/ Ceilings	**Metal Buildings**	Maximum U-factor			0.041
	Non-Metal Buildings				0.034
Walls	**Wood frame buildings**				0.042
	Metal frame buildings				0.057
	Metal buildings				0.057
	Mass/7.0≤ HC				0.170
	All Other Walls				0.059
Floors and Soffits	**Floors and Soffits**				0.048
Roofing Products	**Low-Sloped**	Aged Solar Reflectance			0.63
		Thermal Emittance			0.75
	Steep-Sloped	Aged Solar Reflectance			~~0.20~~0.25
		Thermal Emittance			~~0.75~~0.80
Fenestration	**Windows**	Maximum U-factor			0.47
		Maximum SHGC			0.26
	Glazed Doors (Site-Built and Factory Assembled)	Maximum U-factor			0.45
		Maximum SHGC			0.23
	Skylights	Glass with Curb		Maximum U-factor	0.99
		Glass without Curb			0.57
		Plastic with Curb			0.87
		Glass Type	0-2% SRR	Maximum SHGC	0.46
			2.1-5% SRR		0.36
		Plastic Type	0-2% SRR		0.69
			2.1-5% SRR		0.57

Exterior Doors	**Non-Swinging doors**	Maximum U-factor	0.50
	Swinging doors		0.70

(b) **RESERVED**

(c) **Minimum Daylighting Requirement for Large Enclosed Spaces.** In Climate Zones 2 through 15, conditioned enclosed spaces, and unconditioned enclosed spaces, that are greater than 5,000 ft² and that are directly under a roof with ceiling heights greater than 15 feet, shall meet the following requirements:

1. A combined total of at least 75 percent of the floor area, as determined in building floor plan (drawings) view, shall be within one or more of the following:
   A. Primary Sidelight Daylight Zone in accordance with Section 130.1(d), or
   B. The total floor area in the space within a horizontal distance of 0.7 times the average ceiling height from the edge of rough opening of skylights.
2. All Skylit Daylit Zones and Primary Sidelit Daylit Zones shall be shown on building plans.
3. General lighting in daylit zones shall be controlled in accordance with Section 130.1(d).
4. The total skylight area is at least 3 percent of the total floor area in the space within a horizontal distance of 0.7 times the average ceiling height from the edge of rough opening of skylights; or the product of the total skylight area and the average skylight visible transmittance is no less than 1.5 percent of the total floor area in the space within a horizontal distance of 0.7 times the average ceiling height from the edge of rough opening of skylights.
5. All skylights shall have a glazing material or diffuser that has a measured haze value greater than 90 percent, tested according to ASTM D1003 (notwithstanding its scope) or an\other test method approved by the Commission.
6. Skylights for conditioned and unconditioned spaces shall have an area-weighted average Visible Transmittance (VT) no less than the applicable value required by Section 140.3(a)6D.

EXCEPTION 1 to Section 140.3(c): Auditoriums, churches, movie theaters, museums, and refrigerated warehouses.

EXCEPTION 2 to Section 140.3(c): In buildings with unfinished interiors, future enclosed spaces for which there are plans to have:

A. A floor area of less than or equal to 5,000 square feet; or
B. Ceiling heights of less than or equal to 15 feet. This exception shall not be used for S-1 or S-2 (storage), or for F-1 or F-2 (factory) occupancies.

EXCEPTION 3 to Section 140.3(c): Enclosed spaces having a designed general lighting system with a lighting power density less than 0.5 watts per square foot.

EXCEPTION 4 to Section 140.3(c): Enclosed spaces where it is documented that permanent architectural features of the building, existing structures or natural objects block direct beam sunlight on at least half of the roof over the enclosed space for more than 1500 daytime hours per year between 8 a.m. and 4 p.m.

(d) **Daylighting Design Power Adjustment Factors (PAFs).** To qualify for a Power Adjustment Factor (PAF) as specified in Section 140.6(a)2L, daylighting devices shall meet the following requirements:

1. **Clerestory Fenestration.** To qualify for a PAF, clerestory fenestration shall meet the following requirements:
   A. Shall be installed on east-, west-, or south-facing facades.
   B. Shall have a head height that is at least 10 feet above the finished floor.

C. Shall have a glazing height that is greater than or equal to 10 percent of the head height.

D. If operable shading is installed on the clerestory fenestration, then the clerestory fenestration shading shall be controlled separately from shading serving other vertical fenestration.

2. **Interior and Exterior Horizontal Slats.** To qualify for a PAF, horizontal slats shall meet the following requirements:

A. Shall be installed adjacent to vertical fenestration on east- or west-facing facades with Window Wall Ratios between 20 and 30 percent~~, and extend to the entire height of the vertical fenestration~~.

B. Exterior horizontal slats shall be level or sloped downwards from fenestration. Interior horizontal slats shall be level or sloped upwards from fenestration.

C. Shall have a projection factor as specified in Table 140.3-E. The projection factor is calculated using EQUATION 140.3-C~~E~~.

D. Shall have a minimum Distance Factor of 0.3. The distance factor is calculated using EQUATION 140.3-~~E~~C.

EXCEPTION to Section 140.3(d)2D: Where it is documented that existing adjacent structures or natural objects within view of the vertical fenestration block direct sunlight onto the vertical fenestration between 8 a.m. and 5 p.m. for less than 500 daytime hours per year.

E. Shall have a minimum Visible Reflectance of 0.50 when tested as specified in ASTM E903.

F. Shall be opaque.

EXCEPTION to Section 140.3(d)2F: Horizontal slats with a Visible Transmittance of 0.03 or less when tested as specified in ASTM E1175.

G. Shall be permanently mounted and not adjustable.

H. Shall extend the entire height of the vertical fenestration and beyond each side of the window jamb by a distance equal to or greater than their horizontal projection.

EXCEPTION to Section 140.3(d)2H: Where the slats are located entirely within the vertical fenestration's rough opening or a fin is located at the window jambs and extends vertically the entire height of the window jamb and extends horizontally the entire depth of the projection.

I. Shall be shown on the plans with the dimensions for the slat projection and slat spacing as specified in EQUATION 140.3-~~E.~~C

J. Shall have a conspicuous factory installed label permanently affixed and prominently located on an attachment point of the device to the building envelope, stating the following: "NOTICE: Removal of this device will require re-submittal of compliance documentation to the enforcement agency responsible for compliance with California Title 24, Part 6".

3. **Interior and Exterior Light Shelves.** To qualify for a PAF, light shelves shall meet the following requirements:

A. Where there is vertical fenestration area below the light shelf, both interior and exterior light shelves shall be installed.

B. Shall be installed adjacent to clerestory fenestration on south-facing facades with Window Wall Ratios greater than 30 percent. The head height of the light shelves shall be no more than one foot below the finished ceiling. The clerestory fenestration shall meet the requirements of Section 140.3(d)1.

C. ~~Shall be level or sloped based on their installation.~~ Exterior light shelves shall be level or sloped downwards from fenestration. Interior light shelves shall be level or sloped upwards from fenestration.

D. Shall have a projection factor of the applicable value as specified in Table 140.3-E. The light shelf projection factor is calculated using EQUATION 140.3-~~E~~C.

E. Shall have a minimum Distance Factor of 0.3. The distance factor is calculated using EQUATION 140.3-~~E~~C.

EXCEPTION to Section 140.3(d)3E: Where it is documented that existing adjacent structures or natural objects within view of the vertical fenestration block direct sunlight onto the vertical fenestration between 8 a.m. and 5 p.m. for less than 750 daytime hours per year.

F. Shall have a top surface with a minimum Visible Reflectance of 0.50 when tested as specified in ASTM E903.

EXCEPTION to Section 140.3(d)3F: Where an exterior light shelf is installed greater than two feet below the clerestory sill.

G. Shall extend beyond each side of the window jamb by a distance equal to or greater than their horizontal projection.

H. Shall be shown on the plans with the dimensions for the light shelf projection and light shelf spacing as specified in EQUATION 140.3-~~E~~C.

TABLE 140.3-E Daylighting Devices

Daylighting Device	Orientation of the Vertical Fenestration	Projection Factor
Horizontal Slats	East or West	2.0 to 3.0
Interior Light Shelf	South	1.0 to 2.0
Exterior Light Shelf	South	0.25 to 1.25

EQUATION 140.3-~~E~~ C PROJECTION AND DISTANCE FACTOR CALCULATION

Projection Factor = Projection / Spacing

Distance Factor = $D / (H_{AS} \times \text{Projection Factor})$

WHERE:

Projection = The horizontal distance between the base edge and the projected edge of the overhang, slat, or light shelf.

Spacing = For overhangs, the vertical distance between the projected edge of the overhang and sill of the vertical fenestration below it.

For horizontal slats, the vertical distance between the projected edge of a slat to the base edge of the slat below it.

For interior light shelves, the vertical distance between the projected edge of the light shelf and head of the clerestory fenestration above it.

For exterior light shelves, the vertical distance between the projected edge of the light shelf and sill of the vertical fenestration below it.

D = Distance between the existing structure or nature object and the fenestration

H_{AS} = Height difference between the top of the existing structure or nature object and the bottom of the fenestration

NOTE: The base edge is the edge of an overhang, slat, or light shelf that is adjacent to the vertical fenestration. The projected edge is the opposite edge from the base edge.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 140.4 – PRESCRIPTIVE REQUIREMENTS FOR SPACE CONDITIONING SYSTEMS

A building complies with this section by being designed with and having constructed and installed a space-conditioning system that meets the applicable prescriptive requirements of Subsections (a) through (~~o~~q).

(a) **Sizing, ~~and~~ Equipment Selection, and Type.**

1. **Sizing and Equipment Selection.** Mechanical heating and mechanical cooling equipment serving healthcare facilities shall be sized to meet the design heating and cooling loads as calculated according to the subsection (b). Mechanical heating and mechanical cooling equipment serving ~~high-rise residential buildings,~~ hotel/motel buildings and nonresidential buildings other than healthcare facilities, shall be the smallest size, within the available options of the desired equipment line, necessary to meet the design heating and cooling loads of the building, as calculated according to Subsection (b).

   EXCEPTION 1 to Section 140.4(a)1: Where it can be demonstrated to the satisfaction of the enforcing agency that oversizing will not increase building TDV energy use.

   EXCEPTION 2 to Section 140.4(a)1: Standby equipment with controls that allow the standby equipment to operate only when the primary equipment is not operating.

   EXCEPTION 3 to Section 140.4(a)1: Multiple units of the same equipment type, such as multiple chillers and boilers, having combined capacities exceeding the design load, if they have controls that sequence or otherwise optimally control the operation of each unit based on load.

2. **Single Zone Space Conditioning System Type.** Single zone space conditioning systems with direct expansion cooling with rated cooling capacity 240,000 Btu/hr or less serving the following spaces shall meet the applicable requirements in A-H, or shall meet the performance compliance requirements of Section 140.1. All other system types, including systems with rated cooling capacity greater than 240,000 Btu/hr, multi-zone systems, and systems using central boilers or chillers, shall comply with the applicable requirements of Section 140.

   A. Retail and Grocery Building Spaces in climate zones 2 through 15. The space conditioning system shall be a heat pump.

   B. Retail and Grocery Building Spaces in climate zones 1 and 16 with cooling capacity less than 65,000 Btu/hr. The space conditioning system shall be an air conditioner with furnace.

   C. Retail and Grocery Building Spaces in climate zones 1 and 16 with cooling capacity 65,000 Btu/hr or greater. The space conditioning system shall be a dual-fuel heat pump.

   D. School Building Spaces. For climate zones 2 through 15 , the space conditioning system shall be a heat pump. For climate zones 1 and 16, the space conditioning system shall be a dual-fuel heat pump.

   E. Office, Financial Institution, and Library Building Spaces in climate zones 1 through 15. The space conditioning system shall be a heat pump.

   F. Office, Financial Institution, and Library Building Spaces in climate zones 16 with cooling capacity less than 65,000 Btu/hr. The space conditioning system shall be an air conditioner with furnace, a dual-fuel heat pump.

   G. Office, Financial Institution, and Library Building Spaces in climate zones 16 with cooling capacity 65,000 Btu/hr or greater. The space conditioning system shall be a dual-fuel heat pump.

H. Office Spaces in Warehouses. The space conditioning system shall be a heat pump in all climate zones.

EXCEPTION to Section 140.4(a)2: Systems utilizing recovered heat for space heating.

(b) **Calculations.** In making equipment sizing calculations under Subsection (a), all of the following rules shall apply:

1. **Heating and cooling loads.** Heating and cooling system design loads shall be determined in accordance with the procedures described in subsection A or B below:

   A. For systems serving ~~high-rise residential buildings,~~ hotel/motel buildings~~,~~ and nonresidential buildings other than healthcare facilities, the method in the 2017 ASHRAE Handbook, Fundamentals shall be used, or as specified in a method approved by the Commission.

   B. For system serving healthcare facilities the method in the California Mechanical Code shall be used.

2. **Indoor design conditions.** Indoor design temperature and humidity conditions for comfort applications shall be determined in accordance with subsection A or B below:

   A. For systems serving ~~high-rise residential buildings,~~ hotel/motel buildings~~,~~ and nonresidential buildings other than healthcare facilities, ASHRAE Standard 55 or the 2017 ASHRAE Handbook, Fundamentals Volume, except that winter humidification and summer dehumidification shall not be required.

   B. For system serving healthcare facilities the method in Section 320.0 of the California Mechanical Code shall be used.

3. **Outdoor design conditions.** Outdoor design conditions shall be selected in accordance with subsection A or B below:

   A. For systems serving ~~high-rise residential buildings,~~ hotel/motel buildings~~,~~ and nonresidential buildings other than healthcare facilities the design conditions from Reference Joint Appendix JA2 shall be used, which is based on data from the ASHRAE Climatic Data for Region X. Heating design temperatures shall be no lower than the Heating Winter Median of Extremes values. Cooling design temperatures shall be no greater than the 0.5 percent Cooling Dry Bulb and Mean Coincident Wet Bulb values.

   B. For system serving healthcare facilities the method in Section 320.0 of the California Mechanical Code shall be used.

   EXCEPTION to Section 140.4(b)3: Cooling design temperatures for cooling towers shall be no greater than the 0.5 percent Cooling Design Wet bulb values.

4. **Ventilation.** Outdoor air ventilation loads shall be calculated using the ventilation rates required in Section 120.1(c)3.

5. **Envelope**. Envelope heating and cooling loads shall be calculated using envelope characteristics, including square footage, thermal conductance, Solar Heat Gain Coefficient or shading coefficient, and air leakage, consistent with the proposed design.

6. **Lighting.** Lighting heating and cooling loads shall be based on actual design lighting levels or power densities as specified in Section 140.6.

7. **People.** Occupant density shall be based on the expected occupancy of the building and shall be the same as determined under Section 120.1(c)3A, if used. Sensible and latent heat gains shall be as listed in the 2017 ASHRAE Handbook- Fundamentals, Chapter 18.

8. **Process loads.** Loads caused by a process shall be based upon actual information on the intended use of the building.
9. **Miscellaneous equipment.** Equipment loads other than process loads shall be calculated using design data compiled from one or more of the following sources:
   A. Actual information based on the intended use of the building; or
   B. Published data from manufacturer's technical publications or from technical societies, such as the ASHRAE Handbook, Applications Volume; or
   C. Other data based on the designer's experience of expected loads and occupancy patterns.
10. **Internal heat gains.** Internal heat gains may be ignored for heating load calculations.
11. **Safety factor.** Calculated design loads based on 140.4(b)1 through 10 may be increased by up to 10 percent to account for unexpected loads or changes in space usage.
12. **Other loads.** Loads such as warm-up or cool-down shall be calculated from principles based on the thermal capacity of the building and its contents, the degree of setback, and desired recovery time; or may be assumed to be no more than 30 percent for heating and 10 percent for cooling of the steady-state design loads. In addition, the steady-state load may include a safety factor in accordance with Section 140.4(b)11.

(c) **Fan Systems.** Each fan system moving air into, out of, or between conditioned ~~having a total fan system motor nameplate horsepower exceeding 5 hp used for~~ spaces ~~conditioning~~ or circulating air for the purpose of conditioning air within a space shall meet the requirements of Items 1, 2, and 3 below. ~~Total fan system power demand equals the sum of the power demand of all fans in the system that are required to operate at design conditions in order to supply air from the heating or cooling source to the conditioned space, and to return it back to the source or to exhaust it to the outdoors.~~

1. ~~1.~~ **Fan Power ~~Limitation~~Budget.** ~~At design conditions each fan system shall not exceed the allowable fan system power of option 1 or 2 as specified in Table 140.4-A~~ For each fan system that includes at least one fan or fan array with fan electrical input power ≥ 1 kW, fan system electrical input power (Fan $kW_{design,system}$) determined per Section 140.4(c)1(B) at the fan system design airflow shall not exceed Fan kW_{budget} as calculated per section 140.4(c)1(A).
   A. **Calculation of Fan Power Budget (Fan kW_{budget}).** For each fan system:
      i. Determine the fan system airflow and choose the appropriate table(s) for fan power allowance.
         a. For single-cabinet fan systems, use the fan system airflow and the power allowances in both Table 140.4-A and Table 140.4-B.
         b. For supply-only fan systems, use the fan system airflow and power allowances in Table 140.4-A.
         c. For relief fan systems, use the design relief airflow and the power allowances in Table 140.4-B.
         d. For exhaust, return and transfer fan systems, use the fan system airflow and the power allowances in Table 140.4-B.
         e. For complex fan systems, separately calculate the fan power allowance for the supply and return/exhaust systems and sum them. For the supply airflow, use supply airflow at the fan system design conditions, and the power allowances in Table 140.4-A. For the return exhaust airflow, use

return /exhaust airflow at the fan system design conditions, and the power allowances in Table 140.4-B.

ii. For each fan system determine the components included in the fan system and sum the Fan Power Allowances of those components. All fan systems shall include the System Base Allowance. If, for a given component, only a portion of the fan system airflow passes through the component, calculate the Fan Power Allowance for that component per equation 140.4-A:

EQUATION 140.4-A FAN POWER ALLOWANCE

$$FPA_{adj} = \frac{Q_{comp}}{Q_{sys}} \text{ X } FPA_{comp}$$

Where

FPA_{adj} = The corrected fan power allowance for the component in w/cfm

Q_{comp} = The airflow through component in cfm

Q_{sys} = The fan system airflow in cfm

FPA_{comp} = The fan power allowance of the component from Table 140.4A or Table 140.4B

iii. Multiply the fan system airflow by the sum of the fan power allowances for the fan system.

iv. Divide by 1000 to convert to Fan kW_{budget}.

v. For building sites at elevations greater than 3,000 feet, multiply Fan kW_{budget} by Correction Factor in Table 140.4-C.

B. Determining Fan System Electrical Input Power (Fan $kW_{design,system}$). Fan $kW_{design,system}$ is the sum of Fan kW_{design} for each fan or fan array included in the fan system with Fan $kW_{design} \geq 1$ kW. If variable speed drives are used, their efficiency losses shall be included. Fan input power shall be calculated with mid-life filter pressure drop, which is the mean of the clean filter pressure drop and design final filter pressure drop. The Fan kW_{design} for each fan or fan array shall be determined using one of the following methods. There is no requirement to use the same method for all fans in a fan system:

i. Use the default Fan kW_{design} in Table 140.4-D for one or more of the fans. This method cannot be used for complex fan systems.

ii. Use the Fan kW_{design} at fan system design conditions provided by the manufacturer of the fan, fan array, or equipment that includes the fan or fan array calculated per a test procedure included in USDOE 10 CFR Part 430, USDOE 10 CFR Part 431, ANSI/AMCA Standard 208-2018, ANSI/AMCA Standard 210-2016, AHRI Standard 430-2020, AHRI Standard 440-2019, or ISO 5801-2017.

iii Use the Fan kW_{design} provided by the manufacturer, calculated at fan system design conditions per one of the methods listed in section 5.3 of ANSI/AMCA 208-2018.

iv. Determine the Fan kW_{design} by using the maximum electrical input power provided on the motor nameplate.

TABLE 140.4 – A Fan Power Limitation

	Limit	Constant Volume	Variable Volume
Option 1: Fan system motor nameplate hp	Allowable motor nameplate hp	$hp \leq cfm_s \times 0.0011$	$hp \leq cfm_s \times 0.0015$
Option 2: Fan system bhp	Allowable fan system bhp	$bhp \leq cfm_s \times 0.00094 + A$	$bhp \leq cfm_s \times 0.0013 + A$

[1]cfm_s = maximum design supply airflow rate to conditioned spaces served by the system in cubic feet per minute

hp = maximum combined motor nameplate horsepower for all fans in the system

bhp = maximum combined fan-brake horsepower for all fans in the system

A = sum of (PD × cfm_D/4131)

PD = each applicable pressure drop adjustment from Table 140.4 – B, in inches of water

cfm_D = the design airflow through each applicable device from Table 140.4 – B, in cubic feet per minute

~~*TABLE 140.4-B – Fan Power Limitation Pressure Drop Adjustment*~~

~~Device~~	~~Adjustment Credits~~
~~Return or exhaust systems required by code or accreditation standards to be fully ducted, or systems required to maintain air pressure differentials between adjacent rooms~~	~~0.5 in. of water~~
~~Return and/or exhaust airflow control devices~~	~~0.5 in. of water~~
~~Exhaust filters, scrubbers, or other exhaust treatment~~	~~The pressure drop of device calculated at fan system design condition~~
~~Particulate Filtration Credit: MERV 16 and greater and electronically enhanced filters~~	~~Pressure drop calculated at 2 × clean filter pressure drop at fan system design condition~~
~~Carbon and other gas-phase air cleaners~~	~~Clean filter pressure drop at fan system design condition~~
~~Biosafety cabinet~~	~~Pressure drop of device at fan system design condition~~
~~Energy recovery device, other than coil runaround loop~~	~~For each airstream [(2.2 × Energy Recovery Effectiveness) – 0.5] in. of water~~
~~Coil runaround loop~~	~~0.6 in. of water for each airstream~~
~~Exhaust systems serving fume hoods~~	~~0.35 in. of water~~

Table 140.4-A: Supply Fan Power Allowances (watts/ cfm)

Airflow	Multi-Zone VAV Systems ≤5,000 cfm[1]	Multi-Zone VAV Systems >5,000 and ≤10,000 cfm[1]	Multi-Zone VAV Systems >10,000 cfm[1]	All Other Fan Systems ≤5,000 cfm	All Other Fan Systems >5,000 and ≤10,000 cfm	All Other Fan Systems >10,000 cfm[1]
Supply System Base Allowance for AHU serving spaces ≤ 6 floors away).	0.395	0.453	0.413	0.232	0.256	0.236
Supply system base allowance for AHU serving spaces > 6 floors away	0.508	0.548	0.501	0.349	0.356	0.325
MERV 13 to MERV 16 Filter upstream of thermal conditioning equipment (mid-life)[2]	0.136	0.114	0.105	0.139	0.120	0.107
MERV 13 to MERV 16 Final filter downstream of thermal conditioning equipment. (mid-life)[2]	0.225	0.188	0.176	0.231	0.197	0.177
Filtration allowance for > MERV 16 or HEPA Filter (mid-life) [2]	0.335	0.280	0.265	0.342	0.292	0.264
Central Hydronic heating coil allowance	0.046	0.048	0.052	0.046	0.050	0.054
Electric heat allowance	0.046	0.038	0.035	0.046	0.040	0.036
Gas heat allowance	0.069	0.057	0.070	0.058	0.060	0.072
Hydronic/DX cooling coil or heat pump coil (wet) allowance[3]	0.135	0.114	0.105	0.139	0.120	0.107
Solid or liquid Desiccant system allowance	0.157	0.132	0.123	0.163	0.139	0.124
Allowance for reheat coil for dehumidification	0.045	0.038	0.035	0.046	0.040	0.036

Allowance for Evaporative humidifier/cooler in series with a cooling coil. Value shown is allowed watts/cfm per 1.0 Inches of water gauge (in.w.g.) Determine pressure loss (in.w.g.) at 400 fpm or maximum velocity allowed by the manufacturer, whichever is less. *[Calculation required, see note 4]*	0.224	0.188	0.176	0.231	0.197	0.177
Allowance for 100% Outdoor air system[5].	0.000	0.000	0.000	0.070	0.100	0.107
Energy recovery allowance for 0.50 ≤ ERR <0.55 [6]	0.135	0.114	0.105	0.139	0.120	0.107
Energy recovery allowance for 0.55 ≤ ERR <0.60 [6]	0.160	0.134	0.124	0.165	0.141	0.126
Energy recovery allowance for 0.60 ≤ ERR <0.65 [6]	0.184	0.155	0.144	0.190	0.163	0.146
Energy recovery allowance for 0.65 ≤ ERR <0.70 [6]	0.208	0.175	0.163	0.215	0.184	0.165
Energy recovery allowance for 0.70 ≤ ERR <0.75 [6]	0.232	0.196	0.183	0.240	0.205	0.184
Energy recovery allowance for 0.75 ≤ ERR <0.80 [6]	0.257	0.216	0.202	0.264	0.226	0.203
Energy recovery allowance for ERR ≥ 0.80 [6]	0.281	0.236	0.222	0.289	0.247	0.222

Allowance for sensible-only recovery	0.135	0.114	0.105	0.139	0.120	0.107
Allowance for Gas phase filtration. Value shown is allowed w/cfm per 1.0 in. wg air pressure drop. *[Calculation required, see note 4]*	0.224	0.188	0.176	0.231	0.197	0.177
Air blender allowance	0.045	0.038	0.035	0.046	0.040	0.036
Sound attenuation section [fans serving spaces with design background noise goals below NC35]	0.034	0.029	0.026	0.035	0.030	0.027
Deduction for systems that feed a terminal unit with a fan with electrical input power < 1kW	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100

Footnotes to Table 140.4-A

1. See FAN SYSTEM, MULTI-ZONE VARIABLE AIR VOLUME (VAV) in definition a Multi-Zone VAV System.
2. Filter fan power allowance can only be counted once per fan system, except fan systems in healthcare facilities, which can claim one of the MERV 13 to 16 filter allowances and the HEPA filter allowance if both are included in the fan system.
3. Healthcare facilities can claim this fan power allowance twice per fan system where coil design leaving air temperature is less than 44 ^{o}F.
4. Power allowance requires further calculation by multiplying the actual inches of water gauge (in.w.g.) of the device/ component by the watts/ cfm in Table 140.4-A.
5. The 100% outdoor air system must serve 3 or more HVAC zones and airflow during non-economizer operating periods must not exceed 135% of minimum requirements in Section 120.1(c)(3).
6. Enthalpy Recovery Ratio (ERR) calculated per ANSI/ASHRAE 84-2020.

TABLE 140.4-B: EXHAUST, RETURN, RELIEF, TRANSFER FAN POWER ALLOWANCES (WATTS/ CFM)

Airflow	Multi-Zone VAV Systems[1] >10,000 cfm	Multi-Zone VAV Systems[1] >5,000 and ≤10,000 cfm	Multi-Zone VAV Systems[1] ≤5,000 cfm	All Other Fan Systems >10,000 cfm	All Other Fan Systems >5,000 and ≤10,000 cfm	All Other Fan Systems ≤5,000 cfm
Exhaust System Base Allowance	0.236	0.246	0.221	0.190	0.184	0.186
Filter (any MERV value)[2]	0.036	0.041	0.046	0.035	0.041	0.046
Energy Recovery Allowance For 0.50 ≤ ERR <0.55 [3]	0.107	0.120	0.139	0.109	0.123	0.139
Energy Recovery Allowance For 0.55 ≤ ERR <0.60 [3]	0.126	0.142	0.165	0.128	0.144	0.165
Energy Recovery Allowance For 0.60 ≤ ERR <0.65 [3]	0.146	0.163	0.190	0.148	0.166	0.191
Energy Recovery Allowance For 0.65 ≤ ERR <0.70 [3]	0.165	0.184	0.215	0.167	0.188	0.216
Energy Recovery Allowance For 0.70 ≤ ERR <0.75 [3]	0.184	0.206	0.240	0.186	0.209	0.241
Energy Recovery Allowance For 0.75 ≤ ERR <0.80 [3]	0.203	0.227	0.265	0.205	0.231	0.266
Energy Recovery Allowance For ERR ≥ 0.80 [3]	0.222	0.248	0.289	0.225	0.252	0.291
Allowance For Sensible-only recovery	0.107	0.120	0.139	0.109	0.123	0.139
Economizer Return Damper	0.036	0.041	0.046	0.037	0.041	0.046
Return or exhaust systems required by code or accreditation standards to be fully ducted, or systems required to maintain air pressure differentials between adjacent rooms	0.089	0.100	0.116	0.091	0.102	0.116
Return and/or exhaust airflow control devices	0.089	0.100	0.116	0.091	0.102	0.116

Laboratory and vivarium exhaust systems in high-rise buildings for vertical duct exceeding 75 ft. Value shown is allowed w/cfm per 0.25 in. wg for each 100 feet exceeding 75 feet. [Calculation required, see note 4]	0.045	0.051	0.058	0.046	0.052	0.058
Biosafety cabinet. Value shown is allowed w/cfm per 1.0 in. wg air pressure drop. [Calculation required, see note 4]	0.177	0.198	0.231	0.179	0.202	0.232
Exhaust filters, scrubbers, or other exhaust treatment required by code or standard. Value shown is allowed w/cfm per 1.0 in. wg air pressure drop. [Calculation required, see note 4]	0.177	0.198	0.231	0.179	0.202	0.232
Healthcare facility allowance[5]	0.177	0.198	0.231	0.179	0.202	0.232
Sound attenuation section [Fans serving spaces with design background noise goals below NC35.]	0.027	0.030	0.035	0.028	0.031	0.035

Footnotes to Table 140.4-B

1. See FAN SYSTEM, MULTI-ZONE VARIABLE AIR VOLUME (VAV) in definitions for Multizone to be classified as a Multi-Zone VAV System.
2. Filter pressure loss can only be counted once per fan system.
3. Enthalpy Recovery Ratio (ERR) calculated per ANSI/ASHRAE 84-2020.
4. Power allowance requires further calculation, multiplying the actual pressure drop (in. wg.) of the device/ component by the watts/cfm in the Table 140.4-B.
5. This allowance can only be taken for healthcare facilities.

TABLE 140.4-C AIR DENSITY CORRECTION FACTORS

Altitude (ft)	Correction factor
<3,000	1.000
≥3,000 and <4,000	0.896
≥4,000 and <5,000	0.864
≥5,000 and <6,000	0.832
≥6,000	0.801

TABLE 140.4-D: DEFAULT VALUES FOR FAN KW_{DESIGN} BASED ON MOTOR NAMEPLATE HP

Motor Nameplate HP	Default Fan kW_{design} with variable speed drive (Fan kW_{design})	Default Fan kW_{design} without variable speed drive (Fan kW_{design})
<1	0.96	0.89
≥1 and <1.5	1.38	1.29
≥1.5 and <2	1.84	1.72
≥2 and <3	2.73	2.57
≥3 and <5	4.38	4.17
≥5 and <7.5	6.43	6.15
≥7.5 and <10	8.46	8.13
≥10 and <15	12.47	12.03
≥15 and <20	16.55	16.04
≥20 and <25	20.58	19.92
≥25 and <30	24.59	23.77
≥30 and <40	32.74	31.70
≥40 and <50	40.71	39.46
≥50 and <60	48.50	47.10
≥60 and <75	60.45	58.87
≥75 and ≤100	80.40	78.17

1. This table cannot be used for Motor Nameplate Horsepower values greater than 100.

2. This table is to be used only with motors with a service factor ≤1.15. If the service factor is not provided, this table may not be used.

2. **Variable air volume (VAV) systems.**

   A. Static Pressure Sensor Location. Static pressure sensors used to control variable air volume fans shall be placed in a position such that the controller set point is no greater than one-third the total design fan static pressure, except for systems with zone reset control complying with Section140.4(c)2B. If this results in the sensor being located downstream of any major duct split, multiple sensors shall be installed in each major branch with fan capacity controlled to satisfy the sensor furthest below its setpoint; and

   B. Setpoint Reset. For systems with direct digital control of individual zone boxes reporting to the central control panel, static pressure setpoints shall be reset based on the zone requiring the most pressure; i.e., the set point is reset lower until one zone damper is nearly wide open.

3. **Fractional HVAC Motors for Fans.** HVAC motors for fans that are less than 1 hp and 1/12 hp or greater shall be electronically-commutated motors or shall have a minimum motor efficiency of 70 percent when rated in accordance with NEMA Standard MG 1-2006 at full load rating conditions. These motors shall also have the means to adjust motor speed for either balancing or remote control. Belt-driven fans may use sheave adjustments for airflow balancing in lieu of a varying motor speed.

   EXCEPTION 1 to Section 140.4(c)3: Motors in fan-coils and terminal units that operate only when providing heating to the space served.

   EXCEPTION 2 to Section 140.4(c)3: Motors in space conditioning equipment certified under Section 110.1 or 110.2.

EXCEPTION 1 to 140.4(c): fan system power caused solely by process loads.

~~**EXCEPTION 2 to 140.4(c):** Systems serving healthcare facilities.~~

(d) **Space-conditioning Zone Controls.** Each space-conditioning zone shall have controls designed in accordance with 1 or 2:

1. Each space-conditioning zone shall have controls that prevent:

   A. Reheating; and

   B. Recooling; and

   C. Simultaneous provisions of heating and cooling to the same zone, such as mixing or simultaneous supply of air that has been previously mechanically heated and air that has been previously cooled either by cooling equipment or by economizer systems; or

2. Zones served by variable air-volume systems that are designed and controlled to reduce, to a minimum, the volume of reheated, recooled, or mixed air are allowed only if the controls meet all of the following requirements:

   A. For each zone with direct digital controls (DDC):

i. The volume of primary air that is reheated, recooled or mixed air supply shall not exceed the larger of:

a. 50 percent of the peak primary airflow; or

b. The design zone outdoor airflow rate as specified by Section 120.1(c)3.

ii. The volume of primary air in the deadband shall not exceed the ~~larger of:~~

~~a. 20 percent of the peak primary airflow; or~~

~~b. The~~ design zone outdoor airflow rate as specified by Section 120.1(c)3.

iii. The first stage of heating consists of modulating the zone supply air temperature setpoint up to a maximum setpoint no higher than 95ºF while the airflow is maintained at the deadband flow rate.

iv. The second stage of heating consists of modulating the airflow rate from the deadband flow rate up to the heating maximum flow rate.

B. For each zone without DDC, the volume of primary air that is reheated, re-cooled, or mixed air supply shall not exceed the larger of the following:

i. 30 percent of the peak primary airflow; or

ii. The design zone outdoor airflow rate as specified by Section 120.1(c)3.

EXCEPTION 1 to Section 140.4(d): Zones with special pressurization relationships or cross-contamination control needs.

EXCEPTION 2 to Section 140.4(d): Zones served by space-conditioning systems in which at least 75 percent of the energy for reheating, or providing warm air in mixing systems, is provided from a site-recovered or site-solar energy source.

EXCEPTION 3 to Section 140.4(d): Zones in which specific humidity levels are required to satisfy exempt process loads. Computer rooms or other spaces where the only process load is from IT equipment may not use this exception.

EXCEPTION 4 to Section 140.4(d): Zones with a peak supply-air quantity of 300 cfm or less.

EXCEPTION 5 to Section 140.4(d): Systems serving healthcare facilities.

(e) **Economizers.**

1. Each cooling air handler that has a design total mechanical cooling capacity over ~~54,000~~33,000 Btu/hr, or chilled-water cooling systems without a fan or that use induced airflow that has a cooling capacity greater than the systems listed in Table 140.4-C, shall include either:

A. An air economizer capable of modulating outside-air and return-air dampers to supply 100 percent of the design supply air quantity as outside-air; or

B. A water economizer capable of providing 100 percent of the expected system cooling load, at outside air temperatures of 50°F dry-bulb and 45°F wet-bulb and below.

EXCEPTION 1 to Section 140.4(e)1: Where special outside air filtration and treatment, for the reduction and treatment of unusual outdoor contaminants, makes compliance infeasible.

EXCEPTION 2 to Section 140.4(e)1: Where the use of outdoor air for cooling will affect other systems, such as humidification, dehumidification, or supermarket refrigeration systems, so as to increase overall building TDV energy use.

EXCEPTION 3 to Section 140.4(e)1: Systems serving ~~high-rise residential living quarters and~~ hotel/motel guest rooms.

EXCEPTION 4 to Section 140.4(e)1: Where comfort cooling systems have the cooling efficiency that meets or exceeds the cooling efficiency improvement requirements in TABLE 140.4-D.

EXCEPTION 5 to Section 140.4(e)1: Fan systems primarily serving computer rooms. See Section 140.9(a) for computer room economizer requirements.

~~**EXCEPTION 6 to Section 140.4(e)1:** Systems design to operate at 100 percent outside air at all times.~~**EXCEPTION 6 to Section 140.4(e)1** Each air handler that has a design total mechanical cooling capacity less than 54,000 Btu/hr that utilizes a dedicated outdoor air system (such as a DX-DOAS, HRV, or ERV unit) for ventilation in accordance with 140.4(p)1B and 140.4(p)2 through 140.4(p)6.

EXCEPTION 7 to Section 140.4(e)1: Where the use of an air economizer in controlled environment horticulture spaces will affect carbon dioxide enrichment systems.

TABLE 140.4-C CHILLED WATER SYSTEM COOLING CAPACITY

Climate Zones	Total Building Chilled Water System Capacity, Minus Capacity of the Cooling units with Air Economizers	
	Building Water-Cooled Chilled Water System	Air-Cooled Chilled Water Systems or District Chilled Water Systems
15	≥ 960,000 Btu/h (280 kW)	≥ 1,250,000 Btu/h (365 kW)
1-14	≥720,000 Btu/h (210 kW)	≥940,000 Btu/h (275 kW)
16	≥1,320,000 Btu/h (385 kW)	≥1,720,000 Bu/h (505 kW)

TABLE 140.4-D ECONOMIZER TRADE-OFF TABLE FOR COOLING SYSTEMS

Climate Zone	Efficiency Improvement [a]
1	70%
2	65%
3	65%
4	65%
5	70%
6	30%
7	30%
8	30%
9	30%
10	30%
11	30%
12	30%
13	30%
14	30%
15	30%
16	70%

[a] If a unit is rated with an annualized or part-load metric, ~~IPLV, IEER or SEER,~~ then to eliminate the required ~~air or water~~ economizer, only the applicable minimum cooling efficiency of the ~~HVAC~~ unit must be increased by the percentage shown. If the ~~HVAC~~ unit is only rated with a full load metric, ~~such as~~ like EER or COP cooling, then that metric must be increased by the percentage shown. To determine the efficiency required to eliminate the economizer, when the unit equipment efficiency is rated with an energy-input divided by work-output metric, the metric shall first be converted to COP prior to multiplying by the efficiency improvement percentage and then converted back to the rated metric.

2. If an economizer is required by Section 140.4(e)1, and an air economizer is used to meet the requirement, then it shall be:

   A. Designed and equipped with controls so that economizer operation does not increase the building heating energy use during normal operation; and

      EXCEPTION to Section 140.4(e)2A: Systems that provide 75 percent of the annual energy used for mechanical heating from site-recovered energy or a site-solar energy source.

   B. Capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load.

   C. Designed and equipped with a device type and high limit shut off complying with TABLE 140.4-E.

TABLE 140.4-E AIR ECONOMIZER HIGH LIMIT SHUT OFF CONTROL REQUIREMENTS

Device Type[a]	Climate Zones	Required High Limit (Economizer Off When):	
		Equation[b]	Description
Fixed Dry Bulb	1, 3, 5, 11-16	T_{OA} > 75°F	Outdoor air temperature exceeds 75°F
	2, 4, 10	T_{OA} > 73°F	Outdoor air temperature exceeds 73°F
	6, 8, 9	T_{OA} > 71°F	Outdoor air temperature exceeds 71°F
	7	T_{OA} > 69°F	Outdoor air temperature exceeds 69°F
Differential Dry Bulb	1, 3, 5, 11-16	T_{OA} > T_{RA}°F	Outdoor air temperature exceeds return air temperature
	2, 4, 10	T_{OA} > T_{RA}-2°F	Outdoor air temperature exceeds return air temperature minus 2°F
	6, 8, 9	T_{OA} > T_{RA}-4°F	Outdoor air temperature exceeds return air temperature minus 4°F
	7	T_{OA} > T_{RA}-6°F	Outdoor air temperature exceeds return air temperature minus 6°F
Fixed Enthalpy[c] + Fixed Drybulb	All	h_{OA} > 28 Btu/lb[c] or T_{OA} > 75°F	Outdoor air enthalpy exceeds 28 Btu/lb of dry air[c] or Outdoor air temperature exceeds 75°F

[a] Only the high limit control devices listed are allowed to be used and at the setpoints listed. Others such as Dew Point, Fixed Enthalpy, Electronic Enthalpy, and Differential Enthalpy Controls, may not be used in any Climate Zone for compliance with Section 140.4(e)1 unless approval for use is provided by the Energy Commission Executive Director.

[b] Devices with selectable (rather than adjustable) setpoints shall be capable of being set to within 2°F and 2 Btu/lb of the setpoint listed.

[c] At altitudes substantially different than sea level, the Fixed Enthalpy limit value shall be set to the enthalpy value at 75°F and 50% relative humidity. As an example, at approximately 6,000 foot elevation, the fixed enthalpy limit is approximately 30.7 Btu/lb.

D. The air economizer and all air dampers shall have the following features:

i. **Warranty.** 5-year Manufacturer warranty of economizer assembly.

ii. **Damper reliability testing.** Suppliers of economizers shall certify that the economizer assembly, including but not limited to outdoor air damper, return air damper, drive linkage, and actuator, have been tested and are able to open and close against the rated airflow and pressure of the system for 60,000 damper opening and closing cycles.

iii. **Damper leakage.** Economizer outdoor air and return air dampers shall have a maximum leakage rate of 10 cfm/sf at 250 Pascals (1.0 in. of water) when tested in accordance with AMCA Standard 500-D. The economizer outside air and return air damper leakage rates shall be certified to the Energy Commission in accordance with Section 110.0.

iv. **Adjustable setpoint.** If the high-limit control is fixed dry-bulb or fixed enthalpy + fixed dry-bulb then the control shall have an adjustable setpoint.

v. **Sensor accuracy.** Outdoor air, return air, mixed air, and supply air sensors shall be calibrated within the following accuracies.

1. Drybulb and wetbulb temperatures accurate to ±2°F over the range of 40°F to 80°F;
2. Enthalpy accurate to ±3 Btu/lb over the range of 20 Btu/lb to 36 Btu/lb;
3. Relative humidity (RH) accurate to ±5 percent over the range of 20 percent to 80 percent RH;

vi. **Sensor calibration data.** Data used for control of the economizer shall be plotted on a sensor performance curve.

vii. **Sensor high limit control.** Sensors used for the high limit control shall be located to prevent false readings, including but not limited to being properly shielded from direct sunlight.

viii. **Relief air system.** Relief air systems shall be capable of providing 100 percent outside air without over-pressurizing the building.

E. The space conditioning system shall include the following:

~~A~~i. Unit controls shall have mechanical capacity controls interlocked with economizer controls such that the economizer is at 100 percent open position when mechanical cooling is on and does not begin to close until the leaving air temperature is less than 45°F.

~~B~~ii. Direct Expansion (DX) units greater than 65,000 Btu/hr that control the capacity of the mechanical cooling directly based on occupied space temperature shall have a minimum of two stages of mechanical cooling capacity.

~~C~~iii. DX units not within the scope of Section 140.4(e)2E,B shall (i) comply with the requirements in TABLE 140.4-F, and (ii) shall have controls that do not false load the mechanical cooling system by limiting or disabling the economizer or by any other means except at the lowest stage of mechanical cooling capacity.

TABLE 140.4-F DIRECT EXPANSION (DX) UNIT REQUIREMENTS FOR COOLING STAGES AND COMPRESSOR DISPLACEMENT

Cooling Capacity	Minimum Number of Mechanical Cooling Stages	Minimum Compressor Displacement
≥ 65,000 Btu/h and < 240,000 Btu/h	3 stages	≤ 35% full load
≥ 240,000 Btu/h	4 stages	≤ 25% full load

3. Systems that include a water economizer to meet Section 140.4(e)1 shall include the following:

A. Maximum pressure drop. Precooling coils and water-to-water heat exchangers used as part of a water economizer shall either have a waterside pressure drop of less than 15 feet of water, or a secondary loop shall be installed so that the coil or heat exchanger pressure drop is not contributing to pressure drop when the system is in the normal cooling (non-economizer) mode.

B. Economizer systems shall be integrated with the mechanical cooling system so that they are capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load. Controls shall not false load the mechanical cooling system by limiting or disabling the economizer or by any other means, such as hot gas bypass, except at the lowest stage of mechanical cooling.

(f) **Supply Air Temperature Reset Controls.** Space-conditioning systems supplying heated or cooled air to multiple zones shall include controls that automatically reset supply-air temperatures. Air distribution systems serving zones that are likely to have constant loads shall be designed for the airflows resulting from the fully reset supply air temperature. Supply air temperature reset controls shall be:

1. In response to representative building loads or to outdoor air temperature; and
2. At least 25 percent of the difference between the design supply-air temperature and the design room air temperature.

EXCEPTION 1 to Section 140.4(f): Systems that meet the requirements of Section 140.4(d)1, without using Exception 1 to that section.

EXCEPTION 2 to Section 140.4(f): Where supply-air temperature reset would increase overall building energy use.

EXCEPTION 3 to Section 140.4(f): Systems supplying zones in which specific humidity levels are required to satisfy process loads. Computer Rooms or other spaces with only IT equipment may not use this exception.

EXCEPTION 4 to Section 140.4(f): Systems serving healthcare facilities.

(g) **Electric Resistance Heating.** Electric resistance heating systems shall not be used for space heating.

EXCEPTION 1 to Section 140.4(g): Where an electric-resistance heating system supplements a heating system in which at least 60 percent of the annual energy requirement is supplied by site-solar or recovered energy.

EXCEPTION 2 to Section 140.4(g): Where an electric-resistance heating system supplements a heat pump heating system, and the heating capacity of the heat pump is more than 75 percent of the design heating load calculated in accordance with Section 140.4(a) at the design outdoor temperature specified in Section 140.4(b)4.

EXCEPTION 3 to Section 140.4(g): Where the total capacity of all electric-resistance heating systems serving the entire building is less than 10 percent of the total design output capacity of all heating equipment serving the entire building.

EXCEPTION 4 to Section 140.4(g): Where the total capacity of all electric-resistance heating systems serving the entire building, excluding those allowed under Exception 2, is no more than 3 kW.

EXCEPTION 5 to Section 140.4(g): Where an electric resistance heating system serves an entire building that is not a ~~high-rise residential or~~ hotel/motel building; and has a conditioned floor area no greater than 5,000 square feet; and has no mechanical cooling; and is in an area where natural gas is not currently available.

EXCEPTION 6 to Section 140.4(g): heating systems serving as emergency backup to gas heating equipment.

(h) **Heat Rejection Systems.** Heat rejection equipment used in comfort cooling systems such as air-cooled condensers, open cooling towers, closed-circuit cooling towers, and evaporative condensers shall include the following:

1. **Fan Speed Control.** Each fan powered by a motor of 7.5 hp (5.6 kW) or larger shall have the capability to operate that fan at 2/3 of full speed or less, and shall have controls that automatically change the fan speed to control the leaving fluid temperature or condensing temperature or pressure of the heat rejection device.

   EXCEPTION 1 to Section 140.4(h)1: Heat rejection devices included as an integral part of the equipment listed in TABLE 110.2-A through TABLE 110.2-I.

   EXCEPTION 2 to Section 140.4(h)1: Condenser fans serving multiple refrigerant circuits.

   EXCEPTION 3 to Section 140.4(h)1: Condenser fans serving flooded condensers.

   EXCEPTION 4 to Section 140.4(h)1: Up to one third of the fans on a condenser or tower with multiple fans where the lead fans comply with the speed control requirement.

2. **Tower Flow Turndown.** Open cooling towers configured with multiple condenser water pumps shall be designed so that all cells can be run in parallel with the larger of:

   A. The flow that is produced by the smallest pump; or

   B. 50 percent of the design flow for the cell.

3. **Limitation on Centrifugal Fan Cooling Towers.** Open cooling towers with a combined rated capacity of 900 gpm and greater at 95°F condenser water return, 85°F condenser water supply, and 75°F outdoor wet-bulb temperature, shall use propeller fans and shall not use centrifugal fans.

   EXCEPTION 1 to Section 140.4(h)3: Cooling towers that are ducted (inlet or discharge) or have an external sound trap that requires external static pressure capability.

   EXCEPTION 2 to Section 140.4(h)3: Cooling towers that meet the energy efficiency requirement for propeller fan towers in Section 110.2, TABLE 110.2-G.

4. **Multiple Cell Heat Rejection Equipment.** Multiple cell heat rejection equipment with variable speed fan drives shall:

   A. Operate the maximum number of fans allowed that comply with the manufacturer's requirements for all system components, and

   B. Control all operating fans to the same speed. Minimum fan speed shall comply with the minimum allowable speed of the fan drive as specified by the manufactures recommendation. Staging of fans is allowed once the fans are at their minimum operating speed.

5. **Cooling tower efficiency.** Axial fan, open-circuit cooling towers serving condenser water loops for chilled water plants with a total of 900 gpm or greater, shall have a rated efficiency of no less than 60 gpm/hp when rated in accordance with the conditions as listed in Table 110.2-G.

   EXCEPTION 1 to Section 140.4(h)5: Replacement of existing cooling towers that are inside an existing building or on an existing roof.

   EXCEPTION 2 to Section 140.4(h)5: Cooling towers serving buildings in Climate Zone 1 or 16.

(i) **Minimum Chiller Efficiency.** Chillers shall meet or exceed Path B from TABLE 110.2-D

EXCEPTION 1 to Section 140.4(i): Chillers with electrical service > 600V.

EXCEPTION 2 to Section 140.4(i): Chillers attached to a heat recovery system with a design heat recovery capacity > 40 percent of the design chiller cooling capacity.

EXCEPTION 3 to Section 140.4(i): Chillers used to charge thermal energy storage systems where the charging temperature is < 40 °F.

EXCEPTION 4 to Section 140.4(i): In buildings with more than three chillers, only three chillers are required to meet the Path B efficiencies.

(j) **Limitation of Air-Cooled Chillers.** Chilled water plants shall not have more than 300 tons provided by air-cooled chillers.

EXCEPTION 1 to Section 140.4(j): Where the water quality at the building site fails to meet manufacturer's specifications for the use of water-cooled chillers.

EXCEPTION 2 to Section 140.4(j): Chillers that are used to charge a thermal energy storage system with a design temperature of less than 40° F (4° C).

EXCEPTION 3 to Section 140.4(j): Systems serving healthcare facilities.

(k) **Hydronic System Measures**

1. **Hydronic Variable Flow Systems.** HVAC chilled and hot water pumping shall be designed for variable fluid flow and shall be capable of reducing pump flow rates to no more than the larger of: a) 50 percent or less of the design flow rate; or b) the minimum flow required by the equipment manufacturer for the proper operation of equipment served by the system.

   EXCEPTION 1 to Section 140.4(k)1: Systems that include no more than three control valves.

   EXCEPTION 2 to Section 140.4(k)1: Systems having a total pump system power less than or equal to 1.5 hp.

2. **Chiller Isolation.** When a chilled water system includes more than one chiller, provisions shall be made so that flow through any chiller is automatically shut off when that chiller is shut off while still maintaining flow through other operating chiller(s). Chillers that are piped in series for the purpose of increased temperature differential shall be considered as one chiller.

3. **Boiler Isolation.** When a hot water plant includes more than one boiler, provisions shall be made so that flow through any boiler is automatically shut off when that boiler is shut off while still maintaining flow through other operating boiler(s).

4. **Chilled and Hot Water Temperature Reset Controls.** Systems with a design capacity exceeding 500,000 Btu/hr supplying chilled or heated water shall include controls that automatically reset supply water temperatures as a function of representative building loads or outside air temperature.

   EXCEPTION 1 to Section 140.4(k)4: Hydronic systems that use variable flow to reduce pumping energy in accordance with Section 140.4(k)1.

   EXCEPTION 2 to Section 140.4(k)4: Systems serving healthcare facilities.

5. **Water-Cooled Air Conditioner and Hydronic Heat Pump Systems.** Water circulation systems serving water-cooled air conditioners, hydronic heat pumps, or both, that have total pump system power exceeding 5 hp shall have flow controls that meet the requirements of Section 140.4(k)6. Each such air conditioner or heat pump shall have a two-position automatic valve interlocked to shut off water flow when the compressor is off.

6. **Variable Flow Controls.**

A. Variable Speed Drives. Individual pumps serving variable flow systems and having a motor horsepower exceeding 5 hp shall have controls or devices (such as variable speed control) that will result in pump motor demand of no more than 30 percent of design wattage at 50 percent of design water flow. The pumps shall be controlled as a function of required differential pressure.

B. Pressure Sensor Location and Setpoint.

i. For systems without direct digital control of individual coils reporting to the central control panel, differential pressure shall be measured at the most remote heat exchanger or the heat exchanger requiring the greatest differential pressure.

ii. For systems with direct digital control of individual coils with a central control panel, the static pressure set point shall be reset based on the valve requiring the most pressure, and the setpoint shall be no less than 80 percent open. Pressure sensors may be mounted anywhere.

EXCEPTION 1 to Section 140.4(k)6: Heating hot water systems.

EXCEPTION 2 to Section 140.4(k)6: Condenser water systems serving only water-cooled chillers.

7. **Hydronic Heat Pump (WLHP) Controls.** Hydronic heat pumps connected to a common heat pump water loop with central devices for heat rejection and heat addition shall have controls that are capable of providing a heat pump water supply temperature deadband of at least 20°F between initiation of heat rejection and heat addition by the central devices.

EXCEPTION to Section 140.4(k)7: Where a system loop temperature optimization controller is used to determine the most efficient operating temperature based on real-time conditions of demand and capacity, deadbands of less than 20°F shall be allowed.

8. High Capacity Space Heating Gas Boiler Systems. In Climate Zones 1 through 6, 9 through 14, and 16 with gas hot water boiler systems for space heating with a total system input of at least 1 MMBtu/h but no more than 10 MMBtu/h shall meet all of the following requirements.

A. Boiler System Efficiency. Gas hot water boilers shall have a minimum thermal efficiency of 90 percent. Systems with multiple boilers can meet this requirement if the space-heating input provided by equipment with thermal efficiencies above and below 90 percent has an input capacity-weighted average thermal efficiency of at least 90 percent. For boilers federally regulated by combustion efficiency, the calculation for the input capacity-weighted average thermal efficiency shall use the combustion efficiency value.

B. Hot water distribution design. The hot water distribution system shall be designed to comply with items i and ii.

i. Coils and other heat exchangers shall be selected so that at design conditions the hot water return temperature entering the boilers is 120°F or less.

ii Under all operating conditions, the water temperature entering the boiler is 120°F or less or the flow rate of supply hot water that recirculates directly into the return system, such as by 3-way valves or minimum flow bypass controls, shall be no greater than 20 percent of the design flow of the operating boilers.

Exception 1 to 140.4(k)8: Where 25 percent of the annual space heating requirement is provided by on-site renewable energy, site-recovered energy, or heat recovery chillers.

Exception 2 to 140.4(k)8: Space heating boilers installed in individual dwelling units.

Exception 3 to 140.4(k)8: Where 50 percent or more of the design heating load is served using perimeter convective heating, radiant ceiling panels or both.

Exception 4 to 140.4(k)8: Individual gas boilers with input capacity less than 300,000 Btu/h shall not be included in the calculations of the total system input or total system efficiency.

(l) RESERVED

~~(l) **Air Distribution System Duct Leakage Sealing.** Duct systems shall be sealed in accordance with 1 or 2 below:~~

~~1. Systems serving high-rise residential buildings, hotel/motel buildings and nonresidential buildings other than healthcare facilities, the duct system shall be sealed to a leakage rate not to exceed 6 percent of the nominal air handler airflow rate as confirmed through field verification and diagnostic testing, in accordance with the applicable procedures in Reference Nonresidential Appendices NA1 and NA2 if the criteria in Subsections A, B and C below are met:~~

~~A. The duct system provides conditioned air to an occupiable space for a constant volume, single zone, space-conditioning system; and~~

~~B. The space conditioning system serves less than 5,000 square feet of conditioned floor area; and~~

~~C. The combined surface area of the ducts located in the following spaces is more than 25 percent of the total surface area of the entire duct system:~~

~~i. Outdoors; or~~

~~ii. In a space directly under a roof that~~

~~a. Has a U-factor greater than the U-factor of the ceiling, or if the roof does not meet the requirements of Section 140.3(a)1B, or~~

~~b. Has fixed vents or openings to the outside or unconditioned spaces; or~~

~~iii. In an unconditioned crawl space; or~~

~~iv. In other unconditioned spaces.~~

~~2. Duct systems serving healthcare facilities shall be sealed in accordance with the California Mechanical Code.~~

(m) **Fan Control.** Each cooling system listed in TABLE 140.4-G shall be designed to vary the indoor fan airflow as a function of load and shall comply with the following requirements:

1. DX and chilled water cooling systems that control the capacity of the mechanical cooling directly based on occupied space temperature shall (i) have a minimum of 2 stages of fan control with no more than 66 percent speed when operating on stage 1; and (ii) draw no more than 40 percent of the fan power at full fan speed, when operating at 66 percent speed.
2. All other systems, including but not limited to DX cooling systems and chilled water systems that control the space temperature by modulating the airflow to the space, shall have proportional fan control such that at 50 percent airflow the power draw is no more than 30 percent of the fan power at full fan speed.

3. Systems that include an air side economizer to meet 140.4(e)1 shall have a minimum of two speeds of fan control during economizer operation.

EXCEPTION 1 to Section 140.4(m): Modulating fan control is not required for chilled water systems with all fan motors <1 HP, or for evaporative systems with all fan motors < 1 HP, if the systems are not used to provide ventilation air and all indoor fans cycle with the load.

EXCEPTION 2 to Section 140.0(m): Systems serving healthcare facilities.

TABLE 140.4-G FAN CONTROL SYSTEMS

Cooling System Type	Fan Motor Size	Cooling Capacity
DX Cooling	any	≥ 65,000 Btu/hr
Chilled Water and Evaporative	≥ 1/4 HP	any

(n~~n~~) **Mechanical System Shut-off.** Any directly conditioned space with operable wall or roof openings to the outdoors shall be provided with interlock controls that disable or reset the temperature setpoint to 55°F for mechanical heating and disable or reset the temperature setpoint to 90°F for mechanical cooling to that space when any such opening is open for more than 5 minutes.

EXCEPTION 1 to Section 140.4(n): Interlocks are not required on doors with automatic closing devices.

EXCEPTION 2 to Section 140.4(n): Any space without a thermostatic control (thermostat or a space temperature sensor used to control heating or cooling to the space).

EXCEPTION 3 to Section 140.4(n): Healthcare facilities.

~~**EXCEPTION 4 to Section 140.4(n):** High-rise residential dwelling units.~~

(o~~e~~) Exhaust System Transfer Air. Conditioned supply air delivered to any space with mechanical exhaust shall not exceed the greater of:

1. The supply flow required to meet the space heating or cooling load; or
2. The ventilation rate required by the authority having jurisdiction, the facility Environmental Health and Safety Department, or by Section 120.1(c)3; or
3. The mechanical exhaust flow minus the available transfer air. Available transfer air shall be from another conditioned space or return air plenums on the same floor and same smoke or fire compartment, and that at their closest point are within 15 feet of each other.

EXCEPTION 1 to Section 140.4(o): Biosafety level classified laboratories 3 or higher.

EXCEPTION 2 to Section 140.4(o): Vivarium spaces.

EXCEPTION 3 to Section 140.4(o): Spaces that are required by applicable codes and standards to be maintained at a positive pressure differential relative to adjacent spaces.

EXCEPTION 4 to Section 140.4(o): Spaces where the highest amount of transfer air that could be used for exhaust makeup may exceed the available transfer airflow rate and where the spaces have a required negative pressure relationship.

EXCEPTION 5 to Section 140.4(o): Healthcare facilities.

(p) Dedicated Outdoor Air Systems (DOAS). HVAC systems which utilize a dedicated outdoor air system (DOAS) such as a DX-DOAS, HRV or ERV unit to condition, temper, or filter 100 percent outdoor air separate from local or central space-conditioning systems serving the same space shall meet the following criteria:

1. Provide each space with either of the following configurations:

   A. A DOAS unit and a separate independent space-conditioning system in which the independent space-conditioning system in accordance with the economizer requirements specified by Section 140.4(e) and the DOAS unit in accordance with the exhaust air heat recovery requirements specified in Section 140.4(q).

   B. A DOAS unit which meets or exceeds the following criteria and a separate space cooling system:

      i. Provides at least the minimum ventilation air flow rate as specified in Section 120.1(c)3 and provides no less than 0.3 cfm/ft^2 during economizer operation.

      ii. Ventilation sensible energy recovery ratio of at least 60 percent or enthalpy recovery ratio of at least 50 percent at full flow cooling design conditions and heating design condition.

      iii. Energy recovery bypass or control to directly economize with ventilation air based on outdoor air temperature limits specified in TABLE 140.4-E.

   EXCEPTION 1 to Section 140.4(p)1: Systems installed for the sole purpose of providing makeup air for exhausting toxic, flammable materials, paint, corrosive fumes or dust, dryer exhaust, or commercial kitchen hoods used for collecting and removing grease vapors and smoke.

2. DOAS supply and exhaust fans shall have a minimum of 3 speeds to facilitate system balancing.

3. Heating and cooling equipment fans, heating and cooling circulation pumps, and terminal unit fans shall cycle off and terminal unit primary cooling air shall be shut off when there is no call for heating or cooling in the zone.

   EXCEPTION to Section 140.4(p)3: Fans used for heating and cooling using less than 0.12 watts per cfm, as certified by the manufacturer, may operate when space temperatures are within the thermostat deadband to provide destratification and air mixing in the space.

4. The DOAS supply air shall be delivered directly to the occupied space or downstream of the terminal heating/or cooling coils.

   EXCEPTION 1 to Section 140.4(p)4: Active chilled beam systems.

   EXCEPTION 2 to Section 140.4(p)4: Sensible only cooling terminal units with pressure-independent variable-airflow regulating devices limiting the DOAS supply air to the greater of latent load or minimum ventilation requirements.

EXCEPTION 3 to Section 140.4(p)4: Terminal heating and/or cooling units that comply with the low fan power allowance requirements in Exception to Section 140.4(p)3.

5. DOAS with mechanical cooling providing ventilation to multiple zones and operating in conjunction with zone heating and cooling systems shall not use heating or heat recovery to warm supply air above 60°F when representative building loads or outdoor air temperature indicate that the majority of zones require cooling.

6. DOAS with a total fan system input power less than 1 kW shall not exceed a total combined fan power of 1.0 W/cfm. DOAS with fan power greater than or equal to 1 kW shall meet the requirements of Section 140.4 (c).

(q) Exhaust Air Heat Recovery. Fan systems designed to operate to the criteria listed in either Table 140.4-G or Table 140.4-H shall include an exhaust air heat recovery system which meets the following:

1. A sensible energy recovery ratio of at least 60 percent or an enthalpy recovery ratio of at least 50 percent for both heating and cooling design conditions.

2.Energy recovery bypass or control to disable energy recovery and to directly economize with ventilation air based on outdoor air temperature limits specified in TABLE 140.4-E. For energy recovery systems where the transfer of energy cannot be stopped, bypass shall prevent the total airflow rate of either outdoor air or exhaust air through the energy recovery exchanger from exceeding 10% of the full design airflow rate.

3. For a DOAS unit and a separate independent space-conditioning system meeting the requirements of 140.4(p)1A the design supply fan airflow rate shall be the total airflow of only the DOAS unit.

EXCEPTION 1 to Section 140.4(q)2: For DOAS units with the capability to shut off when a separate independent space-conditioning system meets the economizer requirements specified by section 140.4(e)1A is economizing.

EXCEPTION 1 to Section 140.4(q): Systems meeting Section 140.9(c) Prescriptive Requirements for Laboratory and Factory Exhaust Systems.

EXCEPTION 2 to Section 140.4(q): Systems serving spaces that are not cooled and that are heated to less than 60°F.

EXCEPTION 3 to Section 140.4(q): Where more than 60 percent of the outdoor air heating energy is provided from site-recovered energy in Climate Zone 16.

EXCEPTION 4 to Section 140.4(q): Sensible recovery ratio requirements at heating design conditions are exempted for Climate Zone 15.

EXCEPTION 5 to Section 140.4(q): Sensible recovery ratio requirements at cooling design conditions are exempted for Climate Zone 01.

EXCEPTION 6 to Section 140.4(q): Where the sum of the airflow rates exhausted and relieved within 20 feet of each other is less than 75 percent of the design outdoor airflow rate, excluding exhaust air that is either:

1. used for another energy recovery system,

2. not allowed by California Mechanical Code (Title 24, Part 4) (CMC)for use in energy recovery systems with leakage potential, or

3. of Class 4 as specified in Section 120.1(g).

EXCEPTION 7 to Section 140.4(q): Systems expected to operate less than 20 hours per week.

TABLE 140.4-G: ENERGY RECOVERY REQUIREMENTS BY CLIMATE ZONE AND PERCENT OUTDOOR AIR AT FULL DESIGN AIRFLOW (<8,000 HOURS / YEAR)

% Outdoor Air at Full Design Airflow	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
≥10% and <20%	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
≥20% and <30%	≥15,000	≥20,000	NR	NR	NR	NR	NR	NR	NR	NR	≥18,500	≥18,500	≥18,500	≥18,500	≥18,500	≥18,500
≥30% and <40%	≥13,000	≥15,000	NR	NR	NR	NR	NR	NR	NR	NR	≥15,000	≥15,000	≥15,000	≥15,000	≥15,000	≥15,000
≥40% and <50%	≥10,000	≥12,000	NR	NR	NR	NR	NR	NR	NR	≥22,000	≥10,000	≥10,000	≥10,000	≥10,000	≥10,000	≥10,000
≥50% and <60%	≥9,000	≥10,000	NR	≥18,500	NR	NR	NR	NR	NR	≥17,000	≥8,000	≥8,000	≥8,000	≥8,000	≥8,000	≥8,000
≥60% and <70%	≥7,000	≥7,500	NR	≥16,500	NR	NR	NR	NR	≥20,000	≥15,000	≥7,000	≥7,000	≥7,000	≥7,000	≥7,000	≥7,000
≥70% and <80%	≥6,500	≥7,000	NR	≥15,000	NR	NR	NR	NR	≥17,000	≥14,000	≥5,000	≥5,000	≥5,000	≥5,000	≥5,000	≥5,000
≥80%	≥4,500	≥6,500	NR	≥14,000	NR	NR	NR	NR	≥15,000	≥13,000	≥2,000	≥2,000	≥2,000	≥2,000	≥2,000	≥2,000

1. Flow rates in Table 140.4-G represent the design supply fan airflow rate in CFM.

2. For a DOAS unit and a separate independent space-conditioning system meeting the requirements of 140.4(p)1A, the design supply fan airflow rate shall be the total airflow of only the DOAS unit.

TABLE 140.4-H: ENERGY RECOVERY REQUIREMENTS BY CLIMATE ZONE AND PERCENT OUTDOOR AIR AT FULL DESIGN AIRFLOW (≥8,000 HOURS / YEAR)

% Outdoor Air at Full Design Airflow	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
≥10% and <20%	≥10,000	≥10,000	NR	NR	NR	NR	NR	NR	NR	≥40,000	≥40,000	≥20,000	≥10,000	≥10,000	≥10,000	≥10,000
≥20% and <30%	≥2,000	≥5,000	≥13,000	≥9,000	≥9,000	NR	NR	NR	NR	≥15,000	≥15,000	≥5,000	≥5,000	≥5,000	≥5,000	≥5,000
≥30% and <40%	≥2,000	≥3,000	≥10,000	≥6,500	≥6,500	NR	NR	NR	≥15,000	≥7,500	≥7,500	≥3,000	≥3,000	≥3,000	≥3,000	≥3,000
≥40% and <50%	≥2,000	≥2,000	≥8,000	≥6,000	≥6,000	NR	NR	NR	≥12,000	≥6,000	≥6,000	≥2,000	≥2,000	≥2,000	≥2,000	≥2,000
≥50% and <60%	≥2,000	≥2,000	≥7,000	≥6,000	≥6,000	NR	NR	≥20,000	≥10,000	≥5,000	≥5,000	≥2,000	≥2,000	≥2,000	≥2,000	≥2,000
≥60% and <70%	≥2,000	≥2,000	≥6,000	≥6,000	≥6,000	NR	NR	≥18,000	≥9,000	≥4,000	≥4,000	≥2,000	≥2,000	≥2,000	≥2,000	≥2,000
≥70% and <80%	≥2,000	≥2,000	≥6,000	≥5,000	≥5,000	NR	NR	≥15,000	≥8,000	≥3,000	≥3,000	≥2,000	≥2,000	≥2,000	≥2,000	≥2,000
≥80%	≥2,000	≥2,000	≥6,000	≥5,000	≥5,000	NR	NR	≥12,000	≥7,000	≥3,000	≥3,000	≥2,000	≥2,000	≥2,000	≥2,000	≥2,000

1. Flow rates in Table 140.4-G represent the design supply fan airflow rate in CFM.

2. For a DOAS unit and a separate independent space-conditioning system meeting the requirements of 140.4(p)1A, the design supply fan airflow rate shall be the total airflow of only the DOAS unit.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, Public Resources Code.

SECTION 140.5 – PRESCRIPTIVE REQUIREMENTS FOR SERVICE WATER HEATING SYSTEMS

(a) **Nonresidential Occupancies.** Service water heating systems in nonresidential buildings shall meet the requirements of 1, 2 below, or meet the performance compliance requirements of Section 140.1:

1. School buildings less than 25,000 square feet and less than 4 stories in climate zones 2 through 15. A heat pump water heating system that meets the applicable requirements of Sections 110.1, 110.3 and 120.3.

2. All other occupancies. A service water heating system ~~installed in a nonresidential building complies with this section if it complies with~~that meets the applicable requirements of Sections 110.1, 110.3, ~~and~~ 120.3, and 140.5(c)~~.~~

EXCEPTION to 140.5(a)1: Water heating system serving an individual bathroom space may be an instantaneous electric water heater.

(b) ~~**High-Rise Residential and**~~ **Hotel/Motel Occupancies.** A service water heating system installed in a ~~high-rise residential or~~ hotel/motel building ~~complies with this section if it~~shall meet~~s~~ the requirements of Section ~~150.1(c)8~~170.2(d).

(c) **High Capacity Service Water Heating Systems**. Gas service water-heating systems with a total installed gas water-heating input capacity of 1 MMBtu/h or greater shall have gas service water-heating equipment with a minimum thermal efficiency of 90 percent. Multiple units can meet this requirement if the water-heating input provided by equipment with thermal efficiencies above and below 90 percent averages out to an input capacity-weighted average of at least 90 percent.

Exception 1 to 140.5(c): If 25 percent of the annual service water-heating requirement is provided by site-solar energy or site-recovered energy.

Exception 2 to 140.5(c): Water heaters installed in individual dwelling units.

Exception 3 to 140.5(c): Individual gas water heaters with input capacity at or below 100,000 Btu/h shall not be included in the calculations of the total system input or total system efficiency

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, Public Resources Code.

SECTION 140.6 – PRESCRIPTIVE REQUIREMENTS FOR INDOOR LIGHTING

A building complies with this section if:

i. The Calculation of Adjusted Indoor Lighting Power of all proposed building areas combined, calculated under Subsection (a) is no greater than the Calculation of Allowed Indoor Lighting Power, Specific Methodologies calculated under Subsection (c); and

ii. The Calculation of Allowed Indoor Lighting Power, General Rules comply with Subsection (b)~~; and~~

~~iii. General lighting complies with the Automatic Daylighting Controls in Secondary Daylit Zone requirements in Subsection (d)~~.

The prescriptive limits on indoor lighting power are the smaller of the Adjusted and Allowed Indoor Lighting Power values determined in accordance with item i.

(a) **Calculation of Adjusted Indoor Lighting Power.** The adjusted indoor Lighting Power of all proposed building areas is the total watts of all planned permanent and portable lighting systems in all areas of the proposed building; subject to the applicable adjustments under Subdivisions 1 through 4 of this subsection and the requirements of Subdivision 4 of this subsection.

1. **Two interlocked lighting systems**: No more than two lighting systems may be used for an area, and if there are two they must be interlocked. Where there are two interlocked lighting systems, the watts of the lower wattage system may be excluded from the Adjusted Indoor Lighting Power if:

   A. An Installation Certificate detailing compliance with Section 140.6(a)1 is submitted in accordance with Sections 10-103 and 130.4; and

   B. The area or areas served by the interlocking systems is an auditorium, a convention center, a conference room, a multipurpose room, or a theater; and

   C. The two lighting systems are interlocked with a Nonprogrammable Double-Throw Switch to prevent simultaneous operation of both systems.

      For compliance with Part 6 a Nonprogrammable Double-Throw Switch is an electrical switch commonly called a "single pole double throw" or "three-way" switch that is wired as a selector switch allowing one of two loads to be enabled. It can be a line voltage switch or a low voltage switch selecting between two relays. It cannot be overridden or changed in any manner that would permit both loads to operate simultaneously.

2. **Reduction of wattage through controls.** In calculating Adjusted Indoor Lighting Power, the installed watts of a luminaire providing general lighting in an area listed in TABLE 140.6-A may be reduced by the product of (i) the number of watts controlled as described in TABLE 140.6-A, times (ii) the applicable Power Adjustment Factor (PAF), if all of the following conditions are met:

   A. An Installation Certificate is submitted in accordance with Section 130.4(b); and

   B. Luminaires and controls meet the applicable requirements of Section 110.9, and Sections 130.0 through 130.5; and

   C. The controlled lighting is permanently installed general lighting systems and the controls are permanently installed nonresidential-rated lighting controls.

      When used for determining PAFs for general lighting in offices, furniture mounted luminaires that comply with all of the following conditions shall qualify as permanently installed general lighting systems:

      i. The furniture mounted luminaires shall be permanently installed no later than the time of building permit inspection; and

      ii. The furniture mounted luminaires shall be permanently hardwired; and

      iii. The furniture mounted lighting system shall be designed to provide indirect general lighting; and

iv. Before multiplying the installed watts of the furniture mounted luminaire by the applicable PAF, 0.~~3~~ 2 watts per square foot of the area illuminated by the furniture mounted luminaires shall be subtracted from installed watts of the furniture mounted luminaires; and

v. The lighting control for the furniture mounted luminaire complies with all other applicable requirements in Section 140.6(a)2.

D. At least 50 percent of the light output of the controlled luminaire is within the applicable area listed in TABLE 140.6-A. Luminaires on lighting tracks shall be within the applicable area in order to qualify for a PAF.

E. Only one PAF from TABLE 140.6-A may be used for each qualifying luminaire. PAFs shall not be added together unless allowed in TABLE 140.6-A.

F. Only lighting wattage directly controlled in accordance with Section 140.6(a)2 shall be used to reduce the installed watts as allowed by Section 140.6(a)2 for calculating the Adjusted Indoor Lighting Power. If only a portion of the wattage in a luminaire is controlled in accordance with Section 140.6(a)2, then only that portion of controlled wattage may be reduced in calculating Adjusted Indoor Lighting Power.

G. Lighting controls used to qualify for a PAF shall be designed and installed in addition to manual, multilevel, and automatic lighting controls required in Section 130.1, and in addition to any other lighting controls required by any provision of Part 6. PAFs shall not be available for lighting controls required by Part 6.

H. To qualify for the PAF for daylight continuous dimming plus OFF control, the daylight control and controlled luminaires shall comply with Section 130.1(d), 130.4(a)3 and 130.4(a)7, and the daylight control shall be continuous dimming and shall additionally turn lights completely OFF when the daylight available in the daylit zone is greater than 150 percent of the illuminance received from the general lighting system at full power. The PAF shall apply ~~only~~ to the luminaires in the primary sidelit daylit zone, secondary sidelit daylit zone and the skylit daylit zone.

I. To qualify for the PAF for an occupant sensing control controlling the general lighting in large ~~open plan~~ office areas above workstations, in accordance with TABLE 140.6-A, the following requirements shall be met:

i. The ~~open plan~~ office area shall be greater than 250 square feet; and

ii. This PAF shall be available only in office areas which contain workstations; and

iii. Controlled luminaires shall only be those that provide general lighting directly above the controlled area, or furniture mounted luminaires that comply with Section 140.6(a)2 and provide general lighting directly above the controlled area; and

iv. Qualifying luminaires shall be controlled by occupant sensing controls that meet all of the following requirements, as applicable:

a. Infrared sensors shall be equipped by the manufacturer, of fitted in the field by the installer, with lenses or shrouds to prevent them from being triggered by movement outside of the controlled area.

b. Ultrasonic sensors shall be tuned to reduce their sensitivity to prevent them from being triggered by movements outside of the controlled area.

c. All other sensors shall be installed and adjusted as necessary to prevent them from being triggered by movements outside of the controlled area.

J. To qualify for the PAF for an Institutional Tuning in TABLE 140.6-A, the tuned lighting system shall comply with all of the following requirements:

i. The lighting controls shall limit the maximum output or maximum power draw of the controlled lighting to 85 percent or less of full light output or full power draw; and

ii. The means of setting the limit is accessible only to authorized personnel; and

iii. The setting of the limit is verified by the acceptance test required by Section 130.4(a)7; and

iv. The construction documents specify which lighting systems shall have their maximum light output or maximum power draw set to no greater than 85% of full light output or full power draw.

K. To qualify for the PAF for a Demand Responsive Control in TABLE 140.6-A, the general lighting wattage receiving the PAF shall not be within the scope of Section 110.12(c) and a Demand Responsive Control shall meet all of the following requirements:

~~i. The building shall be 10,000 square feet or smaller; and~~

~~i~~ii. The controlled lighting shall be capable of being automatically reduced in response to a demand response signal; and

~~i~~iii. ~~L~~General lighting shall be reduced in a manner consistent with uniform level of illumination requirements in TABLE 130.1-A~~; and~~.

~~iv. Spaces that are nonhabitable shall not be used to comply with this requirement, and spaces with a lighting power density of less than 0.5 watts per square foot shall not be counted toward the building's total lighting power.~~

L. To qualify for the PAFs for clerestory fenestration, horizontal slats, or light shelves in TABLE 140.6-A, the daylighting design shall meet the requirements in Section 140.3(d). The PAFs shall only apply to lighting in a primary or secondary sidelit daylit zone where continuous dimming daylighting controls meeting the requirements of Section 130.1(d) are installed.

3. **Lighting wattage excluded.** The watts of the following indoor lighting applications may be excluded from Adjusted Indoor Lighting Power. (Indoor lighting not listed below shall comply with all applicable nonresidential indoor lighting requirements in Part 6~~.~~):

A. In theme parks: Lighting for themes and special effects.

B. Studio lighting for film or photography provided that these lighting systems are in addition to and separately switched from a general lighting system.

C. Lighting for dance floors, lighting for theatrical and other live performances, and theatrical lighting used for religious worship, provided that these lighting systems are additions to a general lighting system and are separately controlled by a multiscene or theatrical cross-fade control station accessible only to authorized operators.

Lighting intended for makeup, hair, and costume preparation in performing arts facility dressing rooms, provided that the lighting is separately switched from the general lighting system, switched independently at each dressing station, and is controlled with a Vacancy Sensor.

D. In civic facilities, transportation facilities, convention centers, and hotel function areas: Lighting for temporary exhibits, if the lighting is in addition to a general lighting system and is separately controlled from a panel accessible only to authorized operators.

E. Lighting installed by the manufacturer in walk-in coolers or freezers, vending machines, food preparation equipment, and scientific and industrial equipment.

F. In office buildings with medical and clinical areas and healthcare facilities: Examination and surgical lights, low-ambient night-lights, and lighting integral to medical equipment, provided that these lighting systems are additions to and separately switched from a general lighting system.

G. Lighting for plant growth or maintenance in non-CEH spaces, if it is controlled by a multilevel astronomical time-switch control that complies with the applicable provisions of Section 110.9.

H. Lighting equipment that is for sale.

I. Lighting demonstration equipment in lighting education facilities.

J. Lighting that is required for exit signs subject to the CBC. Exit signs shall meet the requirements of the Appliance Efficiency Regulations.

K. Exitway or egress illumination that is normally off and that is subject to the CBC.

L. In hotel/motel buildings: Lighting in guest rooms (lighting in hotel/motel guest rooms shall comply with Section 130.0(b). (Indoor lighting not in guest rooms shall comply with all applicable nonresidential lighting requirements in Part 6.)

M. In high-rise residential buildings: Lighting in dwelling units (Lighting in high-rise residential dwelling units shall comply with Section 130.0(b).) (Indoor lighting not in dwelling units shall comply with all applicable nonresidential lighting requirements in Part 6.)

N. Temporary lighting systems. ~~(As defined in Section 100.1.)~~

O. Lighting in occupancy group U buildings less than 1,000 square feet.

P. Lighting in unconditioned agricultural buildings less than 2,500 square feet.

Q. Lighting systems in qualified historic buildings, as defined in the California Historical Building Code (Title 24, Part 8), are exempt from the Lighting Power Density allowances, if they consist solely of historic lighting components or replicas of historic lighting components. If lighting systems in qualified buildings contain some historic lighting components or replicas of historic components, combined with other lighting components, only those historic or historic replica components are exempt. All other lighting systems in qualified historic buildings shall comply with the Lighting Power Density allowances.

R. Lighting in nonresidential parking garages for seven or less vehicles: Lighting in nonresidential parking garages for seven or less vehicles shall comply with the applicable residential parking garage provisions of Section 150.0(k).

S. Lighting for signs: Lighting for signs shall comply with Section 140.8.

T. Lighting in refrigerated cases less than 3,000 square feet. (Lighting in refrigerated cases less than 3,000 square feet shall comply with the Title 20 Appliance Efficiency Regulations).

U. Lighting in elevators where the lighting meets the requirements in Section 120.6(f).

V. Lighting connected to a Life Safety Branch or Critical Branch, as specified in Section 517 of the California Electrical Code.

W. Horticultural lighting in CEH spaces (indoor growing and greenhouses) complying with Section 120.6(h).

4. **Luminaire Classification and Power Adjustment.**

A. Luminaire Classification and Power shall be determined in accordance with Section 130.0(c).

B. Small Aperture Tunable-White and Dim-to-Warm Luminaires Lighting Power Adjustment. For qualifying small aperture tunable-white and dim-to-warm LED luminaires, the adjusted indoor lighting power of these luminaires shall be calculated by multiplying their maximum rated wattage by ~~0.75~~0.80. Qualifying luminaires shall meet all of the following:

i. Small Aperture. Qualifying luminaires with a luminaire aperture length longer than 18 inches shall ~~be~~ have a luminaire aperture no wider than four inches. Qualifying luminaires with a luminaire aperture length of 18 inches or less shall ~~be~~ have a luminaire aperture no wider than eight inches.

ii. Color Changing. Qualifying tunable-white luminaires shall be capable of a color change greater than or equal to 2000 Kelvin correlated color temperature (CCT). Qualifying dim-to-warm luminaires shall be capable of color change greater than or equal to 500 Kelvin CCT.

iii. Controls. Qualifying luminaires shall be connected to controls that allows color changing of the luminaires.

C. Tailored Method Display Lighting Mounting Height Lighting Power Adjustment. For wall display luminaires or floor display luminaires meeting Tailored Method Section 140.6(c)3G and H and where the bottom of luminaires are 10 feet 7 inches and greater above the finished floor, the adjusted

indoor lighting power of these luminaires shall be calculated by multiplying their maximum rated wattage and the appropriated mounting height adjustment factor from TABLE 140.6-E. Luminaire mounting height is the distance from the finished floor to the bottom of the luminaire. General lighting shall not qualify for a mounting height multiplier.

(b) ——**Calculation of Allowed Indoor Lighting Power: General Rules**

1. The allowed indoor lighting power allotment for conditioned areas shall be calculated separately from the allowed Lighting Power allotment for unconditioned areas. Each allotment is applicable solely to the area to which it applies, and there shall be no trade-offs between conditioned and unconditioned area allotments.
2. allowed indoor lighting power allotment shall be calculated separately from the allowed Outdoor Lighting Power allotment. Each allotment is applicable solely to the area to which it applies, and there shall be no trade-offs between the separate Indoor and Outdoor allotments.
3. The allowed indoor lighting power allotment for general lighting shall be calculated as follows:
   A. The Complete Building Method, as described in Section 140.6(c)1, shall be used only for an entire building, except as permitted by Section 140.6(c)1. As described more fully in Section 140.6(c)1, and subject to the adjustments listed there, the Allowed Indoor Lighting Power allotment for general lighting for the entire building shall be calculated as follows:
      i. For a conditioned building, the product of the square feet of conditioned space of the building times the applicable allotment of watts per square foot described in TABLE 140.6-B.
      ii. For an unconditioned building, the product of the square foot of unconditioned space of the building times the applicable allotment of watts per square feet described in TABLE 140.6-B.
   B. The Area Category Method, as described in Section 140.6(c)2, shall be used either by itself for all areas in the building, or when some areas in the building use the Tailored Method described in Section 140.6(c)3. Under the Area Category Method (either by itself or in conjunction with the Tailored Method), as described more fully in Section 140.6(c)2, and subject to the adjustments listed there, the allowed Indoor Lighting Power allotment for general lighting shall be calculated for each area in the building as follows:
      i. For conditioned areas, by multiplying the conditioned square feet of the area times the applicable allotment of watts per square foot for the area shown in TABLE 140.6-C (or TABLE 140.6-D if the Tailored Method is used for that area).
      ii. For unconditioned areas, by multiplying the unconditioned square feet of the area times the applicable allotment of watts per square foot for the area shown in TABLE 140.6-C (or TABLE 140.6-D if the Tailored Method is used for that area).

      The allowed indoor lighting power allotment for general lighting for one area for which the Area Category Method was used may be increased up to the amount that the allowed indoor lighting power allotment for general lighting for another area using the Area Category Method or Tailored Method is decreased, except that such increases and decreases shall not be made between conditioned and unconditioned space.
   C. The Tailored Method, as described in Section 140.6(c)3, shall be used either by itself for all areas in the building, or when some areas in the building use the Area Category Method described in Section 140.6(c)2. Under the Tailored Method (either by itself or in conjunction with the Area Category Method) as described more fully in Section 140.6(c)3, and subject to the adjustments listed there, allowed Indoor Lighting Power allotment for general lighting shall be calculated for each area in the building as follows:
      i. For conditioned areas, by multiplying the conditioned square feet of the area times the applicable allotment of watts per square foot for the area shown in TABLE 140.6-D (or TABLE 140.6-C if the Area Category Method is used for that area);
      ii For unconditioned areas, by multiplying the unconditioned square feet of the area times the applicable allotment of watts per square foot for the area shown in TABLE 140.6-D (or TABLE 140.6-C if the Area Category Method is used for that area);

The allowed indoor lighting power allotment for general lighting for one area for which the Tailored Method was used may be increased up to the amount that the allowed indoor power lighting for general lighting for another area is decreased, but only if the Tailored Method or Area Category Method was used for the other area, except that such increases and decreases shall not be made between conditioned and unconditioned space.

D. If the Area Category Method is used for an area, the Tailored Method may not be used for that area. If the Tailored Method is used for an area, the Area Category Method may not be used for that area.

4. Allowed Indoor Lighting Power allotments for all lighting power allotments other than general lighting shall be restricted as follows:

A. When using the Area Category Method, allowed Indoor Lighting Power allotments for specialized task work; ~~ornamental;~~ precision commercial and industrial work; white board or chalk board; accent, display and feature; decorative; or Videoconferencing Studio; may not be increased as a result of, or otherwise traded off against, decreasing any other allotment; and

B. When using the Tailored Method, allowed indoor lighting power allotments for wall display; floor display and task; ~~ornamental~~decorative/special effect; or very valuable display case; may not be increased, or otherwise traded between any of the separate allotments.

(c) **Calculation of Allowed Indoor Lighting Power: Specific Methodologies.** The allowed indoor lighting power for each building type, or each primary function area shall be calculated using only one of the methods in Subsection 1, 2 or 3 below as applicable.

1. **Complete Building Method.** Requirements for using the Complete Building Method include all of the following:

A. The Complete Building Method shall be used only for building types, as defined in Section 100.1, that are specifically listed in TABLE 140.6-B. (For example, retail and wholesale stores, hotel/motel, and high-rise residential buildings shall not use this method.)

B. The Complete Building Method shall be used only on projects involving:

i. Entire buildings with one type of use occupancy; or

ii. Mixed occupancy buildings where one type of use makes up at least 90 percent of the entire building (in which case, when applying the Complete Building Method, it shall be assumed that the primary use is 100 percent of the building); or

iii. A tenant space where one type of use makes up at least 90 percent of the entire tenant space (in which case, when applying the Complete Building Method, it shall be assumed that the primary use is 100 percent of the tenant space).

C. The Complete Building Method shall be used only when the applicant is applying for a lighting permit and submits plans and specifications for the entire building or the entire tenant space.

D. Under the Complete Building Method, the allowed indoor lighting power allotment is the Lighting Power Density value times the floor area of the entire building.

E. For buildings including a parking garage plus another type of use listed in TABLE 140.6-B, the parking garage portion of the building and other type of use portion of the building shall each separately use the Complete Building Method.

2. **Area Category Method.** Requirements for using the Area Category Method include all of the following:

A. The Area Category Method shall be used only for primary function areas, as defined in Section 100.1, that are listed in TABLE 140.6-C. For primary function areas not listed, selection of a reasonably equivalent type shall be permitted.

B. Primary function areas in TABLE 140.6-C shall not apply to a complete building. Each primary function area shall be determined as a separate area.

C. For purposes of compliance with Section 140.6(c)2, an "area" shall be defined as all contiguous areas that accommodate or are associated with a single primary function area listed in TABLE 140.6-C.

D. Where areas are bounded or separated by interior partitions, the floor area occupied by those interior partitions may be included in a primary function area.

E. If at the time of permitting for a newly constructed building, a tenant is not identified for a multitenant area, a maximum of 0.4 watts per square foot shall be allowed for the lighting in each area in which a tenant has not been identified. The area shall be classified as unleased tenant area.

F. Under the Area Category Method, the allowed indoor lighting power for each primary function area is the Lighting Power Density value in TABLE 140.6-C times the square feet of the primary function area. The total allowed indoor lighting power density for the building is the sum of all allowed indoor lighting power densities for all areas in the building.

G. In addition to the allowed indoor lighting power calculated according to Sections 140.6(c)2A through F, the building may add additional lighting power allowances for qualifying lighting systems as specified in the Qualifying Lighting Systems column in TABLE 140.6-C under the following conditions:

i. Only primary function areas having a lighting system as specified in the Qualifying Lighting Systems column in TABLE 140.6-C and in accordance with the corresponding footnote of the TABLE shall qualify for the additional lighting power allowances; and

ii. The additional lighting power allowances shall be used only if the plans clearly identify all applicable task areas and the lighting equipment designed to illuminate these tasks; and

iii. Tasks that are performed less than two hours per day or poor quality tasks that can be improved are not eligible for the additional lighting power allowances; and

iv. The additional lighting power allowances shall not utilize any type of luminaires that are used for general lighting in the building; and

v. The additional lighting power allowances shall not be used when using the Complete Building Method, or when the Tailored Method is used for any area in the building; and

vi. The additional lighting power allowed is the smaller of:

a. the lighting power density listed in the “Allowed Additional Lighting LPD” column in TABLE 140.6-C, times the square feet of the primary function, or

b. the Adjusted Indoor Lighting Power of the applicable lighting; and

vii. In addition to ~~all other additional lighting power allowed under~~meeting Sections 140.6(c)2Gi through vi, ~~up to 1.0 watts per square foot of~~ additional lighting power for videoconferencing as specified in TABLE 140.6-C shall be allowed in a videoconferencing studio, as defined in Section 100.1, provided the following conditions are met:

a. A completed and signed Installation Certificate is prepared and submitted in accordance with Section 130.4(b), specifically detailing compliance with the applicable requirements of Section 140.6(c)2Gvii; and

b. The Videoconferencing Studio is a room with permanently installed videoconferencing cameras, audio equipment, and playback equipment for both audio-based and video-based two-way communication between local and remote sites; and

c. General lighting is switched in accordance with TABLE 130.1-A; and

d. Wall wash lighting is separately switched from the general lighting system; and

e. All of the lighting in the studio, including general lighting and additional lighting power allowed by Section 140.6(c)2Gvii is controlled by a multiscene programmable control system (also known as a scene preset control system).

3. **Tailored Method.** Requirements for using the Tailored Method include all of the following:

A. The Tailored Method shall be used only for primary function areas listed in TABLE 140.6-D, as defined in Section 100.1.

B. Allowed Indoor Lighting Power allotments for general lighting shall be determined according to Section 140.6(c)3F, as applicable.

C. For compliance with Section 140.6(c)3, an "area" shall be defined as all contiguous areas that accommodate or are associated with a single primary function area listed in TABLE 140.6-D.

D. Where areas are bounded or separated by interior partitions, the floor area occupied by those interior partitions may be included in a Primary Function Area.

E. In addition to the allowed indoor lighting power allotments for general lighting calculated according to Sections 140.6(c)3F, as applicable, the building may add additional lighting power allowances for wall display lighting, floor display lighting and task lighting, ~~ornamental~~decorative/special effects lighting, and very valuable display cases lighting according to Sections 140.6(c)3G through J.

F. Determine allowed indoor lighting power allotments for general lighting for primary function areas listed in TABLE 140.6-D as follows:

   i. Use the General Illumination Level (Lux) listed in Column 2 of Table 140.6-D to determine the Allowed General Lighting Power Density allotments for the area.

   ii. Determine the room cavity ratio (RCR) for the area. The RCR shall be calculated according to the applicable equation in TABLE 140.6-F.

   iii. Find the allowed General Lighting Power Density allotments in TABLE 140.6-G that is applicable to the General Illuminance Level (Lux) from Column 2 of Table 140.6-D (as described in Item i.) and the RCR determined in accordance with TABLE 140.6-F (as described in Item ii).

   iv. Determine the square feet of the area in accordance with Section 140.6(c)3C and D.

   v. Multiply the allowed Lighting Power Density allotment, as determined in accordance with Item iii by the square feet of each primary function area, as determined in accordance with Item iv. The product is the allowed indoor lighting power allotment for general lighting for the area.

G. Determine additional allowed power for wall display lighting according to column 3 of Table 140.6-D for each primary function area as follows:

   i. Floor displays shall not qualify for wall display allowances.

   ii. Qualifying wall lighting shall:

      a. Be mounted within 10 feet of the wall having the wall display. When track lighting is used for wall display, and where portions of that lighting track are more than 10 feet from the wall and other portions are within 10 feet of the wall, portions of track more than 10 feet from the wall shall not be used for the wall display allowance.

      b. Be a lighting system type appropriate for wall lighting. Lighting systems appropriate for wall lighting are lighting track adjacent to the wall, wall-washer luminaires, luminaires behind a wall valance or wall cove, or accent light. (Accent luminaires are adjustable or fixed luminaires with PAR, R, MR, AR, or luminaires providing directional display light.)

   iii. Additional allowed power for wall display lighting is available only for lighting that illuminates walls having wall displays. The length of display walls shall include the length of the perimeter walls, including but not limited to closable openings and permanent full height interior partitions. Permanent full height interior partitions are those that (I) extend from the floor to within two feet of the ceiling or are taller than ten feet and (II) are permanently anchored to the floor.

   iv. For wall display lighting where the bottom of the luminaire is greater than 10 feet 6 inches above the finished floor, the mounting height adjustment factor from Table 140.6-E can be used to adjust the installed luminaire wattage as specified in Section 140.6(a)4C.

v. The allowed power for wall display lighting shall be the smaller of:

a. the "wall display lighting power density" determined in accordance with TABLE 140.6-D, multiplied by the wall display lengths determined in accordance with Item iii; and

b. The Adjusted Indoor Lighting Power used for the wall display lighting systems.

vi. Lighting internal to display cases that are attached to a wall or directly adjacent to a wall are counted as wall display lighting as specified in Section 140.6(c)3G. All other lighting internal to display cases are counted as floor display lighting as specified in Section 140.6(c)3H, or as very valuable display case lighting as specified in Section 140.6(c)3J.

H. Determine additional allowed power for floor display lighting and task lighting as follows:

i. Displays that are installed against a wall shall not qualify for the floor display lighting power allowances.

ii. Lighting internal to display cases that are not attached to a wall and not directly adjacent to a wall shall be counted as floor display lighting in accordance with Section 140.6(c)3H; or very valuable display case lighting in accordance with Section 140.6(c)3J.

iii. Additional allowed power for floor display lighting, and additional allowed power for task lighting, may be used by qualifying floor display lighting systems, qualifying task lighting systems, or a combination of both. For floor areas qualifying for both floor display and task lighting power allowances, the additional allowed power shall be used only once for the same floor area, so that the allowance shall not be additive.

iv. Qualifying floor display lighting shall:

a. Be mounted no closer than 2 feet to a wall.

b. Consist of only (I) directional lamp types, such as PAR, R, MR, AR; or (II) luminaires providing directional display light.

c. If track lighting is used, shall be only track heads that are classified as direction lighting types.

v. Qualifying task lighting shall:

a. Be located immediately adjacent to and capable of illuminating the task for which it is installed.

b. Be of a type different from the general lighting system.

c. Be separately switched from the general lighting system.

vi. If there are illuminated floor displays, floor display lighting power shall be used only if allowed by column 4 of TABLE 140.6-D.

vii. The square footage of floor displays or the square footage of task areas shall be determined in accordance with Section 140.6(c)3C and D, except that any floor area designed to not have floor displays or tasks, such as floor areas designated as a path of egress, shall not be included for the floor display allowance.

viii. For floor display lighting where the bottom of the luminaire is greater than 10.6 feet above the finished floor, multiply the floor display installed watts by the appropriate mounting height adjustment factor from Table 140.6-E to calculate the Adjusted Indoor Lighting Power as specified in Section 140.6(a)4C.

ix. The allowed power for floor display lighting for each applicable area shall be the smaller of:

a. The allowed floor display and task lighting power determined in accordance with Section 140.6(c)3Hvi multiplied by the floor square footage determined in accordance with Section 140.6(c)3Hvii; and

b. The Adjusted Indoor Lighting Power used for the floor display lighting systems.

I. Determine additional allowed power for ~~ornamental~~decorative/special effects lighting as follows:

i. Qualifying ~~ornamental~~ decorative lighting includes luminaires such as chandeliers, sconces, lanterns, neon and cold cathode, light emitting diodes, theatrical projectors, moving lights and light color panels, when any of those lights are used in a decorative manner that does not serve as display lighting or general lighting.

ii. Additional lighting power for ~~ornamental~~decorative/special effects lighting shall be used only if allowed by Column 5 of TABLE 140.6-D.

iii. Additional lighting power for ~~ornamental~~decorative/special effects lighting shall be used only in areas having ~~ornamental~~decorative/special effects lighting. The square footage of the floor area shall be determined in accordance with Section 140.6(c)3C and D, and it shall not include floor areas not having ~~ornamental~~decorative/special effects lighting.

iv. The additional allowed power for ~~ornamental~~decorative/special effects lighting for each applicable area shall be the smaller of:

a. The product of the "allowed ~~ornamental~~decorative/special effects lighting power" determined in accordance with Section 140.6(c)~~3Kii~~3Iii, multiplied by the floor square footage determined in accordance with Section 140.6(c)~~3Kiii~~3Iiii; and

b. The Adjusted Indoor Lighting Power of allowed ~~ornamental~~decorative/special effects lighting.

J. Determine additional allowed power for very valuable display case lighting as follows:

i. Additional allowed power for very valuable display case lighting shall be available only for display cases in appropriate function areas in retail merchandise sales, museum and religious worship.

ii. To qualify for additional allowed power for very valuable display case lighting, a case shall contain jewelry, coins, fine china, fine crystal, precious stones, silver, small art objects and artifacts, and/or valuable collections the display of which involves customer inspection of very fine detail from outside of a locked case.

iii. Qualifying lighting includes internal display case lighting or external lighting employing highly directional luminaires specifically designed to illuminate the case or inspection area without spill light, and shall not be fluorescent lighting unless installed inside of a display case.

iv. If there is qualifying very valuable display case lighting, in accordance with Section 140.6(c)3Jii, the smallest of the following separate lighting power for display cases presenting very valuable display items is permitted:

a. The product of the area of the primary function and 0.~~55~~ 50 watt per square foot; or

b. The product of the area of the display case and ~~8~~ 7 watts per square foot; or

c. The Adjusted Indoor Lighting Power of lighting for very valuable displays.

~~(d) **Automatic Daylighting Controls in Secondary Daylit Zones.** All luminaires providing general lighting that is in, or partially in a Secondary Sidelit Daylit Zone, and that is not in a Primary Sidelit Daylit Zone shall:~~

~~1. Be controlled independently from all other luminaires by automatic daylighting controls that meet the applicable requirements of Section 110.9; and~~

~~2. Be controlled in accordance with the applicable requirements in Section 130.1(d); and~~

~~3. All Secondary Sidelit Daylit Zones shall be shown on the plans submitted to the enforcing agency.~~

~~**EXCEPTION 1 to Section 140.6(d):** Luminaires in Secondary Sidelit Daylit Zone(s) in an enclosed space in which the combined total general lighting power in Secondary Daylit Zone(s) is less than 120 watts, or where the combined total general lighting power in Primary and Secondary Daylit Zone(s) is less than 240 watts.~~

~~**EXCEPTION 2 to Section 140.6(d):** Luminaires in parking garages complying with Section 130.1(d)3.~~

~~**EXCEPTION 3 to Section 140.6(d):** Areas adjacent to vertical glazing below an overhang, where there is no vertical glazing above the overhang and where the ratio of the overhang projection to the overhang rise is greater than 1.5 for South, East and West orientations, or where the ratio of the overhang projection to the overhang rise is greater than 1 for North orientations.~~

~~**EXCEPTION 4 to Section 140.6(d):** Rooms that have a total glazing area of less than 24 square feet, or parking garage areas with a combined total of less than 36 square feet of glazing or opening.~~

~~**EXCEPTION 5 to Section 140.6(d):** Luminaires in sidelit daylit zones in retail merchandise sales and wholesale showroom areas.~~

TABLE 140.6-A ————LIGHTING POWER ADJUSTMENT FACTORS (PAF)

TYPE OF CONTROL	TYPE OF AREA		FACTOR
a. To qualify for any of the Power Adjustment Factors in this table, the installation shall comply with the applicable requirements in Section 140.6(a)2 b. Only one PAF may be used for each qualifying luminaire unless combined below. c. Lighting controls that are required for compliance with Part 6 shall not be eligible for a PAF			
1. Daylight Continuous Dimming plus OFF Control	Luminaires in skylit daylit zone or primary sidelit daylit zone or secondary sidelit daylit zone		0.10
2. Occupant Sensing Controls in ~~Large Open Plan~~ Offices Larger than 250 square feet	~~In open plan offices > 250 square feet:~~ One sensor controlling an area that is:	No larger than 125 square feet	~~0.40~~0.30
		From 126 to 250 square feet	~~0.30~~0.20
		~~From 251 to 500 square feet~~	~~0.20~~
3.Institutional Tuning	Luminaires in non-daylit areas. Luminaires that qualify for other PAFs in this table may also qualify for this tuning PAF.		0.10
	Luminaires in daylit areas. Luminaires that qualify for other PAFs in this table may also qualify for this tuning PAF.		0.05
4. Demand Responsive Control	~~All building types of 10,000 square feet or smaller.~~ General lighting luminaires not in the scope of Section 110.12(c). Luminaires that qualify for other PAFs in this table may also qualify for this demand responsive control PAF		0.05
5. Clerestory Fenestration	Luminaires in daylit areas adjacent to the clerestory. Luminaires that qualify for daylight dimming plus OFF control may also qualify for this PAF.		0.05
6. Horizontal Slats	Luminaires in daylit areas adjacent to vertical fenestration with interior or exterior horizontal slats. Luminaires that qualify for daylight dimming plus OFF control may also qualify for this PAF.		0.05
7.Light Shelves	Luminaires in daylit areas adjacent to clerestory fenestration with interior or exterior light shelves. This PAF may be combined with the PAF for clerestory fenestration. Luminaires that qualify for daylight dimming plus OFF control may also qualify for this PAF		0.10

TABLE 140.6-B COMPLETE BUILDING METHOD LIGHTING POWER DENSITY VALUES

TYPE OF BUILDING	ALLOWED LIGHTING POWER DENSITY (WATTS PER SQUARE FOOT)
Assembly Building	~~0.70~~0.65
Bank or Financial Institution Building	0.65
~~Industrial/Manufacturing Facility Building~~	~~0.60~~
Grocery Store Building	~~0.95~~0.90
Gymnasium Building	~~0.65~~0.60
Healthcare Facility	0.90
Industrial/Manufacturing Facility Building	0.60
Library Building	0.70
Motion Picture Theater Building	0.60
Museum Building	0.65
Office Building	~~0.65~~0.60
Parking Garage Building	0.13
Performing Arts Theater Building	0.75
Religious Facility Building	0.70
Restaurant Building	~~0.70~~0.65
Retail Store Building	0.90
School Building	~~0.65~~0.60
Sports Arena Building	0.75
~~Motion Picture Theater Building~~	~~0.70~~
~~Performing Arts Theater Building~~	~~0.80~~
All other~~s~~ buildings	0.40

TABLE 140.6-C AREA CATEGORY METHOD - LIGHTING POWER DENSITY VALUES (WATTS/FT²)

Primary Function Area		Allowed Lighting Power Density for General Lighting (W/ft²)	Additional Lighting Power[1]	
			Qualified Lighting Systems	Additional Allowance (W/ft², unless noted otherwise)
~~Auditorium Area~~		~~0.70~~	~~Ornamental~~	~~0.30~~
			~~Accent, display and feature[3]~~	~~0.20~~
~~Auto Repair / Maintenance Area~~		~~0.55~~	~~Detailed Task Work[7]~~	~~0.20~~
~~Audience Seating Area~~		~~0.60~~	~~Ornamental~~	~~0.30~~
~~Beauty Salon Area~~		~~0.80~~	~~Detailed Task Work[7]~~	~~0.20~~
			~~Ornamental~~	~~0.30~~
~~Civic Meeting Place Area~~		~~1.00~~	~~Ornamental~~	~~0.30~~
~~Classroom, Lecture, Training, Vocational Area~~		~~0.70~~	~~White or Chalk Board[1]~~	~~4.50 W/ft~~
Aging Eye/Low-vision[11]	Corridor Area	0.70	Decorative/Display	0.30
	Dining	0.80	Decorative/Display	0.30
			Tunable white or dim-to-warm[10]	0.10
	Lobby, Main Entry	0.85	Decorative/Display	0.30
			Transition Lighting OFF at night[12]	0.95
			Tunable white or dim-to-warm[10]	0.10
	Lounge/Waiting Area	0.80	Decorative/Display	0.30
			Tunable white or dim-to-warm[10]	0.10
	Multipurpose Room	0.85	Decorative/Display	0.30
			Tunable white or dim-to-warm[10]	0.10
	Religious Worship Area	1.00	Decorative/Display	0.30
			Tunable white or dim-to-warm[10]	0.10
	Restroom	1.00	Decorative/Display	0.20
	Stairwell	0.80	Decorative/Display	0.30
Audience Seating Area		0.50	Decorative/Display	0.25
Auditorium Area		0.70	Decorative/Display	0.45
Auto Repair / Maintenance Area		0.55	Detailed Task Work[7]	0.20
Barber, Beauty Salon, Spa Area		0.65	Detailed Task Work[7]	0.20
			Decorative/Display	0.25
Civic Meeting Place Area		0.90	Decorative/Display	0.25
Classroom, Lecture, Training, Vocational Area		0.60	White or Chalk Board[1]	7 W/ft
Concourse and Atria Area		0.60	Decorative/Display	0.25
Convention, Conference, Multipurpose and Meeting Area	~~Shipping & Handling~~	0.75~~0.60~~	Decorative/Display~~-~~	0.25~~-~~
~~Convention, Conference, Multipurpose and Meeting Area~~		~~0.85~~	~~Ornamental~~	~~0.30~~
Copy Room		0.50	-	-
Corridor Area		~~0.60~~0.40	Decorative/Display~~-~~	0.25~~-~~
Dining Area	Bar/Lounge and Fine Dining	~~0.55~~0.45	Decorative/Display ~~Ornamental~~	~~0.30~~0.35

	Cafeteria/Fast Food	~~0.40~~0.45		
	~~Family and Leisure~~	~~0.50~~		
	Family and Leisure	0.40	Decorative/Display	0.25
Electrical, Mechanical, Telephone Rooms		0.40	Detailed Task Work[7]	0.20
Exercise/Fitness Center and Gymnasium Area		0.50	-	-
Financial Transaction Area		0.70	Decorative/Display	0.25
~~Hotel Function Area~~		~~0.85~~	~~Ornamental~~	~~0.30~~
Healthcare Facility and Hospitals	Exam/Treatment Room	1.15	-	-
	Imaging Room	0.60	Decorative/Display	0.20
			Tunable white or dim-to-warm[10]	0.10
	Medical Supply Room	0.55	-	-
	Nursery	0.80	Tunable white or dim-to-warm[10]	0.10
	Nurse's Station	0.85	Tunable white or dim-to-warm[10]	0.10
			Detailed Task Work[7]	0.20
	Operating Room	1.90	-	-
	Patient Room	0.70	Decorative/Display	0.15
			Tunable white or dim-to-warm[10]	0.10
	Physical Therapy Room	0.75	Tunable white or dim-to-warm[10]	0.10
	Recovery Room	0.90	Tunable white or dim-to-warm[10]	0.10
Hotel Function Area		0.85	Decorative/Display	0.25
Kitchen/Food Preparation Area		0.95	-	-
Laboratory, Scientific		0.90	Specialized Task Work[8]	0.35
Laundry Area		0.45	-	-
Library	Reading Area	0.80	Decorative/Display	0.25
	Stacks Area	1.00	-	-
Lobby, Main Entry		0.70	Decorative/Display	0.35
Locker Room		0.45	-	-
Lounge, Breakroom, or Waiting Area		0.55	Decorative/Display	0.25
Manufacturing, Commercial & Industrial Work Area	Low Bay	0.60	Detailed Task Work[7]	0.20
	High Bay	0.65	Detailed Task Work[7]	0.20
	Precision	0.85	Precision Specialized Work[9]	0.70
Museum Area	Exhibition/Display	0.60	~~Accent, display and feature~~[3]Decorative/Display	~~0.50~~0.45
	Restoration Room	~~0.75~~0.70	Detailed Task Work[7]	~~0.20~~0.35
~~Financial Transaction Area~~		~~0.80~~	~~Ornamental~~	~~0.30~~
~~General/Commercial & Industrial Work Area~~	~~Low Bay~~	~~0.60~~	~~Detailed Task Work[7]~~	~~0.20~~
	~~High Bay~~	~~0.65~~	~~Detailed Task Work[7]~~	~~0.20~~
	~~Precision~~	~~0.85~~	~~Precision Specialized Work[9]~~	~~0.70~~
~~Library~~	~~Reading Area~~	~~0.80~~	~~Ornamental~~	~~0.30~~
	~~Stacks Area~~	~~1.10~~	~~-~~	~~-~~
~~Main Entry Lobby~~		~~0.85~~	~~Ornamental~~	~~0.30~~

~~Locker Room~~		~~0.45~~	~~-~~	~~-~~
~~Lounge, Breakroom, or Waiting Area~~		~~0.65~~	~~Ornamental~~	~~0.30~~
~~Concourse and Atria Area~~		~~0.90~~	~~Ornamental~~	~~0.30~~
Office Area	> 250 square feet	~~0.65~~0.60	Decorative/Display and Portable lighting for office areas[6]	0.20
	≤ 250 square feet	~~0.70~~0.65		
	~~Open plan office~~	~~0.60~~		
Parking Garage Area	Parking Zone and Ramps	0.10	First ATM or Ticket Machine	100 W
			Additional ATM or Ticket Machine	50 W each
	~~Dedicated Ramps~~	~~0.25~~	~~-~~	~~-~~
	Daylight Adaptation Zones[2]	~~0.50~~1.00	-	-

Pharmacy Area		~~1.10~~1.00	Specialized Task Work[8]	0.35
Retail Sales Area	Grocery Sales	~~1.05~~1.00	~~Accent, display and feature[3]~~	~~0.20~~
			Decorative/Display	~~0.15~~0.35
	Retail Merchandise Sales	~~1.00~~0.95	~~Accent, display and feature[3]~~	~~0.20~~
			Decorative/Display~~Decorative~~	~~0.15~~0.35
	Fitting Room	0.60	External Illuminated Mirror[5]	40 W/ea
			Internal Illuminated Mirror[5]	120 W/ea
Religious Worship Area		0.95	Decorative/Display	0.25
Restrooms		0.65	Decorative/Display	0.35
~~Theater Area~~	~~Motion picture~~	~~0.60~~	~~Ornamental~~	~~0.30~~
	~~Performance~~	~~1.00~~		
~~Kitchen/Food Preparation Area~~		~~0.95~~	~~-~~	~~-~~
~~Scientific Laboratory Area~~		~~1.00~~	~~Specialized Task Work[8]~~	~~0.35~~
~~Healthcare Facility and Hospitals~~	~~Exam/Treatment Room~~	~~1.15~~	~~-~~	~~-~~
	~~Imaging Room~~	~~1.00~~	~~-~~	~~-~~
	~~Medical Supply Room~~	~~0.55~~	~~-~~	~~-~~
	~~Nursery~~	~~0.95~~	~~Tunable white or dim-to-warm[10]~~	~~0.10~~
	~~Nurse's Station~~	~~0.75~~	~~Tunable white or dim-to-warm[10]~~	~~0.10~~
	~~Operating Room~~	~~1.90~~	~~-~~	~~-~~
	~~Patient Room~~	~~0.55~~	~~Decorative~~	~~0.15~~
			~~Tunable white or dim-to-warm[10]~~	~~0.10~~
	~~Physical Therapy Room~~	~~0.85~~	~~Tunable white or dim-to-warm[10]~~	~~0.10~~
	~~Recovery Room~~	~~0.90~~	~~Tunable white or dim-to-warm[10]~~	~~0.10~~
~~Laundry Area~~		~~0.45~~	~~-~~	~~-~~
~~Religious Worship Area~~		~~0.95~~	~~Ornamental~~	~~0.30~~
~~Restrooms~~		~~0.65~~	~~Accent, display and feature[3]~~	~~0.20~~
			~~Decorative[4]~~	~~0.15~~
Stairwell		0.60	Decorative/Display	0.35
Storage, Commercial/Industrial	Warehouse	0.40	-	-
	Shipping & Handling	0.60	-	-
~~Transportation Function~~	~~Baggage Area~~	~~0.40~~	~~-~~	~~-~~
	~~Ticketing Area~~	~~0.45~~	~~Accent, display and feature[3]~~	~~0.20~~
Sports Arena – Playing Area	Class I Facility[13]	2.25	-	-
	Class II Facility[13]	1.45	-	-
	Class III Facility[13]	1.10	-	-
	Class IV Facility[13]	0.75	-	-
Theater Area	Motion picture	0.50	Decorative/Display	0.25
	Performance	0.80		
Transportation Function	Baggage Area	0.40	-	-
	Ticketing Area	0.45	Decorative/Display	0.20
~~Stairwell~~		~~0.50~~	~~Accent, display and feature[3]~~	~~0.20~~
			~~Decorative[4]~~	~~0.15~~

Videoconferencing Studio	0.90	Videoconferencing[14]	1.00
All other	0.40	-	-

~~Aging Eye/Low-vision[11]~~	~~Main Entry Lobby~~	~~0.85~~	~~Ornamental~~	~~0.30~~
			~~Transition Lighting OFF at night[12]~~	~~0.95~~
	~~Stairwell~~	~~0.80~~	~~-~~	~~-~~
	~~Corridor Area~~	~~0.80~~	~~Decorative[4]~~	~~0.15~~
	~~Lounge/Waiting Area~~	~~0.75~~	~~Ornamental~~	~~0.30~~
	~~Multipurpose Room~~	~~0.95~~	~~Ornamental~~	~~0.30~~
	~~Religious Worship Area~~	~~1.00~~	~~Ornamental~~	~~0.30~~
	~~Dining~~	~~0.80~~	~~Ornamental~~	~~0.30~~
	~~Restroom~~	~~0.80~~	~~Accent, display and feature[3]~~	~~0.20~~

Footnotes for this table are listed below.

1. White board or chalk board. – Directional lighting dedicated to a white board or chalk board.

2. Daylight Adaptation Zones shall be no longer than 66 feet from the entrance to the parking garage.

3. ~~Accent, display and feature lighting – luminaires shall be adjustable or directional~~Reserved

4. ~~Decorative lighting – primary function shall be decorative and not to provide general lighting~~Reserved.

5. Illuminated mirrors. Lighting shall be dedicated to the mirror.

6. Portable lighting in office areas includes under shelf or furniture-mounted supplemental task lighting qualifies when controlled by a time clock or an occupancy sensor.

7. Detailed task work – Lighting provides high level of visual acuity required for activities with close attention to small elements and/or extreme close up work.

8. Specialized task work – Lighting provides for small-scale, cognitive or fast performance visual tasks; lighting required for operating specialized equipment associated with pharmaceutical/laboratorial activities.

9. Precision specialized work – Lighting for work performed within a commercial or industrial environment that entails working with low contrast, finely detailed, or fast moving objects.

10. Tunable white luminaires capable of color change greater than or equal to 2000K CCT, or dim-to-warm luminaires capable of color change greater than or equal to 500K CCT, connected to controls that allows color changing of the luminaires.

11. Aging Eye/Low-vision areas can be documented as being designed to comply with the light levels in ANSI/IES RP-28 and are or will be licensed by local or state authorities for either senior long-term care, adult day care, senior support, and/or people with special visual needs.

12. Transition lighting OFF at night. Lighting power controlled by astronomical time clock or other control to shut off lighting at night. Additional LPD only applies to area within 30 feet of an exit. Not applicable to lighting in daylit zones.

13. Class I Facility is used for competition play for 5000 or more spectators. Class II Facility is used for competition play for up to 5000 spectators. Class III Facility is used for competition play for up to 2000 spectators. Class IV Facility is normally used for recreational play and there is limited or no provision for spectators.

14. The additional videoconferencing lighting power shall be allowed provided the videoconferencing studio meets all the requirements of Section 140.6(c)2Gvii.

TABLE 140.6-D TAILORED METHOD LIGHTING POWER ALLOWANCES

1	2	3	4	5
Primary Function Area	**General Illumination Level (Lux)**	**Wall Display Lighting Power Density (W/ft)**	**Allowed Combined Floor Display Power and Task Lighting Power Density (W/ft²)**	**Allowed ~~Ornamental~~Decorative/ Special Effect Lighting Power Density (W/ft²)**
Auditorium Area	300	3.00	0.20	~~0.40~~0.35
Convention, Conference, Multipurpose, and Meeting Center Areas	300	2.00	~~0.35~~0.30	~~0.40~~0.35
Dining Areas	200	1.25	~~0.50~~0.45	~~0.40~~0.35
Exhibit, Museum Areas	150	~~11.50~~11.20	~~0.80~~0.70	~~0.40~~0.35
Hotel Area:				
Ballroom/Events	400	1.80	0.12	~~0.40~~0.35
Lobby	200	~~3.50~~3.40	0.20	~~0.40~~0.35
Lobby, Main entry ~~lobby~~	200	~~3.50~~3.40	0.20	~~0.40~~0.35
Religious Worship Area	300	1.30	0.40	~~0.40~~0.35
Retail Sales				
Grocery	600	~~6.80~~6.60	~~0.70~~0.60	~~0.40~~0.35
Merchandise Sales, and Showroom Areas	500	~~11.80~~11.50	~~0.80~~0.70	~~0.40~~0.35
Theater Area:				
Motion picture	200	2.00	0.20	~~0.40~~0.35
Performance Arts	200	~~7.50~~7.30	0.20	~~0.40~~0..35

TABLE 140.6-E TAILORED WALL AND FLOOR DISPLAY MOUNTING HEIGHT ADJUSTMENT FACTORS

Height in feet above finished floor and bottom of luminaire(s)	Floor Display or Wall Display Mounting Height Adjustment Factor
≤ 10’-6”	1.00
> 10’-6” to 14’-0”	0.85
>14’-0” to 18’-0”	0.75
> 18’-0”	0.70

TABLE 140.6-F ROOM CAVITY RATIO (RCR) EQUATIONS

Determine the Room Cavity Ratio for TABLE 140.6-G using one of the following equations.
Room cavity ratio for rectangular rooms $$RCR = \frac{5 \times H \times (L + W)}{L \times W}$$
Room cavity ratio for irregular-shaped rooms $$RCR = \frac{2.5 \times H \times P}{A}$$
Where: L =Length of room; W = Width of room; H =Vertical distance from the work plane to the centerline of the lighting fixture; P = Perimeter of room, and A = Area of room

TABLE 140.6-G TAILORED METHOD GENERAL LIGHTING POWER ALLOWED – BY ILLUMINANCE AND ROOM CAVITY RATIO

	General Lighting Power Density (W/ft²) for the following RCR values[b] ~~values[b]~~			
General Illuminance Level (lux)[a]	**RCR ≤ 2.0**	**RCR > 2.0 and ≤ 3.5**	**RCR > 3.5 and ≤ 7.0**	**RCR > 7.0**
150	~~0.40~~0.35	~~0.45~~0.40	~~0.60~~0.50	~~00.75~~0.65
200	~~0.45~~0.40	~~0.55~~0.50	~~0.75~~0.65	~~1.00~~0.85
300	~~0.65~~0.55	~~0.80~~0.70	~~1.00~~0.85	~~1.40~~1.20
400	~~0.75~~0.65	~~0.95~~0.80	~~1.25~~1.05	~~1.50~~1.25
500	~~0.90~~0.80	~~1.05~~0.90	~~1.45~~1.25	~~1.85~~1.55
600	~~1.08~~0.90	~~1.24~~1.05	~~1.64~~1.40	~~2.38~~2.00

[a] Illuminance values from Column 2 of TABLE 140.6-D.

[b] RCR values are calculated using applicable equations in TABLE 140.6-F.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 140.7 – PRESCRIPTIVE REQUIREMENTS FOR OUTDOOR LIGHTING

(a) An outdoor lighting installation complies with this section if it meets the requirements in Subsections (b) and (c), and the actual outdoor lighting power installed is no greater than the allowed outdoor lighting power calculated under Subsection (d). The allowed outdoor lighting shall be calculated according to Outdoor Lighting Zone in Title 24, Part 1, Section 10-114.

EXCEPTIONS to Section 140.7(a): When more than 50 percent of the light from a luminaire falls within one or more of the following applications, the lighting power for that luminaire shall be exempt from Section 140.7:

1. Temporary outdoor lighting.
2. Lighting required and regulated by the Federal Aviation Administration, and the Coast Guard.
3. Lighting for public streets, roadways, highways and traffic signage lighting, including lighting for driveway entrances occurring in the public right-of-way.
4. Lighting for sports and athletic fields, and children's playgrounds.
5. Lighting for industrial sites, including but not limited to, rail yards, maritime shipyards and docks, piers and marinas, chemical and petroleum processing plants, and aviation facilities.
6. Lighting of public monuments.
7. Lighting of signs complying with the requirements of Sections 130.3 and 140.8.
8. Lighting of tunnels, bridges, stairs, wheelchair elevator lifts for American with Disabilities Act (ADA) compliance, and ramps that are other than parking garage ramps.
9. Landscape lighting.
10. In theme parks: outdoor lighting only for themes and special effects.
11. Lighting for outdoor theatrical and other outdoor live performances, provided that these lighting systems are additions to area lighting systems and are controlled by a multiscene or theatrical cross-fade control station accessible only to authorized operators.
12. Outdoor lighting systems for qualified historic buildings, as defined in the California Historic Building Code (Title 24, Part 8), if they consist solely of historic lighting components or replicas of historic lighting components. If lighting systems for qualified historic buildings contain some historic lighting components or replicas of historic components, combined with other lighting components, only those historic or historic replica components are exempt. All other outdoor lighting systems for qualified historic buildings shall comply with Section 140.7.

(b) **Outdoor Lighting Power Trade-offs.** Outdoor lighting power trade-offs shall be determined as follows:

1. Allowed lighting power determined according to Section 140.7(d)1 for general hardscape lighting allowance may be traded to specific applications in Section 140.7(d)2, provided the hardscape area from which the lighting power is traded continues to be illuminated in accordance with Section 140.7(d)1A.
2. Allowed lighting power determined according to Section 140.7(d)2 for additional lighting power allowances for specific applications shall not be traded between specific applications, or to hardscape lighting in Section 140.7(d)1.
3. Trading of lighting power allowances between outdoor and indoor areas shall not be permitted.

(c) **Calculation of Actual Lighting Power.** The wattage of outdoor luminaires shall be determined in accordance with Section 130.0(c).

(d) **Calculation of Allowed Lighting Power.** The allowed lighting power shall be the combined total of the sum of the general hardscape lighting allowance determined in accordance with Section 140.7(d)1, and the sum of the additional lighting power allowance for specific applications determined in accordance with Section 140.7(d)2.

1. **General Hardscape Lighting Allowance.** Determine the general hardscape lighting power allowances as follows:

   A. The general hardscape area of a site shall include parking lot(s), roadway(s), driveway(s), sidewalk(s), walkway(s), bikeway(s), plaza(s), bridge(s), tunnel(s), and other improved area(s) that are illuminated. In plan view of the site, determine the illuminated hardscape area, which is defined as any hardscape area that is within a square pattern around each luminaire or pole that is ten times the luminaire mounting height with the luminaire in the middle of the pattern, less any areas that are within a building, beyond the hardscape area, beyond property lines or obstructed by a structure. The illuminated hardscape area shall include portions of planters and landscaped areas that are within the lighting application and are less than or equal to 10 feet wide in the short dimensions and are enclosed by hardscape or other improvement on at least three sides. Multiply the illuminated hardscape area by the Area Wattage Allowance (AWA) from Table 140.7-A for the appropriate Lighting Zone.

   B. Determine the perimeter length of the general hardscape area. The total perimeter shall not include portions of hardscape that are not illuminated according to Section 140.7(d)1A. Multiply the hardscape perimeter by the Linear Wattage Allowance (LWA) for hardscape from Table 140.7-A for the appropriate lighting zone. The perimeter length for hardscape around landscaped areas and permanent planters shall be determined as follows:

      i. Landscaped areas completely enclosed within the hardscape area, and which have a width or length less than 10 feet wide, shall not be added to the hardscape perimeter length.

      ii. Landscaped areas completely enclosed within the hardscape area, and which width or length is a minimum of 10 feet wide, the perimeter of the landscaped areas or permanent planter shall be added to the hardscape perimeter length.

      iii. Landscaped edges that are not abutting the hardscape shall not be added to the hardscape perimeter length.

   C. Determine the Initial Wattage Allowance (IWA) for general hardscape lighting from Table 140.7-A for the appropriate lighting zone. The hardscape area shall be permitted one IWA per site.

   D. The general hardscape lighting allowance shall be the sum of the allowed watts determined from (A), (B) and (C) above.

2. **Additional Lighting Power Allowance for Specific Applications.** Additional lighting power for specific applications shall be the smaller of the additional lighting allowances for specific applications determined in accordance with TABLE 140.7-B for the appropriate lighting zone, or the actual installed lighting power meeting the requirements for the allowance.

TABLE 140.7-A GENERAL HARDSCAPE LIGHTING POWER ALLOWANCE

Type of Power Allowance	Lighting Zone 0[3]	Lighting Zone 1[3]	Lighting Zone 2[3]		Lighting Zone 3[3]		Lighting Zone 4[3]
	~~Asphalt/Concrete~~	~~Asphalt/Concrete~~	~~Asphalt~~	~~Concrete[2]~~	~~Asphalt~~	~~Concrete[2]~~	~~Asphalt/Concrete~~
Area Wattage Allowance (AWA)	No allowance[1]	~~0.018~~0.016 W/ft²	~~0.023~~0.019 W/ft²	~~0.025 W/ft²~~	~~0.025~~0.021 W/ft²	~~0.03 W/ft²~~	~~0.03~~0.024 W/ft²
Linear Wattage Allowance (LWA)		~~0.15~~0.13 W/lf	~~0.17~~0.15 W/lf	~~0.4 W/lf~~	~~0.25~~0.20 W/lf	~~0.4 W/lf~~	~~0.35~~0.29 W/lf
Initial Wattage Allowance (IWA)		~~180~~ 150 W	~~250~~ 200 W	~~250 W~~	~~350~~ 250 W	~~350 W~~	~~400~~ 320 W

[1]Continuous lighting is explicitly prohibited in Lighting Zone 0. A single luminaire of 15 Watts or less may be installed at an entrance to a parking area, trail head, fee payment kiosk, outhouse, or toilet facility, as required to provide safe navigation of the site infrastructure. Luminaires installed shall meet the maximum zonal lumen limits as specified in Section 130.2(b).

[2]~~Where greater than 50% of the paved surface of a parking lot is finished with concrete. This does not extend beyond the parking lot, and does not include any other General Hardscape areas~~RESERVED.

[3]Narrow band spectrum light sources with a dominant peak wavelength greater than 580 nm – as mandated by local, state, or federal agencies to minimize the impact on local, active professional astronomy or nocturnal habitat of specific local fauna – shall be allowed a 2.0 lighting power allowance multiplier.

TABLE 140.7-B ADDITIONAL LIGHTING POWER ALLOWANCE FOR SPECIFIC APPLICATIONS
All area and distance measurements in plan view unless otherwise noted.

Lighting Application	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
WATTAGE ALLOWANCE PER APPLICATION. Use all that apply as appropriate.					
Building Entrances or Exits. Allowance per door. Luminaires qualifying for this allowance shall be within 20 feet of the door.	Not applicable	9 watts	15 watts	19 watts	21 watts
Primary Entrances to Senior Care Facilities, Police Stations, Healthcare Facilities, Fire Stations, and Emergency Vehicle Facilities. Allowance per primary entrance(s) only. Primary entrances shall provide access for the general public and shall not be used exclusively for staff or service personnel. This allowance shall be in addition to the building entrance or exit allowance above. Luminaires qualifying for this allowance shall be within 100 feet of the primary entrance.	Not applicable	20 watts	40 watts	57 watts	60 watts
Drive Up Windows. Allowance per customer service location. Luminaires qualifying for this allowance shall be within 2 mounting heights of the sill of the window.	Not applicable	16 watts	30 watts	50 watts	75 watts
Vehicle Service Station Uncovered Fuel Dispenser. Allowance per fueling dispenser. Luminaires qualifying for this allowance shall be within 2 mounting heights of the dispenser.	Not applicable	55 watts	77 watts	81 watts	135 watts
ATM Machine Lighting. Allowance per ATM machine. Luminaires qualifying for this allowance shall be within 50 feet of the dispenser.	Not applicable	100 watts for first ATM machine, 35 watts for each additional ATM machine.			
WATTAGE ALLOWANCE PER UNIT LENGTH (w/linear ft). May be used for one or two frontage side(s) per site.					
Outdoor Sales Frontage. Allowance for frontage immediately adjacent to the principal viewing location(s) and unobstructed for its viewing length. A corner sales lot may include two adjacent sides provided that a different principal viewing location exists for each side. Luminaires qualifying for this allowance shall be located between the principal viewing location and the frontage outdoor sales area.	Not applicable	No Allowance	11 W/linear ft	19 W/linear ft	25 W/linear ft
WATTAGE ALLOWANCE PER HARDSCAPE AREA (W/ft²). May be used for any illuminated hardscape area on the site.					
Hardscape Ornamental Lighting. Allowance for the total site illuminated hardscape area. Luminaires qualifying for this allowance shall be rated for ~~100~~ 50 watts or less as determined in accordance with Section 130.0(~~d~~c), and shall be post-top luminaires, lanterns, pendant luminaires, or chandeliers.	Not applicable	No Allowance	0.007 W/ft²	0.013 W/ft²	0.019 W/ft²
WATTAGE ALLOWANCE PER SPECIFIC AREA (W/ft²). Use as appropriate provided that none of the following specific applications shall be used for the same area.					
Building Facades. Only areas of building façade that are illuminated shall qualify for this allowance. Luminaires qualifying for this allowance shall be aimed at the façade and shall be capable of illuminating it without obstruction or interference by permanent building features or other objects.	Not applicable	No Allowance	0.100 W/ft²	0.170 W/ft²	0.225 W/ft²
Outdoor Sales Lots. Allowance for uncovered sales lots used exclusively for the display of vehicles or other merchandise for sale. Driveways, parking lots or other non sales areas shall be considered hardscape areas even if these areas are completely surrounded by sales lot on all sides. Luminaires qualifying for this allowance shall be within 5 mounting heights of the sales lot area.	Not applicable	0.060 W/ft²	0.210 W/ft²	0.280 W/ft²	0.485 W/ft²
Vehicle Service Station Hardscape. Allowance for the total illuminated hardscape area less area of buildings, under canopies, off property, or obstructed by signs or structures. Luminaires qualifying for this allowance shall be illuminating the hardscape area and shall not be within a building, below a canopy, beyond property lines, or obstructed by a sign or other structure.	Not applicable	0.006 W/ft²	0.068 W/ft²	0.138 W/ft²	0.200 W/ft²
Vehicle Service Station Canopies. Allowance for the total area within the drip line of the canopy. Luminaires qualifying for this allowance shall be located under the canopy.	Not applicable	0.220 W/ft²	0.430 W/ft²	0.580 W/ft²	1.010 W/ft²

Sales Canopies. Allowance for the total area within the drip line of the canopy. Luminaires qualifying for this allowance shall be located under the canopy.	Not applicable	No Allowance	0.470 W/ft²	0.622 W/ft²	0.740 W/ft²
Non-sales Canopies and Tunnels. Allowance for the total area within the drip line of the canopy or inside the tunnel. Luminaires qualifying for this allowance shall be located under the canopy or tunnel.	Not applicable	0.057 W/ft²	0.137 W/ft²	0.270 W/ft²	0.370 W/ft²
Guard Stations. Allowance up to 1,000 square feet per vehicle lane. Guard stations provide access to secure areas controlled by security personnel who stop and may inspect vehicles and vehicle occupants, including identification, documentation, vehicle license plates, and vehicle contents. Qualifying luminaires shall be within 2 mounting heights of a vehicle lane or the guardhouse.	Not applicable	0.081 W/ft²	0.176 W/ft²	0.325 W/ft²	0.425 W/ft²
Student Pick-up/Drop-off zone. Allowance for the area of the student pick-up/drop-off zone, with or without canopy, for preschool through 12th grade school campuses. A student pick-up/drop off zone is a curbside, controlled traffic area on a school campus where students are picked-up and dropped off from vehicles. The allowed area shall be the smaller of the actual width or 25 feet, times the smaller of the actual length or 250 feet. Qualifying luminaires shall be within 2 mounting heights of the student pick-up/drop-off zone.	Not applicable	No Allowance	0.056 W/ft²	0.200 W/ft²	No Allowance
Outdoor Dining. Allowance for the total illuminated hardscape of outdoor dining. Outdoor dining areas are hardscape areas used to serve and consume food and beverages. Qualifying luminaires shall be within 2 mounting heights of the hardscape area of outdoor dining.	Not applicable	0.004 W/ft²	0.030 W/ft²	0.050 W/ft²	0.075 W/ft²
Special Security Lighting for Retail Parking and Pedestrian Hardscape. This additional allowance is for illuminated retail parking and pedestrian hardscape identified as having special security needs. This allowance shall be in addition to the building entrance or exit allowance.	Not applicable	0.004 W/ft²	0.005 W/ft²	0.010 W/ft²	No Allowance
Security Cameras. This additional allowance is for illuminated general hardscape area. This allowance shall apply when a security camera is installed within 2 mounting heights of the general hardscape area and mounted more than 10 feet away from a building.	Not applicable	No Allowance	0.018 W/ft²	0.018 W/ft²	0.018 W/ft²

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 140.8 – PRESCRIPTIVE REQUIREMENTS FOR SIGNS

This section applies to all internally illuminated and externally illuminated signs, unfiltered light emitting diodes (LEDs), and unfiltered neon, both indoor and outdoor. Each sign shall comply with either Subsection (a) or (b), as applicable.

(a) **Maximum Allowed Lighting Power.**

1. For internally illuminated signs, the maximum allowed lighting power shall not exceed the product of the illuminated sign area and 12 watts per square foot. For double-faced signs, only the area of a single face shall be used to determine the allowed lighting power.
2. For externally illuminated signs, the maximum allowed lighting power shall not exceed the product of the illuminated sign area and 2.3 watts per square foot. Only areas of an externally lighted sign that are illuminated without obstruction or interference, by one or more luminaires, shall be used.
3. Lighting for unfiltered light emitting diodes (LEDs) and unfiltered neon shall comply with Section 140.8(b).

(b) **Alternate Lighting Sources.** The sign shall ~~comply if it is~~be equipped ~~only~~ with one or more of the following light sources:

1. High pressure sodium lamps; or
2. Metal halide lamps that are:
   A. Pulse start or ceramic served by a ballast that has a minimum efficiency of 88 percent or greater; or
   B. Pulse start that are 320 watts or smaller, are not 250 watt or 175 watt lamps, and are served by a ballast that has a minimum efficiency of 80 percent.

   Ballast efficiency is the reference lamp power divided by the ballast input power when tested according to ANSI C82.6-2015.
3. Neon or cold cathode lamps with transformer or power supply efficiency greater than or equal to the following:
   A. A minimum efficiency of 75 percent when the transformer or power supply rated output current is less than 50 mA; or
   B. A minimum efficiency of 68 percent when the transformer or power supply rated output current is 50 mA or greater.

   The ratio of the output wattage to the input wattage is at 100 percent tubing load.
4. Fluorescent lighting systems meeting one of the following requirements:
   A. Use only lamps with a minimum color rendering index (CRI) of 80; or
   B. Use only electronic ballasts with a fundamental output frequency not less than 20 kHz.
5. Light emitting diodes (LEDs) with a power supply having an efficiency of 80 percent or greater; or

   EXCEPTION to Section 140.8(b)5: Single voltage external power supplies that are designed to convert 120 volt AC input into lower voltage DC or AC output, and have a nameplate output power less than or equal to 250 watts, shall comply with the applicable requirements of the Appliance Efficiency Regulations (Title 20).
6. Compact fluorescent lamps that do not contain a medium screw base socket (E24/E26).

EXCEPTION 1 to Section 140.8: Unfiltered incandescent lamps that are not part of an electronic message center (EMC), an internally illuminated sign or an externally illuminated sign.

EXCEPTION 2 to Section 140.8: Exit signs. Exit signs shall meet the requirements of the Appliance Efficiency Regulations.

EXCEPTION 3 to Section 140.8: Traffic Signs. Traffic signs shall meet the requirements of the Appliance Efficiency Regulations.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 140.9 – PRESCRIPTIVE REQUIREMENTS FOR COVERED PROCESSES

(a) **Prescriptive Requirements for Computer Rooms.** Space conditioning systems serving a computer room with a power density greater than 20 W/ft^2 shall comply with this section ~~by being designed with and having constructed and installed a cooling system that meets the requirements of Subsections 1 through 6~~.

1. **Economizers.** Each individual cooling system primarily serving computer rooms shall include either:

   A. An integrated air economizer capable of providing 100 percent of the expected system cooling load ~~as calculated in accordance with a method approved by the Commission,~~ at 65°F to 80.6°F supply air temperature at outside air temperatures of ~~55~~65°F dry-bulb and below or ~~/~~50°F wet-bulb and below, and be equipped with a fault detection and diagnostic system as specified by Section 120.2(i); or

   B. An integrated water economizer capable of providing 100 percent of the expected system cooling load ~~as calculated in accordance with a method approved by the Commission,~~at 65°F to 80.6°F supply air temperature at outside air temperatures of ~~40~~50°F dry-bulb and below or ~~/34~~5°F wet-bulb and below.

   C. An integrated pumped refrigerant economizer capable of providing 100 percent of the expected system cooling load at 65°F to 80.6°F supply air temperature at outside air temperatures of 50°F dry-bulb and below.

   EXCEPTION 1 to Section 140.9(a)1: Individual computer rooms with an ITE design load under 5 tons (18 kW) in a building that does not have any economizers.

   ~~**EXCEPTION 2 to Section 140.9(a)1:** New cooling systems serving an existing computer room in an existing building up to a total of 50 tons of new cooling equipment per building.~~

   ~~**EXCEPTION 3 to Section 140.9(a)1:** New cooling systems serving a new computer room in an existing building up to a total of 20 tons of new cooling equipment per building.~~

   EXCEPTION 4~~2~~ to Section 140.9(a)1: A computer room with an ITE design load less than 20 tons (70 kW) may be served by a second fan system without an economizer if it is also served by a fan system with an economizer that also serves other spaces within the building, provided that all of the following are met:

      ~~i. The economizer system is sized to meet the design cooling load of the computer room when the other spaces within the building are at 50 percent of their design load; and~~

      ~~i~~i. The economizer system has the ability to serve only the computer rooms connected to it, e.g., shut off flow to other spaces within the building when unoccupied; and

      ii. The economizer system has the ability to deliver either the computer room ITE design load or the maximum of 5 tons and at least 25 percent of the economizer system capacity at design conditions.

      ~~iii. The noneconomizer system does not operate when the outside air drybulb temperatures is below 60°F and, the cooling load of other spaces within the building served by the economizer system is less than 50 percent of design load.~~

   EXCEPTION 3 to Section 140.9(a)1: If the local water authority does not allow cooling towers the cooling system shall include either:

      i. An integrated air economizer capable of providing 100 percent of the expected system cooling load at 65°F to 80.6°F supply air temperature at outside air temperatures of 55°F dry-bulb and below or 50°F wet-bulb and below, and be equipped with a fault detection and diagnostic system as specified by section 120.2(j); or

      ii. An integrated water economizer capable of providing 100 percent of the expected system cooling load at 65°F to 80.6°F supply air temperature at outside air temperatures of 40°F dry-bulb and below or 35°F wet-bulb and below; or

iii. An integrated refrigerant economizer capable of providing 100 percent of the expected system cooling load at 65°F to 80.6°F supply air temperature supply air temperature at outside air temperatures of 40°F dry-bulb and below or 35°F wet-bulb and below.

~~2. **Reheat.** Each computer room zone shall have controls that prevent reheating, recooling and simultaneous provisions of heating and cooling to the same zone, such as mixing or simultaneous supply of air that has been previously mechanically heated and air that has been previously cooled, either by cooling equipment or by economizer systems.~~

~~3. **Humidification.** Nonadiabatic humidification (e.g. steam, infrared) is prohibited. Only adiabatic humidification (e.g. direct evaporative, ultrasonic) is permitted.~~

4~~2~~. **Power Consumption of Fans.** The total fan power at design conditions of each fan system shall not exceed 27 W/kBtu·h of net sensible cooling capacity.

~~5. **Fan Control.** Each unitary air conditioner with mechanical cooling capacity exceeding 60,000 Btu/hr and each chilled water fan system shall be designed to vary the airflow rate as a function of actual load and shall have controls and/or devices (such as two-speed or variable speed control) that will result in fan motor demand of no more than 50 percent of design wattage at 66 percent of design fan speed.~~

3~~6~~. Air **Containment.** Computer rooms with air-cooled computers in racks and with a ITE design load exceeding ~~175~~10 kW~~/~~ (2.8 tons) per room shall include air barriers such that there is no significant air path for computer discharge air to recirculate back to computer inlets without passing through a cooling system.

EXCEPTION 1 to Section 140.9(a)3~~6~~: Expansions of existing computer rooms.

EXCEPTION 2 to Section 140.9(a)3~~6~~: Computer racks with a design load less than 1 kW (0.28 tons) per ~~/~~rack.

EXCEPTION 3 to Section 140.9(a)3~~6~~: Equivalent energy performance based on computational fluid dynamics or other analysis.

4. **Alternating Current-Output Uninterruptible Power Supplies (UPS).** Alternating current-output UPS systems serving a computer room shall meet or exceed minimum average efficiencies in Table 140.9-A. Minimum average efficiency for alternating current-output UPS shall meet or exceed calculation and testing requirements identified in ENERGY STAR Program Requirements for Uninterruptible Power Supplies (UPSs) – Eligibility Criteria Version 2.0.

Where:

P is the rated output power in watts (W).

E_{MOD} is an allowance of 0.004 for modular UPSs applicable in commercial 1,500-10,000 W range.

ln is the natural logarithm.

The requirement shall be rounded to the third decimal place for certification and reporting.

EXCEPTION to 140.9(a)4: Alternating current-output UPS that utilizes standardized NEMA 1-15P or NEMA 5-15P input plug, as specified in ANSI/NEMA WD-6-2016.

Table 140.9-A Alternating Current-Output Uninterruptible Power Supply Minimum Average Efficiency

	Voltage and Frequency Dependent	Voltage Independent	Voltage and Frequency Independent
P<350 W	$5.71 \times 10^{-5} \times P + 0.962$	$5.71 \times 10^{-5} \times P + 0.964$	$0.011 \times \ln(P) + 0.824$
350 W<P<1,500 W	0.982	0.984	
1,500 W<P<10,000 W	$0.981 - E_{MOD}$	$0.980 - E_{MOD}$	$0.0145 \times \ln(P) + 0.800 - E_{MOD}$
P>10,000 W	0.970	0.940	$0.0058 \times \ln(P) + 0.886$

~~**EXCEPTION to Section 140.9(a):** Computer rooms located in healthcare facilities.~~

(b) **Prescriptive Requirements for Commercial Kitchens.**

1. **Kitchen exhaust systems.**

   A. Replacement air introduced directly into the hood cavity of kitchen exhaust hoods shall not exceed 10 percent of the hood exhaust airflow rate.

   B. For kitchen/dining facilities having total Type I and Type II kitchen hood exhaust airflow rates greater than 5,000 cfm, each Type I hood shall have an exhaust rate that complies with TABLE 140.9-~~A~~B. If a single hood or hood section is installed over appliances with different duty ratings, then the maximum allowable flow rate for the hood or hood section shall not exceed the TABLE 140.9-A values for the highest appliance duty rating under the hood or hood section. Refer to ASHRAE Standard 154-2011 for definitions of hood type, appliance duty and next exhaust flow rate.

   EXCEPTION 1 to Section 140.9(b)1B: 75 percent of the total Type I and Type II exhaust replacement air is transfer air that would otherwise be exhausted.

   EXCEPTION 2 to Section 140.9(b)1B: Existing hoods not being replaced as part of an addition or alteration.

TABLE 140.9-~~A~~B MAXIMUM NET EXHAUST FLOW RATE, CFM PER LINEAR FOOT OF HOOD LENGTH

Type of Hood	Light Duty Equipment	Medium Duty Equipment	Heavy Duty Equipment	Extra Heavy Duty Equipment
Wall-mounted Canopy	140	210	280	385
Single Island	280	350	420	490
Double Island	175	210	280	385
Eyebrow	175	175	Not Allowed	Not Allowed
Backshelf / Passover	210	210	280	Not Allowed

2. **Kitchen ventilation.**

   A. Mechanically cooled or heated makeup air delivered to any space with a kitchen hood shall not exceed the greater of:

      i. The supply flow required to meet the space heating and cooling load; or

      ii. The hood exhaust flow minus the available transfer air from adjacent spaces. Available transfer air is that portion of outdoor ventilation air serving adjacent spaces not required to satisfy other exhaust needs, such as restrooms, not required to maintain pressurization of adjacent spaces, and that would otherwise be relieved from the building.

   EXCEPTION to Section 140.9(b)2A: Existing kitchen makeup air units not being replaced as part of an addition or alteration.

   B. A kitchen/dining facility having a total Type I and Type II kitchen hood exhaust airflow rate greater than 5,000 cfm shall have one of the following:

      i. At least 50 percent of all replacement air is transfer air that would otherwise be exhausted; or

      ii. Demand ventilation system(s) on at least 75 percent of the exhaust air. Such systems shall:

         a. Include controls necessary to modulate airflow in response to appliance operation and to maintain full capture and containment of smoke, effluent and combustion products during cooking and idle; and

         b. Include failsafe controls that result in full flow upon cooking sensor failure; and

         c. Include an adjustable timed override to allow occupants the ability to temporarily override the system to full flow; and

d. Be capable of reducing exhaust and replacement air system airflow rates to the larger of:

(i) 50 percent of the total design exhaust and replacement air system airflow rates; or

(ii) The ventilation rate required as specified by Section 120.1(c)3.

iii. Listed energy recovery devices with a sensible heat recovery effectiveness of not less than 40 percent on at least 50 percent of the total exhaust airflow; or

iv. A minimum of 75 percent of makeup air volume that is:

a. Unheated or heated to no more than 60°F; and

b. Uncooled or cooled without the use of mechanical cooling.

EXCEPTION to Section 140.9(b)2B: Existing hoods not being replaced as part of an addition or alteration.

3. **Kitchen Exhaust System Acceptance.** Before an occupancy permit is granted for a commercial kitchen subject to Section 140.9(b), the following equipment and systems shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified by the Reference Nonresidential Appendix NA7. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in NA7.11.

EXCEPTION to Section 140.9(b): healthcare facilities.

(c) **Prescriptive Requirements for Laboratory and Factory Exhaust Systems.**

1. **Airflow Reduction Requirements.** For buildings with laboratory exhaust systems where the minimum circulation rate to comply with code or accreditation standards is 10 ACH or less, the design exhaust airflow shall be capable of reducing zone exhaust and makeup airflow rates to the regulated minimum circulation rate, or the minimum required to maintain pressurization requirements, whichever is larger. Variable exhaust and makeup airflow shall be coordinated to achieve the required space pressurization at varied levels of demand and fan system capacity.

EXCEPTION 1 to Section 140.9(c)1: Laboratory exhaust systems serving zones where constant volume is required by the Authority Having Jurisdiction, facility Environmental Health & Safety department or other applicable code.

EXCEPTION 2 to Section 140.9(c)1: New zones on an existing constant volume exhaust system.

2. **Exhaust System Transfer Air.** Conditioned supply air delivered to any space with mechanical exhaust shall comply with the requirements of Section 140.4(o).

3. **Fan System Power Consumption.** All newly installed fan exhaust systems serving a laboratory or factory greater than 10,000 ~~CFM~~cfm, shall meet subsection A and either B, C, or D:

A. System shall meet all discharge requirements in ANSI Z9.5-2012.

B. The exhaust fan system power shall not exceed 0.85 watts per cfm of exhaust air for systems with air filtration, scrubbers, or other air treatment devices. For all other exhaust fan systems the system power shall not exceed 0.65 watts per cfm of exhaust air. Exhaust fan system power equals the sum of the power of all fans in the exhaust system that are required to operate at normal occupied design conditions in order to exhaust air from the conditioned space to the outdoors. Exhaust air does not include entrained air, but does include all exhaust air from fume hoods, hazardous exhaust flows, or other manifolded exhaust streams.

EXCEPTION to Section 140.9(c)3B: Laboratory exhaust systems where applicable local, state, or federal exhaust treatment requirements specify installation of air treatment devices that cause more than 1 in. of water pressure drop.

C. The volume flow rate at the stack shall vary based on the measured 5-minute averaged wind speed and wind direction obtained from a calibrated local anemometer.

i. At least one sonic anemometer or at least two anemometers of other types shall be installed in a location that experiences similar wind conditions to the free stream environment above the exhaust stacks and be at a height that is outside the wake region of nearby structures.

ii. Look-up tables shall be used to define the required exhaust volume flow rate, as a function of at least eight wind speeds and eight wind directions, to maintain downwind concentrations below health and odor limits, as defined by the 2018 American Conference of Governmental Industrial Hygienists Threshold Limit Values and Biological Exposure Indices, for all ~~detectable~~ contaminants, or as defined by applicable local, state, or federal jurisdictions, if more stringent.

iii. Wind speed/direction sensors shall be certified by the manufacturer to be accurate within plus or minus 40 fpm (0.2 m/s) and 5.0° when measured at sea level and 25°C, factory calibrated, and certified by the manufacturer to require calibration no more frequently than once every 5 years.

iv. Upon detection of anemometer and/or signal failure, the system shall reset the exhaust volume flow rate to the value needed to maintain downwind concentrations below health and odor limits for all ~~detectable~~ contaminants at worst-case wind conditions and shall report the fault to an Energy Management Control System or fault management application which automatically provides notification of the fault to a remote system provider. The ECMS or fault management system shall log the error and the time when it occurred. The system shall have logic that automatically checks for anemometer failure by the following means.

a. If any anemometer has not been calibrated within the manufacturer's recommended calibration period, the ~~sensor~~ anemometer has failed.

b. During unoccupied periods the system compares the readings of all anemometers. If any anemometer is more than 30% above or below the average reading for a period of 4 hours, the anemometer has failed.

c. Wind speed and wind direction readings shall be sampled at least 10 times per minute. If the difference between the maximum and minimum readings from the average of either the wind direction or the wind speed over a one minute period is less than 10% of the average value, the measurements shall be considered a signal failure.

d. Other error signals sent by the anemometer

v. Before an occupancy permit is granted for a laboratory or process facility subject to Section 140.9(c)3C, the applicable equipment and systems shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified by the Reference Nonresidential Appendix NA7.16. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in NA7.16.

D. The volume flow rate at the stack shall vary based on the measured contaminant concentration in the exhaust plenum from a calibrated contaminant sensor installed within each exhaust plenum.

i. A contaminant-event threshold shall be established based on maintaining downwind concentrations below health and odor limits for all ~~detectable~~ chemicals at worst-case wind conditions, as defined by the 2018 American Conference of Governmental Industrial Hygienists Threshold Limit Values and Biological Exposure Indices, or as defined by applicable local, state, or federal jurisdictions, if more stringent.

ii. At least two contaminant concentration sensors shall be Photo Ionization Detectors (PID) certified by the manufacturer to be accurate within plus or minus 5% when measured at sea level and 25°C, factory calibrated, and certified by the manufacturer to require calibration no more frequently than once every 6 months.

iii. Upon detection of sensor and/or signal failure, the system shall reset the exhaust volume flow rate to the value needed to maintain downwind concentrations below health and odor limits for all ~~detectable~~ contaminants at worst-case wind conditions and shall report the fault to an Energy Management Control System or fault management application which automatically provides

notification of the fault to a remote system provider. The system shall have logic that automatically checks for sensor failure by the following means.

a. If any sensor has not been calibrated within the manufacturer's recommended calibration period, the sensor has failed.

b. During unoccupied periods the system compares the readings of all sensors. If any sensor is more than 30% above or below the average reading for a period of 4 hours, the sensor has failed.

iv. Before an occupancy permit is granted for a laboratory or process facility subject to Section 140.9(c)3D, the applicable equipment and systems shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified by the Reference Nonresidential Appendix NA7.16. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in NA7.16.

4. **Fume Hood Automatic Sash Closure.** Variable air volume laboratory fume hoods with vertical only sashes located in fume hood intensive laboratories, as described in Table 140.9-~~B~~C, shall have an automatic sash closure system that complies with the following:

A. The automatic sash closure system shall be capable of the following:

i. The automatic sash closure system shall have a dedicated zone presence sensor that detects people in the area near the fume hood sash and automatically closes the sash within 5 minutes of no detection.

ii. The automatic sash closure system shall have controls to prevent the sash from automatic closing when a force of no more than 10 lbs is detected.

iii. The automatic sash closure system shall be equipped with an obstruction sensor that prevents the sash from automatic closing with obstructions in the sash opening. Obstruction sensor shall be capable of sensing transparent materials such as laboratory glassware.

iv. The automatic sash closure system shall be capable of being configured in a manual open mode where once the sash is closed, detection of people in the area near the fume hood by the zone presence sensor does not open the fume hood sash.

B. Fume Hood Automatic Sash Closure Acceptance. Before an occupancy permit is granted for the fume hoods subject to 140.9(c)4, the equipment and systems shall be certified as meeting the Acceptance Requirement for Code Compliance as specified by the Reference Nonresidential Appendix NA7. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in NA7.17.

Table 140.9-~~B~~ C Fume Hood Intensive Laboratories

Occupied Minimum Ventilation ACH	≤ 4	> 4 and ≤ 6	> 6 and ≤ 8	> 8 and ≤ 10	> 10 and ≤ 12	> 12 and ≤ 14
Hood Density (linear feet per 10,000 ft^3 of laboratory space	≥ 6	≥ 8	≥ 10	≥ 12	≥ 14	≥ 16

EXCEPTION to Section 140.9(c): healthcare facilities.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, Public Resources Code.

SECTION 140.10 – PRESCRIPTIVE REQUIREMENTS FOR PHOTOVOLTAIC AND BATTERY STORAGE SYSTEMS

(a) Photovoltaic Requirements. All newly constructed building types specified in Table 140.10-A, or mixed occupancy buildings where one or more of these building types constitute at least 80 percent of the floor area of the building, shall have a photovoltaic (PV) system meeting the minimum qualification requirements of Reference Joint Appendix JA11. The PV size in kW_{dc} shall be not less than the smaller of the PV system size determined by Equation 140.10-A, or the total of all available Solar Access Roof Areas (SARA) multiplied by 14 W/ft^2.

1. SARA include the area of the building's roof space capable of structurally supporting a PV system, and the area of all roof space on covered parking areas, carports, and all other newly constructed structures on the site that are compatible with supporting a PV system per Title 24, Part 2, Section 1511.2.
2. SARA does NOT include:
   A. Any area that has less than 70 percent annual solar access. Annual solar access is determined by dividing the total annual solar insolation (accounting for shading obstructions) by the total annual solar insolation if the same areas were unshaded by those obstructions. For all roofs, all obstructions including those that are external to the building, and obstructions that are part of the building design and elevation features may be considered for the annual solar access calculations.
   B. Occupied roofs as specified by CBC Section 503.1.4.
   C. Roof space that is otherwise not available due to compliance with other building code requirements if confirmed by the Executive Director.

EQUATION 140.10-A PHOTOVOLTAIC DIRECT CURRENT SIZE

$kW_{PVdc} = (CFA \times A)/1000$

WHERE:

kW_{PVdc} = Size of the PV system in kW

CFA = Conditioned floor area in square feet

A = PV capacity factor specified in Table 140.10-A for the building type

Where the building includes more than one of the space types listed in Table 140.10-A, the total PV system capacity for the building shall be determined by applying Equation 140.10-A to each of the listed space types and summing the capacities determined for each.

EXCEPTION 1 to Section 140.10(a). No PV system is required where the total of all available SARA is less than three percent of the conditioned floor area.

EXCEPTION 2 to Section 140.10(a). No PV system is required where the required PV system size is less than 4 kW_{dc}.

EXCEPTION 3 to Section 140.10(a). No PV system is required if the SARA contains less than 80 contiguous square feet.

EXCEPTION 4 to Section 140.10(a). Buildings with enforcement-authority-approved roof designs, where the enforcement authority determines it is not possible for the PV system, including panels, modules, components, supports, and attachments to the roof structure, to meet ASCE 7-16, Chapter 7, Snow Loads.

EXCEPTION 5 to Section 140.10(a). Multi-tenant buildings in areas where a load serving entity does not provide either a Virtual Net Metering (VNEM) or community solar program.

(b) Battery Storage System Requirements. All buildings that are required by Section 140.10(a) to have a PV system shall also have a battery storage system meeting the minimum qualification requirements of Reference Joint Appendix JA12. The rated energy capacity and the rated power capacity shall be not less than the values determined by Equation 140.10-B and Equation 140.10-C. Where the building includes more than one of the space types listed in Table 140.10-B, the total battery system capacity for the building shall be determined by applying Equations 140.10-B and 140.10-C to each of the listed space types and summing the capacities determined for each space type and equation.

EXCEPTION 1 to Section 140.10(b). No battery storage system is required if the installed PV system size is less than 15 percent of the size determined by Equation 140.10-A.

EXCEPTION 2 to Section 140.10(b). No battery storage system is required in buildings with battery storage system requirements with less than 10 kWh rated capacity.

EXCEPTION 3 to Section 140.10(b). For multi-tenant buildings, the energy capacity and power capacity of the battery storage system shall be based on the tenant spaces with more than 5,000 square feet of conditioned floor area. For single-tenant buildings with less than 5,000 square feet of conditioned floor area, no battery storage system is required.

EXCEPTION 4 to Section 140.10(b). In climate zone 1, no battery storage system is required for offices, schools, and warehouses.

EQUATION 140.10-B - BATTERY STORAGE RATED ENERGY CAPACITY

$kWh_{batt} = kW_{PVdc} \times B / D^{0.5}$

WHERE:

kWh_{batt} = Rated Useable Energy Capacity of the battery storage system in kWh

kW_{PVdc} = PV system capacity required by section 140.10(a) in kWdc

B = Battery energy capacity factor specified in Table 140.10-B for the building type

D = Rated single charge-discharge cycle AC to AC (round-trip) efficiency of the battery storage system

EQUATION 140.10-C - BATTERY STORAGE RATED POWER CAPACITY

$kW_{batt} = kW_{PVdc} \times C$

WHERE:

kW_{batt} = Power capacity of the battery storage system in kWdc

kW_{PVdc} = PV system capacity required by section 140.10(a) in kWdc

C = Battery power capacity factor specified in Table 140.10-B for the building type

Table 140.10-A – PV Capacity Factors

	Factor A – Minimum PV Capacity (W/ft² of conditioned floor area)		
Climate Zone	**1, 3, 5, 16**	**2, 4, 6-14**	**15**
Grocery	2.62	2.91	3.53
Highrise Multifamily	1.82	2.21	2.77
Office, Financial Institutions, Unleased Tenant Space	2.59	3.13	3.80
Retail	2.62	2.91	3.53
School	1.27	1.63	2.46
Warehouse	0.39	0.44	0.58
Auditorium, Convention Center, Hotel/Motel, Library, Medical Office Building/Clinic, Restaurant, Theater	0.39	0.44	0.58

Table 140.10-B – Battery Storage Capacity Factors

	Factor B – Energy Capacity	Factor C – Power Capacity
Storage to PV Ratio	**Wh/W**	**W/W**
Grocery	1.03	0.26
Highrise Multifamily	1.03	0.26
Office, Financial Institutions, Unleased Tenant Space	1.68	0.42
Retail	1.03	0.26
School	1.87	0.46
Warehouse	0.93	0.23
Auditorium, Convention Center, Hotel/Motel, Library, Medical Office Building/Clinic, Restaurant, Theater	0.93	0.23

NOTE~~1~~: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, Public Resources Code.

SUBCHAPTER 6
NONRESIDENTIAL, ~~HIGH-RISE RESIDENTIAL,~~ AND HOTEL/MOTEL OCCUPANCIES—ADDITIONS, ALTERATIONS, AND REPAIRS

SECTION 141.0 – ADDITIONS, ALTERATIONS, AND REPAIRS TO EXISTING NONRESIDENTIAL, ~~HIGH-RISE RESIDENTIAL,~~ AND HOTEL/MOTEL BUILDINGS, TO EXISTING OUTDOOR LIGHTING, AND TO INTERNALLY AND EXTERNALLY ILLUMINATED SIGNS

Additions, alterations, and repairs to existing nonresidential, ~~high-rise residential,~~ and hotel/motel buildings, existing outdoor lighting for these occupancies, and internally and externally illuminated signs, shall meet the requirements specified in Sections 100.0 through 110.10, and 120.0 through 130.5 that are applicable to the building project, and either the performance compliance approach (energy budgets) in Section 141.0(a)2 (for additions) or 141.0(b)3 (for alterations), or the prescriptive compliance approach in Section 141.0(a)1 (for additions) or 141.0(b)2 (for alterations), for the Climate Zone in which the building is located. Climate zones are shown in FIGURE 100.1-A.

Covered process requirements for additions, alterations and repairs to existing nonresidential, ~~high-rise residential,~~ and hotel/motel buildings are specified in Section 141.1.

EXCEPTION to Section 141.0: Alterations to healthcare facilities are not required to comply with this Section.

NOTE<u>S</u>:

<u>1.</u> <u>For alterations that change the occupancy classification of the building, the requirements specified in Section 141.0(b) apply to the occupancy after the alterations.</u>

<u>**2.** Relocation or moving of a relocatable public school building is not, by itself, considered an alteration for the purposes of Title 24, Part 6.</u>

(a) **Additions.** Additions shall meet either Item 1 or 2 below.

1. **Prescriptive approach.** The envelope and lighting of the addition; any newly installed space-conditioning system, electrical power distribution system, or water-heating system; any addition to an outdoor lighting system; and any new sign installed in conjunction with an indoor or outdoor addition shall meet the applicable requirements of Sections 110.0 through 120.7, 120.9 through 130.5, and 140.2 through 140.9.
2. **Performance approach.**
   A. The envelope and indoor lighting in the conditioned space of the addition, and any newly installed space-conditioning system, electrical power distribution system, or water-heating system, shall meet the applicable requirements of Sections 110.0 through 120.7, 120.9 through 130.5; and
   B. Either:
      i. The addition alone shall comply with Section 140.1; or
      ii. Existing plus addition plus alteration. The standard design for existing plus addition, plus alteration energy use is the combination of the existing building's unaltered components to remain, existing building altered components that are the more efficient, in TDV energy, of either the existing conditions, or the requirements of Section 141.0(b)2, plus the proposed addition's energy use meeting the requirements of Section 140.1. The proposed design energy use is the

combination of the existing building's unaltered components to remain and the altered component's energy features, plus the proposed energy features of the addition.

EXCEPTION 1 to Section 141.0(a): When heating, cooling, or service water heating to an addition are provided by expanding existing systems, the existing systems and equipment need not comply with Sections 110.0 through 120.9, or Sections 140.4 through 140.5.

EXCEPTION 2 to Section 141.0(a): Where an existing system with electric reheat is expanded by adding variable air volume (VAV) boxes to serve an addition, total electric reheat capacity may be expanded so that the total capacity does not exceed 150 percent of the existing installed electric heating capacity in any one permit, and the system need not comply with Section 140.4(g). Additional electric reheat capacity in excess of 150 percent of the existing installed electric heating capacity may be added subject to the requirements of Section 140.4(g).

EXCEPTION 3 to Section 141.0(a): Duct Sealing. When ducts are extended from an existing duct system to serve the addition, the existing duct system and the extended ducts shall meet the applicable requirements specified in Section 141.0(b)2D.

EXCEPTION 4 to Section 141.0(a): Additions that increase the area of the roof by 2,000 square feet or less are exempt from the requirements of Section 110.10.

EXCEPTION 5 to Section 141.0(a): A gas hot water boiler system with a total system input of at least 1 MMBtu/h but no more than 10 MMBtu/h added to an existing building is exempt from the requirements of 140.4(k)8.

EXCEPTION 6 to Section 141.0(a): A gas service water heating with a total system input of at least 1 MMBtu/h added to an existing building is exempt from the requirements of 140.5(c).

(b) **Alterations.** Alterations to components of existing nonresidential, ~~high-rise residential,~~ hotel/motel, or relocatable public school buildings, including alterations made in conjunction with a change in building occupancy to a nonresidential, high-rise residential, or hotel/motel occupancy shall meet item 1, and either Item 2 or 3 below:

1. **Mandatory Requirements**. Altered components in a nonresidential~~, high-rise residential,~~ or hotel/motel building shall meet the minimum requirements in this Section.

   A. **Roof/Ceiling Insulation.** The opaque portions of the roof/ceiling that separate conditioned spaces from unconditioned spaces or ambient air shall meet the requirements of Section 141.0(b)2Bii~~i~~.

   B. **Wall Insulation.** For the altered opaque portion of walls separating conditioned spaces from unconditioned spaces or ambient air shall meet the applicable requirements of Items 1 through 4 below:

      1. **Metal Building.** A minimum of R-13 insulation between framing members, or the area-weighted average U-factor of the wall assembly shall not exceed U-0.113.

      2. **Metal Framed.** A minimum of R-13 insulation between framing members, or the area-weighted average U-factor of the wall assembly shall not exceed U-0.217.

      3. **Wood Framed and Others.** A minimum of R-11 insulation between framing members, or the area-weighted average U-factor of the wall assembly shall not exceed U-0.110.

      4. **Spandrel Panels and Glass Curtain Walls.** A minimum of R-4, or the area-weighted average U-factor of the wall assembly shall not exceed U-0.280.

      EXCEPTION to Section 141.0(b)1B: Light and heavy mass walls.

   C. **Floor Insulation.** For the altered portion of raised floors that separate conditioned spaces from unconditioned spaces or ambient air shall meet the applicable requirements of Items 1 through 3 below:

1. **Raised Framed Floors.** A minimum of R-11 insulation between framing members, or the area-weighted average U-factor of the floor assembly shall not exceed the U-factor of U-0.071.

2. **Raised Mass Floors in ~~High-rise Residential and~~ Hotel/Motel Guest Rooms.** A minimum of R-6 insulation, or the area-weighted average U-factor of the floor assembly shall not exceed the U-factor of U-0.111.

3. **Raised Mass Floors in Other Occupancies.** No minimum U-factor requirement.

D. Fan Energy Index: New fan systems serving an existing building shall meet the requirements of Section 120.10.

2. **Prescriptive approach.** The altered components of the envelope, or space conditioning, lighting, electrical power distribution and water heating systems, and any newly installed equipment serving the alteration, shall meet the applicable requirements of Sections 110.0 through 110.9, Sections 120.0 through 120.6, and Sections 120.9 through 130.5.

EXCEPTION to Section 141.0(b)2: The requirements of Section 120.2(i) shall not apply to alterations of space-conditioning systems or components.

A. Fenestration alterations other than repair and those subject to Section 141.0(b)2 shall meet the requirements below:

i. Vertical fenestration alterations shall meet the requirements in Table 141.0-A.

ii. Added vertical fenestration shall meet the requirements of TABLE 140.3-B, C, or D.

iii. All altered or newly installed skylights shall meet the requirements of TABLE 140.3-B, C or D.

EXCEPTION 1 to Section 141.0(b)2Ai: In an alteration, where 150 square feet or less of the entire building's vertical fenestration is replaced, RSHGC and VT requirements of TABLE 141.0-A shall not apply.

EXCEPTION 2 to Section 141.0(b)2Aii: In an alteration, where 50 square feet or less of vertical fenestration is added, RSHGC and VT requirements of TABLE 140.3-B, C or D shall not apply.

EXCEPTION 3 to Section 141.0(b)2Aiii: In an alteration, where 50 square feet or less of skylight is added, SHGC and VT requirements of TABLE 140.3-B, C or D shall not apply.

NOTE: Glass replaced in an existing sash and frame or sashes replaced in an existing frame are considered repairs. In these cases, Section 141.0(c) requires that the replacement be at least equivalent to the original in performance.

Table 141.0-A Altered Vertical Fenestration Maximum U-Factor and Maximum RSHGC

Climate Zone	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
U-factor	0.47	0.47	0.58	0.47	0.58	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
RSHGC	0.41	0.31	0.41	0.31	0.41	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.41
VT	See TABLE 140.3-B, C, and D for all Climate Zones															

B. Existing roofs of a nonresidential or hotel/motel building being replaced, recovered or recoated, ~~of nonresidential, high-rise residential and hotels/motels~~as defined in Section 100.1(b) and Title 24, Part 2, Chapter 2, shall meet the requirements of Section 110.8(i). Roofs with more than 50 percent of the roof area or more than 2,000 square feet of roof, whichever is less, is being altered the requirements of i ~~through~~ and ii~~i~~ below apply:

i. Roofing Products~~. Nonresidential buildings~~ shall comply with requirements in Section 140.3(a)1A:

~~a. Low-sloped roofs in Climate Zones 1 through 16 shall have a minimum aged solar reflectance of 0.63 and a minimum thermal emittance of 0.75, or a minimum SRI of 75.~~

EXCEPTION 1 to Section 141.0(b)2Bi~~a~~: An aged solar reflectance less than 0.63 is allowed for low-sloped roofs provided the maximum roof/ceiling U-factor in TABLE 141.0-B is not exceeded.

~~b. Steep-sloped roofs in Climate Zones 1 through 16 shall have a minimum aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16.~~

~~ii. Roofing Products. High-rise residential buildings and hotels and motels:~~

~~a. Low-sloped roofs in Climate Zones 10, 11, 13, 14 and 15 shall have a minimum aged solar reflectance of 0.55 and a minimum thermal emittance of 0.75, or a minimum SRI of 64.~~

~~b. Steep-sloped roofs Climate Zones 2 through 15 shall have a minimum aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16.~~

EXCEPTION ~~1~~2 to Sections 141.0(b)2Bi ~~and ii~~: Roof area covered by building integrated photovoltaic panels and building integrated solar thermal panels are not required to meet the minimum requirements for solar reflectance, thermal emittance, or SRI.

EXCEPTION ~~2~~3 to Sections 141.0(b)2Bi ~~and ii~~: Roof constructions with a weight of at least 25 lb/ft² are not required to meet the minimum requirements for solar reflectance, thermal emittance, or SRI.

Table 141.0-B Roof/Ceiling Insulation Tradeoff for Low-Sloped Aged Solar Reflectance

Aged Solar Reflectance	Climate Zones ~~1, 3-9~~6, 7, & 8 U-factor	All Other Climate Zones ~~2, 10-16~~ U-factor
0.62- 0.60	~~0.075~~0.043	~~0.052~~0.035
0.59-0.55	~~0.066~~0.041	~~0.048~~0.034
0.54-0.50	~~0.060~~0.038	~~0.044~~0.031
0.49-0.45	~~0.055~~0.034	~~0.041~~0.029
0.44-0.40	~~0.051~~0.032	~~0.039~~0.028
0.39-0.35	~~0.047~~0.029	~~0.037~~0.026
0.34-0.30	~~0.044~~0.028	~~0.035~~0.025
0.29-0.25	~~0.042~~0.026	~~0.034~~0.024

ii~~i~~. ~~For nonresidential buildings, high-rise residential buildings and hotels/motels, when low-sloped roofs are exposed to the roof deck or to the roof recover boards, and meets Section 141.0(b)2Bia or iia, the exposed area shall be insulated to the levels specified in TABLE 141.0-C.~~**Roof/ceiling insulation.** For low-sloped roofs, the area of the roof recover or roof replacement shall be insulated to the level specified in Table 141.0-C. The area of the roof recoat is not required to be insulated.

~~**EXCEPTION to Section 141.0(b)2Biii:**~~

~~a. Existing roofs that are insulated with at least R-7 insulation or that has a U-factor lower than 0.089 are not required to meet the R-value requirement of TABLE 141.0-C.~~

~~b. If mechanical equipment is located on the roof and will not be disconnected and lifted as part of the roof replacement, insulation added may be limited to the maximum insulation thickness that will allow a height of 8 inches (203 mm) from the roof membrane surface to the top of the base flashing.~~

~~c. If adding the required insulation will reduce the base flashing height to less than 8 inches (203 mm) at penthouse or parapet walls, the insulation added may be limited to the maximum insulation thickness that will allow a height of 8 inches (203 mm) from the roof membrane surface to the top of the base flashing, provided that the conditions in Subsections i through iv apply:~~

~~I. The penthouse or parapet walls are finished with an exterior cladding material other than the roofing covering membrane material; and~~

~~II. The penthouse or parapet walls have exterior cladding material that must be removed to install the new roof covering membrane to maintain a base flashing height of 8 inches (203 mm); and~~

~~III. For nonresidential buildings, the ratio of the replaced roof area to the linear dimension of affected penthouse or parapet walls shall be less than 25 square feet per linear foot for Climate Zones 2, and 10 through 16, and less than 100 square feet per linear foot for Climate Zones 1, and 3 through 9; and~~

~~IV. For high-rise residential buildings, hotels or motels, the ratio of the replaced roof area to the linear dimension of affected penthouse or parapet walls shall be less than 25 square feet per linear foot for all Climate Zones.~~

~~d. Tapered insulation may be used which has a thermal resistance less than that prescribed in TABLE 141.0-C at the drains and other low points, provided that the thickness of insulation is increased at the high points of the roof so that the average thermal resistance equals or exceeds the value that is specified in TABLE 141.0-C.~~

EXCEPTION 1 to Section 141.0(b)2Bii: Roof Recovers. Roof recovers with new R-10 insulation added above deck do not need to be insulated to the level specified in Table 141.0-C.

EXCEPTION 2 to Section 141.0(b)2Bii: Roof replacements. When existing mechanical equipment located on the roof will not be disconnected and lifted, insulation added is the greater of R-10 or the maximum installed thickness that will allow the distance between the height of the roof membrane surface to the top of the base flashing to remain in accordance with the manufacturer's instructions.

EXCEPTION 3 to Section 141.0(b)2Bii: Drains. At the drains and other low points, tapered insulation with a thermal resistance less than that prescribed in Table 141.0-C may be used, provided that insulation thickness is increased at the high points of the roof so that the average thermal resistance equals or exceeds the value specified in Table 141.0-C.

TABLE 141.0-C INSULATION REQUIREMENTS FOR ROOF ALTERATIONS

	~~Nonresidential~~		~~High-Rise Residential and Guest Rooms of Hotel/Motel Buildings~~	
~~Climate Zone~~	~~Continuous Insulation R-value~~	~~U-factor~~	~~Continuous Insulation R-value~~	~~U-factor~~
~~1~~	~~R-8~~	~~0.082~~	~~R-14~~	~~0.055~~
~~2~~	~~R-14~~	~~0.055~~	~~R-14~~	~~0.055~~
~~3-9~~	~~R-8~~	~~0.082~~	~~R-14~~	~~0.055~~
~~10-16~~	~~R-14~~	~~0.055~~	~~R-14~~	~~0.055~~

Climate Zone	Continuous Insulation R-value	U-factor
1-5, 9-16	R-23	0.037, with at least R-10 above deck
6-8	R-17	0.047, with at least R-10 above deck

C. **New or Replacement Space-Conditioning Systems or Components** other than new or replacement space-conditioning system ducts shall meet the requirements of Section 140.4 applicable to the systems or components being altered. Additional Fan Power Allowances are available when determining the Fan Power Budget (Fan kW_{budget}) as specified in Table 141.0-D. These values can be added to the Fan Power Allowance values in Tables 140.4-A and Table 140.4-B. ~~For compliance with Section 140.4(c)1, additional fan power adjustment credits are available as specified in Table 141.0-D.~~

~~*Table 141.0-D Fan Power Limitation Pressure Drop Adjustment*~~

~~Device~~	~~Adjustment Credits~~
~~Particulate Filtration Credit: MERV 9 through 12~~	~~0.5 in. of water~~
~~Particulate Filtration Credit: MERV 13 through 15~~	~~0.9 in. of water~~

TABLE 141.0-D: ADDITIONAL FAN POWER ALLOWANCES

Airflow	Multi-Zone VAV Systems[1] ≤5,000 cfm	Multi-Zone VAV Systems[1] >5,000 and ≤10,000 cfm	Multi-Zone VAV Systems[1] >10,000 cfm	All Other Fan Systems ≤5,000 cfm	All Other Fan Systems >5,000 and ≤10,000 cfm	All Other Fan Systems >10,000 cfm
Supply Fan System Additional Allowance	0.135	0.114	0.105	0.139	0.12	0.107
Exhaust/ Relief/ Return/ Transfer Fan System Additional Allowance	0.07	0.061	0.054	0.07	0.062	0.055

Footnotes to Table 141.0-D:

1. See FAN SYSTEM, MULTI-ZONE VARIABLE AIR VOLUME (VAV) for the definition of a Multi-Zone VAV System.

EXCEPTION 1 to Section 141.0(b)2C: Section 140.4(a)2 shall not apply to new or replacement space conditioning systems or components. ~~Subsection (b)2C does not apply to replacements of equivalent or lower capacity electric resistance space heaters for high rise residential apartment units.~~

EXCEPTION 2 to Section 141.0(b)2C: Subsection (b)2C does not apply to replacement of electric reheat of equivalent or lower capacity electric resistance space heaters, when natural gas is not available.

EXCEPTION 3 to Section 141.0(b)2C: Section 140.4(n) is not applicable to new or replacement space conditioning systems.

EXCEPTION 4 to Section 141.0(b)2C: Section 140.4(e) is applicable to systems, other than single package air-cooled commercial unitary air conditioners and heat pumps, with cooling capacity less than 54,000 Btu/h.

EXCEPTION 5 to Section 141.0(b)2C: A new or replacement gas hot water boiler system with a total system input of at least 1 MMBtu/h but no more than 10 MMBtu/h need not comply with the requirements of 140.4(k)8.

D. **Altered Duct Systems.** ~~When n~~New or replacement space-conditioning system ducts ~~are~~ installed to serve an existing building~~, the new ducts~~ shall meet the requirements of Section 120.4~~. If the space conditioning system meets the criteria of Section 140.4(l)1, the duct system shall be sealed as confirmed through field verification and diagnostic testing in accordance with the procedures for duct sealing of an existing duct system as specified in Reference Nonresidential Appendix NA2, to meet one of the following requirements:~~ (a) through (f) and meet i or ii below:

~~i. If the new ducts form an entirely new or replacement duct system directly connected to the air handler, the measured duct leakage shall be equal to, or less than 6 percent of the system air handler airflow as confirmed by field verification and diagnostic testing utilizing the procedures in Reference Nonresidential Appendix Section NA2.1.4.2.1.~~

i. Entirely new or complete replacement duct systems installed as part of an alteration shall be leakage tested in accordance with Section 120.4(g). An ~~E~~entirely new or complete replacement duct systems installed as part of an alteration shall be constructed of at least 75 percent new duct material, and up to 25 percent may consist of reused parts from the building's existing duct system, including registers, grilles, boots, air handlers, coils, plenums, and ducts, if the reused parts are accessible and can be sealed to prevent leakage.

ii. If the new ducts are an extension of an existing duct system~~,~~ and the combined new and existing duct system meets the criteria in Subsections 1, 2, 3, and 4 below, the duct system shall be sealed to a leakage rate not to exceed 15 percent of the nominal air handler airflow rate as confirmed through HERS field verification and diagnostic testing, in accordance with the applicable procedures in Reference Nonresidential Appendices NA1 and NA2:

1. The duct system does not serve a healthcare facility;
2. The duct system provides conditioned air to an occupiable space for a constant volume, single zone, space-conditioning system;
3. The space conditioning system serves less than 5,000 square feet of conditioned floor area; and
4. The combined surface area of the ducts located outdoors or in unconditioned space is more than 25 percent of the total surface area of the entire duct system.

~~shall meet one of the following requirements:~~

~~a. The measured duct leakage shall be equal to or less than 15 percent of the system air handler airflow as confirmed by field verification and diagnostic testing utilizing the procedures in Reference Nonresidential Appendix Section NA2.1.4.2.1; or~~

~~b. If it is not possible to comply with the duct leakage criterion in Subsection 141.0(b)2Diia, then all accessible leaks shall be sealed and verified through a visual inspection and a smoke test performed by a certified HERS Rater utilizing the methods specified in Reference Nonresidential Appendix NA2.1.4.2.2.~~

EXCEPTION 1 to Section 141.0(b)2Dii: When it is not possible to achieve the duct leakage criterion in Section 141.0(b)2Dii, then all accessible leaks shall be sealed and verified through a visual inspection and a smoke test performed by a certified HERS Rater utilizing the methods specified in Reference Nonresidential Appendix NA2.1.4.2.2.

EXCEPTION 2 to Section 141.0(b)2Dii: Duct Sealing. Existing duct systems that are extended, which are constructed, insulated or sealed with asbestos are exempt from the requirements of subsection 141.0(b)2Dii.

iii. If new ducts installed as part of an alteration are exempt from leakage testing according to section 141.0(b)2Di or 141.0(b)2Dii, then the new ducts shall meet the duct leakage testing requirements of CMC Section 603.10.1.

E. **Altered Space-Conditioning Systems.** When a space-conditioning system is altered by the installation or replacement of space-conditioning system equipment (including replacement of the air handler, outdoor condensing unit of a split system air conditioner or heat pump, or cooling or heating coil:

i. For all altered units where the existing thermostat does not comply with the requirements for demand responsive controls specified in Section 110.12, the existing thermostat shall be replaced with a demand responsive thermostat that complies with Section 110.12. All newly installed space-conditioning systems requiring a thermostat shall be equipped with a demand responsive thermostat that complies with Section 110.12; and

ii. The duct system that is connected to the new or replaced space-conditioning system equipment shall be sealed in accordance with Section 141.0(b)2Dii.~~, if the duct system meets the criteria of Section 140.4(l)1, as confirmed through field verification and diagnostic testing, in accordance with the applicable procedures for duct sealing of altered existing duct systems as specified in Reference Nonresidential Appendix NA2, and conforming to the applicable leakage compliance criteria in Section 141.0(b)2D.~~

EXCEPTION 1 to Section 141.0(b)2Eii: Duct Sealing. Buildings altered so that the duct system no longer meets the criteria of Section ~~140.4(l)1 are exempt from the requirements of Subsection 141.0(b)2Eii~~ 141.0(b)2Dii.

EXCEPTION 2 to Section 141.0(b)2Eii: Duct Sealing. Duct systems that are documented to have been previously sealed as confirmed through field verification and diagnostic testing in accordance with procedures in the Reference Nonresidential Appendix NA2 ~~are exempt from the requirements of Subsection 141.0(b)2Eii~~.

EXCEPTION 3 to Section 141.0(b)2Eii: Duct Sealing. Existing duct systems constructed, insulated or sealed with asbestos are exempt from the requirements of Subsection 141.0(b)2Eii.

F. Spaces with lighting systems installed for the first time shall meet the requirements of Sections 110.9, 130.0, 130.1, 130.2, 130.4, 140.3(c), 140.6 and 140.7.

G. When the requirements of Section 130.1(d) are triggered by the addition of skylights to an existing building and the lighting system is not recircuited, the daylighting control need not meet the multilevel requirements in Section 130.1(d).

H. New internally and externally illuminated signs shall meet the requirements of Sections 110.9, 130.3 and 140.8.

I. **Altered Indoor Lighting Systems.** Alterations to indoor lighting systems that include 10% or more of the luminaires serving an enclosed space shall meet the requirements of i, ii, or iii below:

i. The alteration shall comply with the indoor lighting power requirements specified in Section 140.6 and the lighting control requirements specified in Table 141.0-F;

ii. The alteration shall not exceed 80% of the indoor lighting power requirements specified in Section 140.6, and shall comply with the lighting control requirements specified in Table 141.0-F; or

iii. The alteration shall be a one-for-one luminaire alteration within a building or tenant space of 5,000 square feet or less, the total wattage of the altered luminaires shall be at least 40% lower compared to their total pre-alteration wattage, and the alteration shall comply with the lighting control requirements specified in Table 141.0-F.

Alterations to indoor lighting systems shall not prevent the operation of existing, unaltered controls, and shall not alter controls to remove functions specified in Section 130.1.

Alterations to lighting wiring are considered alterations to the lighting system. Alterations to indoor lighting systems are not required to separate existing general, floor, wall, display, or ~~ornamental~~ decorative lighting on shared circuits or controls. New or completely replaced lighting circuits shall comply with the control separation requirements of Section 130.1(a)3 and 130.1(c)1D.

EXCEPTION 1 to Section 141.0(b)2I. Alteration of portable luminaires, luminaires affixed to moveable partitions, or lighting excluded as specified in Section 140.6(a)3.

EXCEPTION 2 to Section 141.0(b)2I. Any enclosed space with only one luminaire.

EXCEPTION 3 to Section 141.0(b)2I. Any alteration that would directly cause the disturbance of asbestos, unless the alteration is made in conjunction with asbestos abatement.

EXCEPTION 4 to Section 141.0(b)2I. Acceptance testing requirements of Section 130.4 are not required for alterations where lighting controls are added to control 20 or fewer luminaires.

EXCEPTION 5 to Section 141.0(b)2I. Any alteration limited to adding lighting controls or replacing lamps, ballasts, or drivers.

EXCEPTION 6 to Section 141.0(b)2I. One-for-one luminaire alteration of up to 50 luminaires either per complete floor of the building or per complete tenant space, per annum.

J. **Reserved.**

K. **Reserved.**

L. Alterations to existing outdoor lighting systems in a lighting application listed in TABLE 140.7-A or 140.7-B shall meet the applicable requirements of Sections 130.0, ~~130.2(a),~~ 130.2(b), and 130.4, and:

i. In alterations that increase the connected lighting load, the added or altered luminaires shall meet the applicable requirements of Section 130.2(c) and the requirements of Section 140.7 for general hardscape lighting or for the specific lighting applications containing the alterations; and

ii. In alterations that do not increase the connected lighting load, where ~~the greater of 5 luminaires or~~ 10 percent or more of the existing luminaires are replaced in a general hardscape or a specific lighting application, the alterations shall meet the following requirements:

a. In parking lots and outdoor sales lots where the bottom of the luminaire is mounted 24 feet or less above the ground, the replacement luminaires shall comply with Section 130.2(c)1 AND Section 130.2(c)3;

b. For parking lots and outdoor sales lots ~~all other lighting applications and~~ where the bottom of the luminaire is mounted greater than 24 feet above the ground and for all other lighting applications, the replacement luminaires shall comply with Section 130.2(c)1 AND EITHER comply with Section 130.2(c)2 or be controlled by lighting control systems, including motion sensors, that automatically reduce lighting power by at least 40 percent in response to the area being vacated of occupants; and

EXCEPTION to Section 141.0(b)2Lii. Alterations where less than 5 existing luminaires are replaced.

iii. In alterations that do not increase the connected lighting load, where ~~the greater of 5 luminaires or~~ 50 percent or more of the existing luminaires are replaced in general hardscape or a specific application, the replacement luminaires shall meet the requirements of subsection ii above and the requirements of Section 140.7 for general hardscape lighting or specific lighting applications containing the alterations.

EXCEPTION 1 to Section 141.0(b)2Liii. Alterations where the replacement luminaires have at least 40 percent lower power consumption compared to the original luminaires are not required to comply with the lighting power allowances of Section 140.7.

EXCEPTION 2 to Section 141.0(b)2Liii. Alterations where less than 5 existing luminaires are replaced.

EXCEPTION to Section 141.0(b)2L. Acceptance testing requirements of Section 130.4 are not required for alterations where controls are added to 20 or fewer luminaires.

M. Alterations to existing internally and externally illuminated signs that increase the connected lighting load, replace and rewire more than 50 percent of the ballasts, or relocate the sign to a different location on the same site or on a different site shall meet the requirements of Section 140.8.

EXCEPTION to Section 141.0(b)2M. Replacement of parts of an existing sign, including replacing lamps, the sign face or ballasts, that do not require rewiring or that are done at a time other than when the sign is relocated, is not an alteration subject to the requirements of Section 141.0(b)2M.

N. Service water-heating systems shall meet the requirements of Section 140.5, except for the solar water heating requirements and the high capacity service water heating system requirements of Section 140.5(c) for systems with a total water heating input of at least 1 MMBtu/h.

O. A building shell for which interior walls or ceilings are installed for the first time shall meet the requirements of Section 140.3(c).

P. **Electrical Power Distribution Systems.** Alterations to electrical power distribution systems shall meet the applicable requirements of Section 130.5 as follows:

i. **Service Electrical Metering.** New or replacement electrical service equipment shall meet the requirements of Section 130.5(a) applicable to the electrical power distribution system altered.

ii. **Separation Of Electrical Circuits For Electrical Energy Monitoring.** For entirely new or complete replacement of electrical power distribution systems, the entire system shall meet the applicable requirements of Section 130.5(b).

iii. **Voltage Drop.** Alterations of feeders and branch circuits where the alteration includes addition, modification, or replacement of both feeders and branch circuits, the altered circuits shall meet the requirements of Section 130.5(c).

EXCEPTION to Section 141.0(b)2Piii: Voltage drop permitted by California Electrical Code Sections 647.4, 695.6 and 695.7.

iv. **Circuit Controls for 120-Volt Receptacles and Controlled Receptacles**. For entirely new or complete replacement of electrical power distribution systems, the entire system shall meet the applicable requirements of Sections 130.5(d) and 130.5(e).

Q. Existing building envelope wall where at least 25% or more of the wall area is being altered must comply with Section 140.3(a)9. Where the building is tested in accordance with the procedures for whole building air leakage in NA2.4 and the tested leakage rate exceeds 0.4 cfm/ft^2 of building shell at 75 pa. A Visual Inspection and Diagnostic Evaluation shall be done in accordance with NA2.4.7 and all observed leaks shall be sealed where such sealing can be made without destruction of existing building components.

Exception to Section 141.0(b)2Q healthcare facilities.

R. **Exterior doors.** Alterations that add exterior door area shall meet the U-factor requirements of Section 140.3(a)7.

3. Performance approach.

A. The altered envelope, space–conditioning system, lighting and water heating components, and any newly installed equipment serving the alteration, shall meet the applicable requirements of Sections 110.0 through 110.9, Sections 120.0 through 120.6, and Sections 120.9 through 130.5.

EXCEPTION 1 to Section 141.0(b)3A: Window Films. Applied window films installed as part of an alteration complies with the U-factor, RSHGC and VT requirements of TABLE 141.0-E.

EXCEPTION 2 to Section 141.0(b)3A: The requirements of Section 120.2(i) shall not apply to alterations of space-conditioning systems or components.

B. The standard design for an altered component shall be the higher efficiency of existing conditions or the requirements of Section 141.0(b)2. For components not being altered, the standard design shall

be based on the unaltered existing conditions such that the standard and proposed designs for these components are identical.

C. When the third party verification option is specified, all components proposed for alteration, for which the additional credit is taken, must be verified. The Executive Director shall determine the qualifications required by the third party inspector.

D. The proposed design shall be based on the actual values of the altered components.

NOTES TO SECTION 141.0(b)3:

1. If an existing component is replaced with a new component, that component is considered an altered component for the purpose of determining the energy budget and shall meet the requirements of Section 141.0(b)3.
2. The standard design assumes the same geometry and orientation as the proposed design.
3. The "existing efficiency level" modeling rules, including situations where nameplate data is not available, are described in the Nonresidential ACM Reference Manual.

EXCEPTION 1 to Section 141.0(b): When heating, cooling or service water heating for an alteration are provided by expanding existing systems, the existing systems and equipment need not comply with Sections 110.0 through 120.9 and Section 140.4 or 140.5.

EXCEPTION 2 to Section 141.0(b): When existing heating, cooling or service water heating systems or components are moved within a building, the existing systems or components need not comply with Sections 110.0 through 120.9 and Section 140.4 or 140.5.

EXCEPTION 3 to Section 141.0(b): Where an existing system with electric reheat is expanded when adding variable air volume (VAV) boxes to serve an alteration, total electric reheat capacity may be expanded not to exceed 20 percent of the existing installed electric capacity in any one permit and the system need not comply with Section 140.4(g). Additional electric reheat capacity in excess of 20 percent may be added subject to the requirements of the Section 140.4(g).

EXCEPTION 4 to Section 141.0(b): The requirements of Section 120.2(i) shall not apply to alterations of space-conditioning systems or components.

TABLE 141.0-E – The Standard Design For An Altered Component

Altered Component	Standard Design Without Third Party Verification of Existing Conditions Shall be Based On	Standard Design With Third Party Verification of Existing Conditions Shall be Based On
Roof/Ceiling Insulation, Wall Insulation, and Floor/Soffit Insulation	The requirements of Section 141.0(b)1 and 141.0(b)2Bii.	
Fenestration The allowed glass area shall be the smaller of the a. or b. below: a. The proposed glass area: or b. The larger of: 1.The existing glass area that remains; or 2.The area allowed in Section 140.3(a)5A.	The U-factor and RSHGC requirements of TABLE 141.0-A.	The existing U-factor and RSHGC levels.
Space-Conditioning System Equipment and Ducts	The requirements of Sections 141.0(b)2C, 141.0(b)2Di or Section 141.0(b)2Dii, and Section 141.0(b)2E.	
Window Film	The U-factor of 0.40 and SHGC value of 0.35.	The existing fenestration in the alteration shall be based on TABLE 110.6-A and Table 110.6-B.
Service Water Heating Systems	The requirements of Section 140.5 without solar water heating requirements.	
Roofing Products	The requirements of Section 141.0(b)2B.	
Lighting System	The requirements of Sections 141.0(b)2F, through 141.0(b)2K.	
All Other Measures	The proposed efficiency levels.	

~~D. The proposed design shall be based on the actual values of the altered components.~~

~~**NOTES TO SECTION 141.0(b)3:**~~

1. ~~If an existing component must be replaced with a new component, that component is considered an altered component for the purpose of determining the energy budget and must therefore meet the requirements of Section 141.0(b)3.~~
2. ~~The standard design assumes the same geometry and orientation as the proposed design.~~
3. ~~The "existing efficiency level" modeling rules, including situations where nameplate data is not available, are described in the Nonresidential ACM Reference Manual.~~

~~**EXCEPTION 1 to Section 141.0(b):** When heating, cooling or service water heating for an alteration are provided by expanding existing systems, the existing systems and equipment need not comply with Sections 110.0 through 120.9 and Section 140.4 or 140.5.~~

~~**EXCEPTION 2 to Section 141.0(b):** When existing heating, cooling or service water heating systems or components are moved within a building, the existing systems or components need not comply with Sections 110.0 through 120.9 and Section 140.4 or 140.5.~~

~~**EXCEPTION 3 to Section 141.0(b):** Where an existing system with electric reheat is expanded when adding variable air volume (VAV) boxes to serve an alteration, total electric reheat capacity may be expanded not to exceed 20 percent of the existing installed electric capacity in any one permit and the system need not comply with Section 140.4(g). Additional electric reheat capacity in excess of 20 percent may be added subject to the requirements of the Section 140.4(g).~~

~~**EXCEPTION 4 to Section 141.0(b):** The requirements of Section 120.2(i) shall not apply to alterations of space-conditioning systems or components.~~

~~**NOTE:** Relocation or moving of a relocatable public school building is not, by itself, considered an alteration for the purposes of Title 24, Part 6.~~

(c) **Repairs.** Repairs shall not increase the preexisting energy consumption of the repaired component, system, or equipment.

(d) **Alternate Method of Compliance.** Any addition, alteration, or repair may comply with the requirements of Title 24, Part 6 by meeting the applicable requirements for the entire building.

Table 141.0-F – Control Requirements for Indoor Lighting System Alterations

Control Specifications		**Projects complying with Section 141.0(b)2Ii**	**Projects complying with Sections 141.0(b)2Iii ~~and~~ or 141.0(b)2Iiii**
Manual Area Controls	130.1(a)1	Required	Required
	130.1(a)2	Required	Required
	130.1(a)3	Only required for new or completely replaced circuits	Only required for new or completely replaced circuits
Multilevel Controls	130.1(b)	Required	Not Required
Automatic Shut Off Controls	130.1(c)1	Required; 130.1(c)1D only required for new or completely replaced circuits	Required; 130.1(c)1D only required for new or completely replaced circuits
	130.1(c)2	Required	Required
	130.1(c)3	Required	Required
	130.1(c)4	Required	Required
	130.1(c)5	Required	Required
	130.1(c)6	Required	Required; except for 130.1(c)6D
	130.1(c)7	Required	Required
	130.1(c)8	Required	Required
Daylighting Controls	130.1(d)	Required	Not Required
Demand Responsive Controls	~~130.1(c)~~110.12(a) and 110.12(c)	Required	Not Required

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, 25910, and 25943, Public Resources Code.

SECTION 141.1 – REQUIREMENTS FOR COVERED PROCESSES IN ADDITIONS, ALTERATIONS TO EXISTING NONRESIDENTIAL, ~~HIGH-RISE RESIDENTIAL~~, AND HOTEL/MOTEL BUILDINGS

Covered processes in additions or alterations to existing buildings that will be nonresidential, ~~high-rise residential,~~ and hotel/motel occupancies shall comply with the applicable subsections of section 120.6 and 140.9.

(a) Lab and Process Facility Exhaust Systems. All newly installed fan systems for a laboratory or process facility exhaust system greater than 10,000 ~~CFM~~ cfm shall meet the requirements of Section 140.9(c).

(b) Computer Rooms. All newly installed computer room cooling systems and uninterruptible power supply systems in additions/alterations shall meet the requirements of Sections 120.6(i), 140.9(a)2, and 140.9(a)5 and comply with item 1 below.

1. **Economizers.** Each individual cooling system primarily serving computers in an existing building shall include either:

   A. An integrated air economizer capable of providing 100 percent of the expected system cooling load up to 80°F room supply air temperature at outside air temperatures of 55°F dry-bulb and below or 50°F wet-bulb and below, and be equipped with a fault detection and diagnostic system as specified by section 120.2(j); or

   B. An integrated water economizer capable of providing 100 percent of the expected system cooling load up to 80°F room supply air temperature at outside air temperatures of 40°F dry-bulb and below or 35°F wet-bulb and below; or

   C. In climate zones 1-9, 11-14, and 16, an integrated refrigerant economizer capable of providing 100 percent of the expected system cooling load up to 80°F room supply air temperature at outside air temperatures of 40°F dry-bulb and below or 35°F wet-bulb and below.

   EXCEPTION 1 to Section 141.1(b)1: Individual computer rooms with an ITE design load under 5 tons (18 kW) in a building that does not have any economizers.

   EXCEPTION 2 to Section 141.1.(b)1: New cooling systems serving an existing computer room in an existing building with an ITE design load up to a total of 50 tons (176 kW).

   EXCEPTION 3 to Section 141.1(b)1: New cooling systems serving a new computer room in an existing building with an ITE design load up to a total of 20 tons (70 kW).

   EXCEPTION 4 to Section 141.1(b)1: A computer room with an ITE design load less than 20 tons (70 kW) may be served by a fan system without an economizer if it is also served by a second fan system with an economizer that also serves other spaces within the building provided that all of the following are met:

      i. The economizer system has the ability to serve only the computer rooms connected to it, e.g., shut off flow to other spaces within the building when unoccupied; and

      ii. The economizer system has the ability to deliver either the computer room ITE design load or the maximum of 5 tons and at least 25 percent of the economizer system capacity at design conditions.

(c) Controlled Environment Horticulture Spaces.

1. Indoor Growing, Space-Conditioning Systems and Dehumidification. All newly installed heating, ventilation, air conditioning systems or dehumidification systems in buildings with indoor growing shall meet the applicable requirements of Section 120.6(h)1 and 120.6(h)2.

2. Greenhouses, Building Envelope and Space-Conditioning Systems. A greenhouse being converted to a conditioned greenhouse or additions to a conditioned greenhouse shall meet the requirements of Sections 120.6(h)5 and 120.6(h)6.

3. Indoor Growing and Greenhouses, Horticultural Lighting. When alterations to horticultural lighting systems increase lighting wattage or include adding, replacing, or altering 10 percent or more of the horticultural luminaires serving an enclosed space, the newly installed, replaced, or altered lighting shall meet the requirements of Section 120.6(h)3 for indoor growing or Section 120.6(h)7 for greenhouses.

   EXCEPTION to Section 141.1(c)3: Any alteration limited to adding lighting controls or replacing lamps, ballasts, or drivers.

NOTE: For alterations that change the occupancy classification of the building, the requirements of Section 141.1 apply to the occupancy that will exist after the alterations.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.8, and 25943, Public Resources Code.

SUBCHAPTER 7
~~LOW-RISE~~SINGLE-FAMILY RESIDENTIAL BUILDINGS – MANDATORY FEATURES AND DEVICES

SECTION 150.0 – MANDATORY FEATURES AND DEVICES

~~Low-rise~~Single-family residential buildings shall comply with the applicable requirements of Sections 150(a) through 150.0(~~r~~v).

NOTE: The requirements of Sections 150.0(a) through 150.0(r) apply to newly constructed buildings. Sections 150.2(a) and 150.2(b) specify which requirements of Sections 150.0(a) through 150.0(r) also apply to additions or alterations.

(a) Roof Deck, **Ceiling and Rafter Roof Insulation.** The opaque portions of ceilings and roofs separating conditioned spaces from unconditioned spaces or ambient air shall meet the requirements of Items 1 through ~~3~~ 4 below:

1. In climate zones 4 and 8 through 16 Roof decks in newly constructed attic systems shall be insulated to achieve an area-weighted average U-factor not exceeding U-0.184.

   EXCEPTION to Section 150.0(a)1: No roof deck insulation is required when ducts and air handler are located in conditioned space.

2. Ceilings and rafter roofs ~~Shall~~ shall be insulated to achieve an area-weighted average U-factor not exceeding U-0.043 or shall be insulated between wood-framing members with insulation resulting in an installed thermal resistance of R-22 or greater for the insulation alone. For vented attics, the mandatory insulation shall be installed at the ceiling level; for unvented attics, the mandatory insulation shall be placed at either ceiling or roof level; and

   EXCEPTION to Section 150.0(a)2~~1~~: Ceilings and rafter roofs in an alteration shall be insulated to achieve an area-weighted average U-factor not exceeding 0.054 or shall be insulated between wood-framing members with insulation resulting in an installed thermal resistance of R-19 or greater.

~~2~~3. Attic access doors shall have permanently attached insulation using adhesive or mechanical fasteners. The attic access shall be gasketed to prevent air leakage; and

~~3~~4. Insulation shall be installed in direct contact with a ~~continuous~~ roof or ceiling which is sealed to limit infiltration and exfiltration as specified in Section 110.7, including but not limited to placing insulation either above or below the roof deck or on top of a drywall ceiling.

(b) **Loose-fill Insulation.** When loose-fill insulation is installed, the minimum installed weight per square foot shall conform with the insulation manufacturer's installed design weight per square foot at the manufacturer's labeled R-value.

(c) **Wall Insulation.** Opaque portions of above grade walls separating conditioned spaces from unconditioned spaces or ambient air shall meet the following requirements:

1. 2×4 inch framing shall have an overall assembly U-factor not exceeding U-0.102.

   EXCEPTION to Section 150.0(c)1: Existing walls already insulated to a U-factor not exceeding U-0.110 or already insulated between framing members with insulation having an installed thermal resistance of R-11 or greater.

2. 2×6 inch or greater framing shall have an overall assembly U-factor not exceeding U-0.071.

3. Opaque nonframed assemblies shall have an overall assembly U-factor not exceeding U-0.102.

4. Bay or Bow Window roofs and floors shall be insulated to meet the wall insulation requirements of TABLE 150.1-A or B.
5. Masonry walls shall be insulated to meet the wall insulation requirements of TABLE 150.1-A or B.
6. In wood framed assemblies, compliance with U-factors may be demonstrated by installing wall insulation with an R-value of 13 in 2x4 assemblies, and 20 in 2x6 assemblies.

(d) **Raised-floor Insulation.** Raised floors separating conditioned space from unconditioned space or ambient air shall have an overall assembly U-factor not exceeding U-0.037. In a wood framed assembly, compliance with the U-factor may be demonstrated by installing insulation with an R-value of 19 or greater.

EXCEPTION to Section 150.0(d): A building with a controlled ventilation or unvented crawl space may omit raised floor insulation if all of the following are met:

A. The foundation walls are insulated to meet the wall insulation minimums as shown in TABLE 150.1-A or B; and
B. A Class I or Class II vapor retarder is placed over the entire floor of the crawl space; and
C. Vents between the crawl space and outside air are fitted with automatically operated louvers that are temperature actuated; and
D. The requirements in Reference Residential Appendix RA4.5.1.

(e) **Installation of Fireplaces, Decorative Gas Appliances and Gas Logs.** If a masonry or factory-built fireplace is installed, it shall comply with Section 110.5, Section 4.503 of Part 11, and shall have the following:

1. Closable metal or glass doors covering the entire opening of the firebox; and
2. A combustion air intake to draw air from the outside of the building, which is at least 6 square inches in area and is equipped with a readily accessible, operable, and tight-fitting damper or combustion-air control device; and

EXCEPTION to Section 150.0(e)2: An outside combustion-air intake is not required if the fireplace will be installed over concrete slab flooring and the fireplace will not be located on an exterior wall.

3. A flue damper with a readily accessible control.

EXCEPTION to Section 150.0(e)3: When a gas log, log lighter, or decorative gas appliance is installed in a fireplace, the flue damper shall be blocked open if required by the CMC or the manufacturer's installation instructions.

(f) **Slab Edge Insulation.** Material used for slab edge insulation shall meet the following minimum specifications:

1. Water absorption rate for the insulation material alone without facings no greater than 0.3 percent when tested in accordance with Test Method A – 24-Hour-Immersion of ASTM C272.
2. Water vapor permeance no greater than 2.0 perm/inch when tested in accordance with ASTM E96.
3. Concrete slab perimeter insulation shall be protected from physical damage and ultraviolet light deterioration.
4. Insulation for a heated slab floor shall meet the requirements of Section 110.8(g).

(g) **Vapor Retarder.**

1. In Climate Zones 1-16, the earth floor of unvented crawl space shall be covered with a Class I or Class II vapor retarder. This requirement shall also apply to controlled ventilation crawl space for buildings complying with the Exception to Section 150.0(d).
2. In Climate Zones 14 and 16, a Class I or Class II vapor retarder shall be installed on the conditioned space side of all insulation in all exterior walls, vented attics and unvented attics with air-permeable insulation.

(h) **Space-Conditioning Equipment.**

1. **Building Cooling and Heating Loads.** Building heating and cooling loads shall be determined using a method based on any one of the following:

   A. The ASHRAE Handbook, Equipment Volume, Applications Volume, and Fundamentals Volume; or

   B. The SMACNA Residential Comfort System Installation Standards Manual; or

   C. The ACCA Manual J.

   The cooling and heating loads are two of the criteria that shall be used for equipment sizing and selection.

   NOTE: Heating systems are required to have a minimum heating capacity adequate to meet the minimum requirements of the CBC. The furnace output capacity and other specifications are published in the Commission's directory of certified equipment or other directories approved by the Commission.

2. **Design conditions**. For the purpose of sizing the space-conditioning (HVAC) system, the indoor design temperatures shall be 68°F for heating and 75°F for cooling. Outdoor design conditions shall be selected from Reference Joint Appendix JA2, which is based on data from the ASHRAE Climatic Data for Region X. The outdoor design temperatures for heating shall be no lower than the Heating Winter Median of Extremes values. The outdoor design temperatures for cooling shall be no greater than the 1.0 percent Cooling Dry Bulb and Mean Coincident Wet Bulb values.

3. **Outdoor Condensing Units.**

   A**. Clearances.** Installed air conditioner and heat pump outdoor condensing units shall have a clearance of at least five (5) feet (1.5 meters) from the outlet of any dryer vent.

   B**. Liquid Line Drier.** Installed air conditioner and heat pump systems shall be equipped with liquid line filter driers if required, as specified by manufacturer's instructions.

4. **Central Forced-Air Heating Furnaces**.

   A. **Temperature Rise**. Central forced-air heating furnace installations shall be configured to operate in conformance with the furnace manufacturer's maximum inlet-to-outlet temperature rise specifications.

(i) **Thermostats**. All heating or cooling systems, including heat pumps, not controlled by a central energy management control system (EMCS) shall have a setback thermostat, as specified in Section 110.2(c).

(j) **Insulation for Piping and Tanks.**

1. **Storage tank insulation.** Unfired hot water tanks, such as storage tanks and backup storage tanks for solar water-heating systems, shall be externally wrapped with insulation having an installed thermal resistance of R-~~12~~ 4 or greater.

   EXCEPTION to Section 150.0(j)1 ~~or~~ Unfired storage tank with~~have~~ internal insulation of at least R-16 and a label on the exterior of the tank showing the insulation R-value.

2. **Water piping, solar water-heating system piping, and space conditioning system line insulation thickness and conductivity.** Piping shall be insulated as follows:

   A. All domestic hot water piping shall be insulated as specified in Section 609.11 of the California Plumbing Code. ~~In addition, the following piping conditions shall have a minimum insulation wall thickness of 1 inch or a minimum insulation R-value of 7.7:~~

   ~~i. The first 5 feet (1.5 meters) of cold water pipes from the storage tank.~~

   ~~ii. All hot water piping with a nominal diameter equal to or greater than 3/4 inch (19 millimeter) and less than 1 inch.~~

   ~~iii. All hot water piping with a nominal diameter less than 3/4 inch that is:~~

   ~~a. Associated with a domestic hot water recirculation system;~~

   ~~b. From the heating source to the kitchen fixtures;~~

~~c. From the heating source to a storage tank or between storage tanks; or~~

~~d. Buried below grade.~~

B. Piping for space conditioning systems, solar water-heating system collector loop, and distribution piping for steam and hydronic heating system, shall meet the requirements of Section 120.3(c).

EXCEPTION 1 to Section 150.0(j)2: Factory-installed piping within space-conditioning equipment certified under Section 110.1 or 110.2.

EXCEPTION 2 to Section 150.0(j)2: Piping that penetrates framing members shall not be required to have pipe insulation for the distance of the framing penetration. Piping that penetrates metal framing shall use grommets, plugs, wrapping or other insulating material to assure that no contact is made with the metal framing. Insulation shall butt securely against all framing members.

EXCEPTION 3 to Section 150.0(j)2: Piping installed in interior or exterior walls shall not be required to have pipe insulation if all of the requirements are met for compliance with Quality Insulation Installation (QII) as specified in the Reference Residential Appendix RA3.5.

EXCEPTION 4 to Section 150.0(j)2: Piping surrounded with a minimum of 1 inch of wall insulation, 2 inches of crawl space insulation, or 4 inches of attic insulation, shall not be required to have pipe insulation.

3. **Insulation Protection.** Pipe insulation shall meet the insulation protection requirements of Section 120.3(b).

(k) **Residential Lighting.**

1. **Luminaire Requirements.**

A. **Luminaire Efficacy.** All installed luminaires shall meet the requirements in TABLE 150.0-A.

EXCEPTION 1 to Section 150.0(k)1A: Integrated device lighting. Lighting integral to exhaust fans, kitchen range hoods, bath vanity mirrors, and garage door openers.

EXCEPTION 2 to Section 150.0(k)1A: Navigation lighting such as night lights, step lights, and path lights less than 5 watts.

EXCEPTION 3 to Section 150.0(k)1A: Cabinet Lighting. Lighting internal to drawers, cabinetry, and linen closets with an efficacy of 45 lumens per watt or greater.

B. **Screw based luminaires~~Blank Electrical Boxes~~.** Screw based luminaires shall contain lamps that comply with Reference Joint Appendix JA8 or contain lamps as specified in Table 150.0-A including qualified colored lamps, dim-to-warm lamps, tunable-white lamps, color-tunable lamps, and Title 20-compliant LED lamps~~The number of electrical boxes that are more than 5 feet above the finished floor and do not contain a luminaire or other device shall be no greater than the number of bedrooms. These electrical boxes must be served by a dimmer, vacancy sensor control, or fan speed control~~.

C. **Recessed Downlight Luminaires in Ceilings.** In addition to complying with 150.0(k)1A, luminaires recessed into ceilings shall meet all ~~all~~ of the following requirements ~~requirements~~:

i. Shall not contain screw base lamp sockets~~Be listed, as defined in Section 100.1, for zero clearance insulation contact (IC) by Underwriters Laboratories or other nationally recognized testing/rating laboratory~~; and

ii. Have a label that certifies the luminaire is airtight with air leakage less than 2.0 ~~CFM~~ cfm at 75 Pascals when tested in accordance with ASTM E283. An exhaust fan housing with integral light shall not be required to be certified airtight; and

iii. Be sealed with a gasket or caulk between the luminaire housing and ceiling, and have all air leak paths between conditioned and unconditioned spaces sealed with a gasket or caulk, or be installed per manufacturer's instructions to maintain airtightness between the luminaire housing and ceiling; and

iv. Meet the clearance and installation requirements of California Electrical Code Section 410.116~~For luminaires with hardwired ballasts or drivers, allow ballast or driver maintenance and replacement to be readily accessible to building occupants from below the ceiling without requiring the cutting of holes in the ceiling; and~~

~~v. Shall not contain screw base sockets~~.

EXCEPTION to Section 150.0(k)1Cii and iii: Recessed luminaires marked for use in fire-rated installations ~~extruded into ceiling spac~~e and recessed luminaires installed in non-insulated ceilings.

D. **Light Sources in Enclosed or Recessed Luminaires~~Electronic Ballasts for Fluorescent Lamps~~.** Lamps and other separable light sources that are not compliant with the JA8 elevated temperature requirements, including marking requirements, shall not be installed in enclosed or recessed luminaires~~Ballasts for fluorescent lamps rated 13 watts or greater shall be electronic and shall have an output frequency no less than 20 kHz~~.

~~E. **Night Lights, Step Lights and Path Lights.** Night lights, step lights and path lights shall not be required to comply with Table 150.0-A or be controlled by vacancy sensors provided they are rated to consume no more than 5 watts of power and emit no more than 150 lumens.~~

~~F. **Lighting Integral to Exhaust Fans.** Lighting integral to exhaust fans shall meet the applicable requirements of Section 150.0(k).~~

~~**EXCEPTION to Section 150.0(k)1F:** Lighting installed by the manufacturer in kitchen exhaust hoods.~~

~~G. **Screw-based luminaires.** Screw based luminaires shall contain lamps that comply with Reference Joint Appendix JA8.~~

~~**EXCEPTION to Section 150.0(k)1G**: Luminaires with hard-wired ballasts for high intensity discharge lamps.~~

~~H. **Light Sources in Enclosed or Recessed Luminaires.** Lamps and other separable light sources that are not compliant with the JA8 elevated temperature requirements, including marking requirements, shall not be installed in enclosed or recessed luminaires.~~

~~I. **Light Sources in Drawers, Cabinets, and Linen Closets.** Light sources internal to drawers, cabinetry or linen closets shall not be required to comply with Table 150.0-A or be controlled by vacancy sensors provided that they are rated to consume no more than 5 watts of power and emit no more than 150 lumens, and are equipped with controls that automatically turn the lighting off when the drawer, cabinet or linen closet is closed.~~**Blank Electrical Boxes**. The number of electrical boxes that are more than 5 feet above the finished floor and do not contain a luminaire or other device shall be no greater than the number of bedrooms. These electrical boxes must be served by a dimmer, vacancy sensor control, low voltage wiring or fan speed control.

2. ~~**Interior**~~ **Indoor Lighting ~~Switching Devices and~~ Controls.**

~~A. All forward phase cut dimmers used with LED light sources shall comply with NEMA SSL 7A.~~

~~B. Exhaust fans shall be controlled separately from lighting systems.~~

~~**EXCEPTION to Section 150.0(k)2B:** Lighting integral to an exhaust fan may be on the same control as the fan provided the lighting can be turned OFF in accordance with the applicable provisions in Section 150.0(k)2 while allowing the fan to continue to operate.~~

~~C~~A. Lighting shall have readily accessible wall-mounted controls that allow the lighting to be manually turned ON and OFF.

EXCEPTION to Section 150.0(k)~~2C~~2A: Ceiling fans may provide control of integrated lighting via a remote control.

~~D. Lighting controls and equipment shall be installed in accordance with the manufacturer's instructions.~~

~~E~~B. No controls shall bypass a dimmer, occupant sensor or vacancy sensor function where that dimmer or sensor has been installed to comply with Section 150.0(k).

~~F~~C. Lighting controls shall comply with the applicable requirements of Section 110.9.

~~G~~D. An Energy Management Control System (EMCS) or a multiscene programmable control may be used to comply with dimming, occupancy, and lighting control requirements in Section 150.0(k)2 if ~~at a minimum~~ it provides the functionality of the specified controls in accordance with Section 110.9, and the physical controls specified in 150.0(k)2A~~, meets the installation certificate requirements in Section 130.4, meets the EMCS requirements in Section 130.0(e), and complies with all other applicable requirements in Section 150.0(k)2~~.

~~H. A multiscene programmable controller may be used to comply with dimmer requirements in Section 150.0(k) if at a minimum it provides the functionality of a dimmer in accordance with Section 110.9, and complies with all other applicable requirements in Section 150.0(k)2.~~

~~I~~E. **Automatic Off Controls.**

i. In bathrooms, garages, laundry rooms, ~~and~~ utility rooms, and walk-in closets, at least one installed luminaire ~~in each of these spaces~~ shall be controlled by an ~~occupant~~ occupancy or vacancy sensor providing automatic-off functionality. If an occupant sensor is installed, it shall be initially configured to manual-on operation using the manual control required under Section 150.0(k)2A~~C~~.

ii. For lighting internal to drawers and cabinetry with opaque fronts or doors, controls that turn light off when the drawer or door is closed shall be provided.

~~J~~F. **Dimming Controls**. ~~Luminaires that are or contain light sources that meet Reference Joint Appendix JA8 requirements for dimming, and that are not controlled by occupancy or vacancy sensors, shall have dimming controls~~Lighting in habitable spaces, including but not limited to living rooms, dining rooms, kitchens, and bedrooms, shall have readily accessible wall-mounted dimming controls that allow the lighting to be manually adjusted up and down. Forward phase cut dimmers controlling LED light sources in these spaces shall comply with NEMA SSL 7A.

EXCEPTION 1 to Section 150.0(k)~~2J~~2F: ~~Luminaires in closets less than 70 square feet.~~ Ceiling fans may provide control of integrated lighting via a remote control.

~~**EXCEPTION 2 to Section 150.0(k)2J:** Luminaires in hallways.~~

EXCEPTION 2 to Section 150.0(k)2F: Luminaires connected to a circuit with controlled lighting power less than 20 watts or controlled by an occupancy or vacancy sensor providing automatic-off functionality.

EXCEPTION 3 to Section 150.0(k)2F: Navigation lighting such as night lights, step lights, and path lights less than 5 watts, and lighting internal to drawers and cabinetry with opaque fronts or doors.

~~K~~G. **Independent controls.** Integrated lighting of exhaust fans shall be controlled independently from the fans. ~~Undercabinet lighting~~The following shall be controlled separately from ceiling-installed lighting such that one can be turned on without turning on the other:

i. Undercabinet lighting

ii. Undershelf lighting

iii. Interior lighting of display cabinets

iv. Switched outlets~~.~~

3. **Residential Outdoor Lighting.** In addition to meeting the requirements of Section 150.0(k)1A, luminaires providing residential outdoor lighting shall meet the following requirements, as applicable:

A. For single-family residential buildings, outdoor lighting permanently mounted to a residential building or to other buildings on the same lot shall meet the requirement in item i and the requirements in either item ii or item iii:

i. Controlled by a manual ON and OFF control switch that permits the automatic actions of items ii or iii below; and

ii. Controlled by a photocell and ~~either~~ a motion sensor ~~or an automatic time switch control~~; or

iii. Controlled by an astronomical time clock control or an automatic time switch control. Time switch or time clock controls that override to ON shall not be allowed unless the override automatically returns the automatic control to its normal operation within 6 hours.

~~Controls that override to ON shall not be allowed unless the override automatically returns the automatic control to its normal operation within 6 hours.~~ An energy management control system that provides the specified lighting control functionality and complies with all requirements applicable to the specified controls may be used to meet these requirements.

~~B. For low-rise residential buildings with four or more dwelling units, outdoor lighting for private patios, entrances, balconies, porches; and residential parking lots and carports with less than eight vehicles per site shall comply with either:~~

~~i. Section 150.0(k)3A; or~~

~~ii. The applicable requirements in Sections 110.9, 130.0, 130.2, 130.4, 140.7 and 141.0.~~

~~C. For low-rise residential buildings with four or more dwelling units, any outdoor lighting for residential parking lots or carports with a total of eight or more vehicles per site and any outdoor lighting not regulated by Section 150.0(k)3B shall comply with the applicable requirements in Sections 110.9, 130.0, 130.2, 130.4, 140.7 and 141.0.~~

4. **Internally illuminated address signs.** Internally illuminated address signs shall either:

A. Comply with Section 140.8; or

B. Consume no more than 5 watts of power.

5. **Residential Garages for Eight or More Vehicles.** Lighting for residential parking garages for eight or more vehicles shall comply with the applicable requirements for nonresidential garages in Sections 110.9, 130.0, 130.1, 130.4, 140.6, and 141.0.

~~6. **Interior Common Areas of Low-rise Multifamily Residential Buildings.**~~

~~A. In a low-rise multifamily residential building where the total interior common area in a single building equals 20 percent or less of the floor area, permanently installed lighting for the interior common areas in that building shall comply with Table 150.0-A and be controlled by an occupant sensor.~~

~~B. In a low-rise multifamily residential building where the total interior common area in a single building equals more than 20 percent of the floor area, permanently installed lighting for the interior common areas in that building shall:~~

~~i. Comply with the applicable requirements in Sections 110.9, 130.0, 130.1, 140.6 and 141.0; and~~

~~ii. Lighting installed in corridors and stairwells shall be controlled by occupant sensors that reduce the lighting power in each space by at least 50 percent. The occupant sensors shall be capable of turning the light fully on and off from all designed paths of ingress and egress.~~

(l) RESERVED

(m) **Air-Distribution and Ventilation System Ducts, Plenums, and Fans.**

1. **CMC Compliance.**

A. All air-distribution system ducts and plenums, including, but not limited to, mechanical closets and air-handler boxes, shall meet the requirements of the CMC Sections 601.0, 602.0, 603.0, 604.0, 605.0 and

ANSI/SMACNA-006-2006 HVAC Duct Construction Standards Metal and Flexible 3rd Edition, incorporated herein by reference.

B. Portions of supply-air and return-air ducts and plenums of a space heating or cooling system shall either be insulated to:

i. a minimum installed level of R-6.0, or

ii. a minimum installed level ~~of R-4.2~~as specified in subsections a or b below when the duct system is located entirely in conditioned space as confirmed through field verification and diagnostic testing in accordance with the requirements of Reference Residential Appendix RA3.1.4.3.8.

a. R-1 for ducts with a surface emissivity greater than or equal to 0.8.

b. R-3 for ducts with a surface emissivity less than 0.8.

EXCEPTION 1 to Section 150.0(m)1B: Portions of the duct system located in wall cavities are not required to be insulated if all of the following conditions are met:

i. The ~~cavity, duct or plenum~~cavity containing the non-insulated portion of the duct system is located entirely inside the building's thermal envelope as confirmed by visual inspection.

ii. The non-insulated portion of the duct system has outer cross-sectional dimensions that are within 0.25 inch of the inner cross-sectional dimensions of the cavity.

iii. At all locations where non-insulated portions of ~~non-insulated cavities,~~the duct system~~, or plenums~~ make a transition into unconditioned space, the transition ~~shall be~~is air-sealed to prevent air infiltration into the cavity and ~~be~~ insulated to a minimum of R-6 as confirmed by visual inspection.

EXCEPTION 2 to Section 150.0(m)1B: Portions of the duct system completely exposed and surrounded by directly conditioned space are not required to be insulated.

C. Connections of metal ducts and the inner core of flexible ducts shall be mechanically fastened.

D. Openings shall be sealed with mastic, tape, or other duct-closure system that meets the applicable requirements of UL 181, UL 181A or UL 181B or aerosol sealant that meets the requirements of UL 723. If mastic or tape is used to seal openings greater than 1/4 inch, the combination of mastic and either mesh or tape shall be used.

E. Building cavities, support platforms for air handlers, and plenums designed or constructed with materials other than sealed sheet metal, duct board or flexible duct shall not be used for conveying conditioned air. Building cavities and support platforms may contain ducts. Ducts installed in cavities and support platforms shall not be compressed to cause reductions in the cross-sectional area of the ducts.

EXCEPTION to Section 150.0(m)1: Ducts and fans integral to a wood heater or fireplace.

2. **Factory-Fabricated Duct Systems.**

A. All factory-fabricated duct systems shall comply with UL 181 for ducts and closure systems, including collars, connections, and splices, and be labeled as complying with UL 181. UL 181 testing may be performed by UL laboratories or a laboratory approved by the Executive Director.

B. All pressure-sensitive tapes, heat-activated tapes, and mastics used in the manufacture of rigid fiberglass ducts shall comply with UL 181 and UL 181A.

C. All pressure-sensitive tapes and mastics used with flexible ducts shall comply with UL 181 and UL 181B.

D. Joints and seams of duct systems and their components shall not be sealed with cloth-back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.

3. **Field-Fabricated Duct Systems.**

A. Factory-made rigid fiberglass and flexible ducts for field-fabricated duct systems shall comply with UL 181. All pressure-sensitive tapes, mastics, aerosol sealants, or other closure systems used for installing field-fabricated duct systems shall meet the applicable requirements of UL 181, UL 181A, and UL 181B.

B. Mastic sealants and mesh.

i. Sealants shall comply with the applicable requirements of UL 181, UL 181A, and UL 181B, and be nontoxic and water resistant.

ii. Sealants for interior applications shall be tested in accordance with ASTM C731 and D2202, incorporated herein by reference.

iii. Sealants for exterior applications shall be tested in accordance with ASTM C731, C732, and D2202, incorporated herein by reference.

iv. Sealants and meshes shall be rated for exterior use.

C. Pressure-sensitive tape. Pressure-sensitive tapes shall comply with the applicable requirements of UL 181, UL 181A, and UL 181B.

D. Joints and seams of duct systems and their components shall not be sealed with cloth-back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.

E. Drawbands used with flexible duct.

i. Drawbands shall be either stainless-steel worm-drive hose clamps or UV-resistant nylon duct ties.

ii. Drawbands shall have a minimum tensile strength rating of 150 pounds.

iii. Drawbands shall be tightened as recommended by the manufacturer with an adjustable tensioning tool.

F. Aerosol-sealant closures.

i. Aerosol sealants shall meet the requirements of UL 723 and be applied according to manufacturer specifications.

ii. Tapes or mastics used in combination with aerosol sealing shall meet the requirements of this section.

4. **Duct Insulation R-value Ratings**. All duct insulation product R-values shall be based on insulation only (excluding air films, vapor retarder, or other duct components) and tested C-values at 75°F mean temperature at the installed thickness, in accordance with ASTM C518 or ASTM C177, incorporated herein by reference, and certified pursuant to Section 110.8.

5. **Duct Insulation Thickness**. The installed thickness of duct insulation used to determine its R-value shall be determined as follows:

A. For duct board, duct liner, and factory-made rigid ducts not normally subjected to compression, the nominal insulation thickness shall be used.

B. For duct wrap, installed thickness shall be assumed to be 75 percent (25 percent compression) of nominal thickness.

C. For factory-made flexible air ducts, the installed thickness shall be determined by dividing the difference between the actual outside diameter and nominal inside diameter by two.

6. **Duct Labeling.** Insulated flexible duct products installed to meet this requirement shall include labels, in maximum intervals of 3 feet, showing the thermal performance R-value for the duct insulation itself (excluding air films, vapor retarders or other duct components), based on the tests in Section 150.0(m)4 and the installed thickness determined by Section 150.0(m)5C.

7. **Backdraft Dampers**. All fan systems, regardless of volumetric capacity, that exchange air between the building conditioned space and the outside of the building shall be provided with backdraft or automatic dampers to prevent unintended air leakage through the fan system when the fan system is not operating.

8. **Gravity Ventilation Dampers.** All gravity ventilating systems that serve conditioned space shall be provided with either automatic or readily accessible, manually operated dampers in all openings to the outside except combustion inlet and outlet air openings and elevator shaft vents.

9. **Protection of Insulation.** Insulation shall be protected from damage, including that due to sunlight, moisture, equipment maintenance, and wind but not limited to the following: Insulation exposed to weather shall be suitable for outdoor service, e.g., protected by aluminum, sheet metal, painted canvas, or plastic cover. Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation that can cause degradation of the material.

10. **Porous Inner Core Flex Duct.** Flexible ducts having porous inner cores shall have a non-porous layer or air barrier between the inner core and the outer vapor barrier.

11. **Duct System Sealing and Leakage Testing**. When space conditioning systems utilize forced air duct systems to supply conditioned air to an occupiable space, the ducts shall be sealed~~,~~ as confirmed through field verification and diagnostic testing~~,~~ in accordance with all applicable procedures specified in Reference Residential Appendix RA3.1, ~~and the leakage compliance criteria specified in Reference Residential Appendix TABLE RA3.1-2,~~ and conforming to one of the following Subsections A, B, or C as applicable.~~:~~ Air handler airflow for calculation of duct leakage rate compliance targets shall be determined according to methods specified in Reference Residential Appendix RA3.1.4.2.

    A. For single~~-~~family dwellings and townhouses with the air-handling unit installed and the ducts connected directly to the air handler, the total leakage of the duct system shall not exceed 5 percent of the ~~nominal system~~ air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1.

    B. For single~~-~~family dwellings and townhouses at the rough-in stage of construction prior to installation of the dwelling's interior finishing:

        i. **Air-handling unit installed.** If the air-handling unit is installed and the ducts are connected directly to the air handler, the total leakage of the duct system shall not exceed 5 percent of the ~~nominal system~~ air handler airflow as determined utilizing the procedures in Reference Residential Appendix Sections RA3.1.4.3.2, RA3.1.4.3.2.1 and RA3.1.4.3.3.

        ii. **Air-handling unit not yet installed.** If the air-handling unit is not yet installed, the total leakage of the duct system shall not exceed 4 percent of the ~~nominal system~~ air handler airflow as determined utilizing the procedures in Reference Residential Appendix Sections RA3.1.4.3.2, RA3.1.4.3.2.2 and RA3.1.4.3.3.

    ~~C. For multifamily dwellings with the air-handling unit installed and the ducts connected directly to the air handler, regardless of duct system location:~~

        ~~i. The total leakage of the duct system shall not exceed 12 percent of the nominal system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1; or~~

        ~~ii. The duct system leakage to outside shall not exceed 6 percent of the nominal system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.4.~~

12. **Air Filtration.**

    A. System types specified in subsections i, ii, and iii shall be provided with air filters in accordance with Sections 150.0(m)12B, 150.0(m)12C, and 150.0(m)12D. System types specified in subsection i shall also comply with Section 150.0(m)12E.

i. Mechanical space conditioning systems that supply air to an occupiable space through ductwork exceeding 10 ft (3 m) in length.

ii. Mechanical supply-only ventilation systems and makeup air systems that provide outside air to an occupiable space.

iii. The supply side of mechanical balanced ventilation systems, including heat recovery ventilation systems, and energy recovery ventilation systems that provide outside air to an occupiable space.

EXCEPTION 1 to Section 150.0(m)12A: Evaporative coolers are exempt from the air filtration requirements in Section 150.0(m)12.

B. **System Design and Installation**.

i. The system shall be designed to ensure that all recirculated air and all outdoor air supplied to the occupiable space is filtered before passing through any system's thermal conditioning components.

EXCEPTION 1 to Section 150.0(m)12Bi: For heat recovery ventilators and energy recovery ventilators the location of the filters required by Section 150.0(m)12 may be downstream of a system thermal conditioning component, provided the system is equipped with ancillary filtration upstream of the system's thermal conditioning component.

ii. All systems shall be designed to accommodate the clean-filter pressure drop imposed by the system air filter(s). The design airflow rate, and maximum allowable clean-filter pressure drop at the design airflow rate applicable to each air filter shall be determined and reported on labels according to subsection iv below.

Systems specified in Section 150.0(m)12Ai shall be equipped with air filters that meet either subsection a or b below.

a. Nominal two-inch minimum depth filter(s) shall be sized by the system designer, or

b. Nominal one-inch minimum depth filter(s) shall be allowed if the filter(s) are sized according to Equation 150.0-A, based on a maximum face velocity of 150 ft per minute, and according to the maximum allowable clean-filter pressure drop specified in Section 150.0(m)12Dii.

$$A_{face} = Q_{filter} / V_{face} \qquad \text{(Equation 150.0-A)}$$

where

A_{face} = air filter face area, the product of air filter nominal length × nominal width, ft^2

Q_{filter} = design airflow rate for the air filter, ft^3/min

V_{face} = air filter face velocity ≤ 150, ft/min

iii. All system air filters shall be located and installed in such a manner as to be accessible for regular service by the system owner.

iv. All system air filter installation locations shall be labeled to disclose the applicable design airflow rate and the maximum allowable clean-filter pressure drop. The labels shall be permanently affixed to the air filter installation location, readily legible, and visible to a person replacing the air filter.

v. Filter racks or grilles shall be gasketed or sealed to eliminate any gaps around the filter to prevent air from bypassing the filter.

C. **Air Filter Efficiency**. The system shall be provided with air filters having a designated efficiency equal to or greater than MERV 13 when tested in accordance with ASHRAE Standard 52.2, or a particle size efficiency rating equal to or greater than 50 percent in the 0.30-1.0 µm range, and equal to or greater than 85 percent in the 1.0-3.0 µm range when tested in accordance with AHRI Standard 680.

D. **Air Filter Pressure Drop**. All systems shall be provided with air filters that conform to the applicable maximum allowable clean-filter pressure drop specified in subsections i, ii, iii, or iv below, when tested using ASHRAE Standard 52.2, or as rated using AHRI Standard 680, for the applicable design airflow rates for the system air filters.

i. The maximum allowable clean-filter pressure drop shall be determined by the system design for the nominal two-inch minimum depth air filter required by Section 150.0(m)12Biia, or

ii. A maximum of 25 PA (0.1 inches water) clean-filter pressure drop shall be allowed for a nominal one-inch depth air filter sized according to Section 150.0(m)12Biib, or

iii. For systems specified in 150.0(m)12Aii, and 150.0(m)12Aiii, the maximum allowable clean filter pressure drop shall be determined by the system design.

iv. If EXCEPTION 1 to Section 150.0(m)13B or D is utilized for compliance with cooling system airflow rate and fan efficacy requirements, the clean-filter pressure drop for the system air filter shall conform to the requirements given in TABLE 150.0-B or 150.0-C.

E. **Air Filter Product Labeling**. Systems described in 150.0(m)12)Ai shall be equipped with air filters that have been labeled by the manufacturer to disclose the efficiency and pressure drop ratings that demonstrate conformance with Sections 150.0(m)12C and 150.0(m)12D.

13. **Space Conditioning System Airflow Rate and Fan Efficacy.** Space conditioning systems that utilize forced air ducts to supply cooling to an occupiable space shall:

A. **Static Pressure Probe.** Have a hole for the placement of a static pressure probe (HSPP), or a permanently installed static pressure probe (PSPP) in the supply plenum downstream of the air conditioning evaporator coil. The size, location, and labeling of the HSPP or PSPP shall conform to the requirements specified in Reference Residential Appendix RA3.3.1.1 as confirmed by field verification and diagnostic testing; and

EXCEPTION to 150.0(m)13A: Systems that cannot conform to the specifications for hole location in Reference Residential Appendix Figure RA3.3-1 shall not be required to provide holes as described in Figure RA3.3-1.

B. **Single Zone Central Forced Air Systems**. Demonstrate, in every control mode, airflow greater than or equal to 350 cfm per ton of nominal cooling capacity through the return grilles, and an air-handling unit fan efficacy less than or equal to the maximum W/cfm specified in subsections i or ii below. The airflow rate and fan efficacy requirements in this section shall be confirmed by field verification and diagnostic testing in accordance with the procedures given in Reference Residential Appendix RA3.3.

i. 0.45 W/cfm for gas furnace air-handling units.

ii. 0.58 W/cfm for air-handling units that are not gas furnaces.

C. **Zonally Controlled Central Forced Air Systems.** Zonally controlled central forced air cooling systems shall be capable of simultaneously delivering, in every zonal control mode, an airflow from the dwelling, through the air handler fan and delivered to the dwelling, of greater than or equal to 350 cfm per ton of nominal cooling capacity, and operating at an air-handling unit fan efficacy of less than or equal to the maximum W/cfm specified in subsections i or ii below. The airflow rate and fan efficacy requirements in this section shall be confirmed by field verification and diagnostic testing in accordance with the applicable procedures specified in Reference Residential Appendix RA3.3.

i. 0.45 W/cfm for gas furnace air-handling units.

ii. 0.58 W/cfm for air-handling units that are not gas furnaces.

D. **Small Duct High Velocity Forced Air Systems.** Demonstrate, in every control mode, airflow greater than or equal to 250 cfm per ton of nominal cooling capacity through the return grilles, and an air-handling unit fan efficacy less than or equal to 0.62 W/cfm as confirmed by field verification and diagnostic testing in accordance with the procedures given in Reference Residential Appendix RA3.3

EXCEPTION 1 to Section 150.0(m)13B and D: Standard ducted systems without zoning dampers may comply by meeting the applicable requirements in TABLE 150.0-B or 150.0-C as confirmed by field verification and diagnostic testing in accordance with the procedures in Reference Residential Appendix Sections RA3.1.4.4 and RA3.1.4.5. The design clean-filter pressure drop requirements specified by Section 150.0(m)12Div for the system air filter(s) shall conform to the requirements given in TABLES 150.0-B and 150.0-C.

EXCEPTION 2 to Section 150.0(m)13B and D: Multispeed compressor systems or variable speed compressor systems shall verify airflow (cfm/ton) and fan efficacy (Watt/cfm) for system operation at the maximum compressor speed and the maximum air handler fan speed.

EXCEPTION 3 to Section 150.0(m)13B: Gas furnace air-handling units manufactured prior to July 3, 2019 shall comply with a fan efficacy value less than or equal to 0.58 w/cfm as confirmed by field verification and diagnostic testing in accordance with the procedures given in Reference Residential Appendix RA3.3.

EXCEPTION 1 to Section 150.0(m)13C: Multispeed or variable speed compressor systems, or single speed compressor systems that utilize the performance compliance approach, shall demonstrate compliance with the airflow (cfm/ton) and fan efficacy (Watt/cfm) requirements of Section 150.0(m)13C by operating the system at maximum compressor capacity and system fan speed with all zones calling for conditioning, rather than in every zonal control mode.

EXCEPTION 2 to Section 150.0(m)13C: Gas furnace air-handling units manufactured prior to July 3, 2019 shall comply with a fan efficacy value less than or equal to 0.58 w/cfm as confirmed by field verification and diagnostic testing in accordance with the procedures given in Reference Residential Appendix RA3.3.

(n) **Water Heating System**.

1. Systems using gas or propane water heaters to serve individual dwelling units shall ~~include the following components:~~ designate a space at least 2.5 feet by 2.5 feet wide and 7 feet tall suitable for the future installation of a heat pump water heater (HPWH) by meeting either A or B below. All electrical components shall be installed in accordance with the *California Electrical Code*:

   A. If the designated space is within 3 feet from the water heater, then this space shall include the following:

      i. A dedicated 125 volt, 20 amp electrical receptacle that is connected to the electric panel with a 120/240 volt 3 conductor, 10 AWG copper branch circuit, within 3 feet from the water heater and accessible to the water heater with no obstructions; and~~. In addition, all of the following:~~

      ii. Both ends of the unused conductor shall be labeled with the word “spare” and be electrically isolated; and

      iii. A reserved single pole circuit breaker space in the electrical panel adjacent to the circuit breaker for the branch circuit in A above and labeled with the words “Future 240V Use”; and

   ~~B. A Category III or IV vent, or a Type B vent with straight pipe between the outside termination and the space where the water heater is installed; and~~

      iv. ~~C.~~ A condensate drain that is no more than 2 inches higher than the base of the installed water heater, and allows natural draining without pump assistance~~.; and~~

   ~~D. A gas supply line with a capacity of at least 200,000 Btu/hr.~~

   B. If the designated space is more than 3 feet from the water heater, then this space shall include the following:

      i. A dedicated 240 volt branch circuit shall be installed within 3 feet from the designated space. The branch circuit shall be rated at 30 amps minimum. The blank cover shall be identified as “240V ready”; and

ii. The main electrical service panel shall have a reserved space to allow for the installation of a double pole circuit breaker for a future HPWH installation. The reserved space shall be permanently marked as "For Future 240V use"; and

iii. Either a dedicated cold water supply, or the cold water supply shall pass through the designated HPWH location just before reaching the gas or propane water heater; and

iv. The hot water supply pipe coming out of the gas or propane water heater shall be routed first through the designated HPWH location before serving any fixtures; and

v. The hot and cold water piping at the designated HPWH location shall be exposed and readily accessible for future installation of a HPWH; and

vi. A condensate drain that is no more than 2 inches higher than the base of the installed water heater, and allows natural draining without pump assistance.

2. Water heating recirculation loops serving multiple dwelling units shall meet the requirements of Section 110.3(c)4.

3. Solar water-heating systems and collectors shall be certified and rated by the Solar Rating and Certification Corporation (SRCC), the International Association of Plumbing and Mechanical Officials, Research and Testing (IAPMO R&T), or by a listing agency that is approved by the Executive Director.

4. Instantaneous water heaters with an input rating greater than 6.8 kBTU/hr (2kW) shall meet the requirements of Section 110.3(c)6.

(o) **Requirements for Ventilation and Indoor Air Quality.** All dwelling units shall meet the requirements of ASHRAE Standard 62.2, Ventilation and Acceptable Indoor Air Quality in Residential Buildings subject to the amendments specified in Section 150.0(o)1 below. All dwelling units shall comply with Section 150.0(o)2 below.

Exception to Section 150.0(o): The following sections of ASHRAE 62.2 shall not be required for compliance: Section 4.1.1, Section 4.1.2; Section 4.1.4; Section 4.3; Section 4.6, Section 5, Section 6.1.1, Section 6.5.2, and Normative Appendix A.

1. **Amendments to ASHRAE 62.2 requirements**.

A. **Window Operation.** Window operation is not a permissible method of providing the dwelling unit ventilation airflow specified in ~~subsections~~ Section 150.0(o)1C~~, E, or F~~ below.

B. **Central Fan Integrated (CFI) Ventilation Systems**. CFI ventilation systems shall meet the following requirements.

i. **Continuous Operation Prohibition**. Continuous operation of a dwelling unit's central forced air system air handler~~s~~ used in ~~central fan integrated~~CFI ventilation systems is not a permissible method of providing the whole-dwelling unit ventilation airflow required in Section 150.0(o)1C ~~Section 4 of ASHRAE Standard 62.2~~.

ii. **Outdoor Air Damper(s)**. A motorized damper(s) shall be installed on the connected ventilation duct(s) of CFI systems that prevents all airflow into or out of the space conditioning duct system when the damper(s) is closed.

iii. **Damper Control**. The required motorized damper(s) shall be controlled to be in an opened position when outdoor air ventilation is required for compliance, and shall be in the closed position when ventilation air is not required. The damper(s) shall be closed whenever the space conditioning system air handling unit is not operating. If the outdoor airflow for the CFI ventilation system is fan-powered, then the outdoor air fan shall not operate when the required motorized damper(s) on the outdoor air ventilation duct(s) is closed.

iv. **Variable Ventilation.** CFI ventilation systems shall incorporate controls that track outdoor air ventilation run time, and either open or close the required motorized damper(s) depending on whether or not outdoor air ventilation is required for compliance with section 150.0(o)1C. During

periods when comfort conditioning is not called for by the space conditioning thermostat, the CFI ventilation system controls shall operate the space conditioning system central fan and outdoor air damper(s) when necessary to ensure compliance with the minimum outdoor air ventilation required by sections 150.0(o) in accordance with applicable variable mechanical ventilation methods specified in ASHRAE 62.2 section 4.5.

C. **Whole-Dwelling Unit Mechanical Ventilation for Single-Family Detached and Townhouses.** Single-family detached dwelling units, and attached dwelling units not sharing ceilings or floors with other dwelling units, occupiable spaces, public garages, or commercial spaces shall have mechanical ventilation airflow ~~provided at rates determined in accordance with ASHRAE 62.2 Sections 4.1.1 and 4.1.2~~ as specified in subsections i, ii, and iii below.

i. **Total Required Ventilation Rate [ASHRAE 62.2:4.1.1].**

The total required ventilation rate shall be calculated using Equation 150.0-B

$$Q_{tot} = 0.03A_{floor} + 7.5(N_{br} + 1) \quad \text{(Equation 150.0-B)}$$

where

Q_{tot} = total required ventilation rate, cfm

A_{floor} = dwelling-unit floor area, ft^2

N_{br} = number of bedrooms (not to be less than 1)

ii. **Effective Annual Average Infiltration Rate.** The effective annual average infiltration rate shall be determined in accordance with subsections a and b:

a. An enclosure leakage rate in cubic feet per minute at 50 Pa (0.2 inch water) (Q_{50}) shall be determined by either subsection 1, or subsection 2 below.

1. Q_{50} shall be calculated based on the conditioned volume of the dwelling unit and a default value for dwelling unit envelope leakage of 2 air changes per hour at 50 PA (0.2 inch water) (2 ACH_{50}) as specified by equation 150.0-C below.

$$Q_{50} = V_{du} \times 2\ ACH_{50} / 60\ \text{min} \quad \text{(Equation 150.0-C)}$$

where

Q_{50} = leakage rate at 50 Pa

V_{du} = dwelling unit conditioned volume, ft^3

ACH_{50} = air changes per hour at 50 Pa (0.2 inch water)

2. If dwelling unit envelope leakage less than 2 ACH_{50} is confirmed by field verification and diagnostic testing, Q_{50} shall be calculated according to Equation 150.0-D below, using the value for dwelling unit envelope leakage less than 2 ACH_{50} verified by the procedures specified in Reference Residential Appendix RA3.8.

$$Q_{50} = V_{du} \times Verified\ ACH_{50} / 60\ \text{min} \quad \text{(Equation 150.0-D)}$$

where

Q_{50} = leakage rate at 50 Pa

V_{du} = dwelling unit conditioned volume, ft^3

ACH_{50} = air changes per hour at 50 Pa (0.2 inch water)

b. The Effective Annual Average Infiltration Rate (Q_{inf}) shall be calculated using Equation 150.0-E [ASHRAE 62.2:4.1.2.1].

$$Q_{inf} = 0.052 \times Q_{50} \times wsf \times [H/H_r]^z \quad \text{(Equation 150.0-E)}$$

where

Q_{inf} = effective annual infiltration rate, cfm (L/s)

Q_{50} = leakage rate at 50 Pa from equation 150.0-C, or equation 150.0-D

wsf = weather and shielding factor from Table 150.0-D

H = vertical distance between the lowest and highest above-grade points within the pressure boundary, ft (m)

H_r = reference height, 8.2 ft (2.5 m)

z = 0.4 for the purpose of calculating the Effective Annual Average Infiltration Rate

iii. **Required Mechanical Ventilation Rate [ASHRAE 62.2:4.1.2].**

The Required Mechanical Ventilation Rate (Q_{fan}) shall be calculated using Equation 150.0-F

$$Q_{fan} = Q_{tot} - \Phi\,(Q_{inf} \times A_{ext}) \quad \text{(Equation 150.0-F)}$$

where

Q_{fan} = required mechanical ventilation rate, cfm (L/s)

Q_{tot} = total required ventilation rate, cfm (L/s) from Equation 150.0-B

Q_{inf} = effective annual average infiltration rate, cfm (L/s) from Equation 150.0-E

A_{ext} = 1 for single-family detached homes, or the ratio of exterior envelope surface area that is not attached to garages or other dwelling units to total envelope surface area for attached dwelling units not sharing ceilings or floors with other dwelling units, occupiable spaces, public garages, or commercial spaces.

Φ=1 for balanced ventilation systems and Q_{inf}/Q_{tot} otherwise

D. **Air Filtration.** Air filtration shall conform to the specifications in Section 150.0(m)12. Compliance with ASHRAE 62.2 Sections 6.7 (Minimum Filtration) and 6.7.1 (Filter Pressure Drop) shall not be required.

E. **RESERVED.**~~Multifamily attached dwelling units shall have mechanical ventilation airflow provided at rates in accordance with Equation 150.0-B [ASHRAE 62.2:4.1.1], and comply with one of the following subsections i or ii below. When subsection ii below is utilized for compliance, all dwelling units in the multifamily building shall use the same ventilation system type.~~

~~i. A balanced ventilation system shall provide the required dwelling-unit ventilation airflow, or~~

~~ii. Continuously operating supply ventilation systems, or continuously operating exhaust ventilation systems shall be allowed to be used to provide the required dwelling unit ventilation airflow if the dwelling-unit envelope leakage is less than or equal to 0.3 cubic feet per minute at 50 Pa (0.2 inch water) per ft² of dwelling unit envelope surface area as confirmed by field verification and diagnostic testing in accordance with the procedures specified in Reference Residential Appendix RA3.8.~~

F. **RESERVED.**~~Multifamily building central ventilation systems that serve multiple dwelling units shall be balanced to provide ventilation airflow for each dwelling unit served at a rate equal to or greater than the rate specified by Equation 150.0-B [ASHRAE 62.2:4.1.1], but no more than twenty percent greater than the specified rate. These systems shall utilize balancing means to ensure the dwelling-unit airflows can be adjusted to meet this balancing requirement. These system balancing means may~~

~~include but not be limited to constant air regulation devices, orifice plates, and variable speed central fans.~~

G. **Local Mechanical Exhaust.** A local mechanical exhaust system shall be installed in each kitchen and bathroom. Systems shall be rated for airflow in accordance with ASHRAE 62.2 section 7.1.

i. **Nonenclosed kitchens** shall have a demand-controlled mechanical exhaust system meeting the requirements of Section 150.0(o)1Giii.

ii **Enclosed kitchens and all bathrooms** shall have either one of the following alternatives a or b:

a. A demand-controlled mechanical exhaust system meeting the requirements of Section 150.0(o)1Giii

b. A continuous mechanical exhaust system meeting the requirements of Section 150.0(o)1Giv.

iii **Demand-Controlled Mechanical Exhaust.** A local mechanical exhaust system shall be designed to be operated as needed.

a. **Control and Operation.** Demand-controlled mechanical exhaust systems shall be provided with at least one of the following controls:

1. A readily accessible occupant-controlled ON-OFF control

2. An automatic control that does not impede occupant ON control

b. **Ventilation Rate and Capture Efficiency.** The system shall meet or exceed either the minimum airflow in accordance with Table 150.0-E or the minimum capture efficiency in accordance with Table 150.0-E, and Table 150.0-G. Capture efficiency ratings shall be determined in accordance with ASTM E3087 and listed in a product directory approved by the Energy Commission.

iv. **Continuous Mechanical Exhaust.** A mechanical exhaust system shall be installed to operate continuously. The system may be part of a balanced mechanical ventilation system.

a. **Control and Operation**. A manual ON-OFF control shall be provided for each continuous mechanical exhaust system. The system shall be designed to operate during all occupiable hours. The ON-OFF control shall be accessible to the dwelling unit occupant.

Exception to 150.0(o)1Giva: For multifamily dwelling units, the manual ON-OFF control shall not be required to be accessible to the dwelling unit occupant.

b. **Ventilation Rate.** The minimum delivered ventilation shall be at least the amount indicated in Table 150.0-F during each hour of operation.

v**. Airflow Measurement of Local Mechanical Exhaust by The System Installer.** The airflow required by section 150.0(o)1G is the quantity of indoor air exhausted by the ventilation system as installed in the dwelling unit. When a vented range hood utilizes a capture efficiency rating to demonstrate compliance with 150.0(o)1Giiib, the airflow listed in the approved directory corresponding to the compliant capture efficiency rating point shall be met by the installed system. The as-installed airflow shall be verified by the system installer to ensure compliance by use of either subsection a or b below:

a. The system installer shall measure the airflow by using a flow hood, flow grid, or other airflow measuring device at the mechanical ventilation fan's inlet terminals/grilles or outlet terminals/grilles in accordance with the procedures in Reference Residential Appendix RA3.7.

b. As an alternative to performing an airflow measurement of the system as installed in the dwelling unit, compliance may be demonstrated by installing an exhaust fan and duct system that conforms to the specifications of Table 150.0-H. Visual inspection shall verify the installed system conforms to the requirements of Table 150.0-H.

When using Table 150.0-H for demonstrating compliance, the airflow rating shall be greater than or equal to the value required by Section 150.0(o)1G at a static pressure greater than or equal to 0.25 in. of water (62.5 Pa). When a vented range hood utilizes a capture efficiency rating to demonstrate compliance with 150.0(o)1Giiib, a static pressure greater than or equal to 0.25 in. of water at the rating point shall not be required, and the airflow listed in the approved directory corresponding to the compliant capture efficiency rating point shall be applied to Table 150.0-H for determining compliance.

Use of Table 150.0-H is limited to ventilation systems that conform to all of the following three specifications:

1. total duct length is less than or equal to 25 ft (8 m),
2. duct system has no more than three (3) elbows, and
3. duct system has exterior termination fitting with a hydraulic diameter greater than or equal to the minimum duct diameter and not less than the hydraulic diameter of the fan outlet.

vi. **Sound Ratings for Local Mechanical Exhaust.** Local mechanical exhaust systems ~~Kitchen range hoods~~ shall be rated for sound in accordance with Section 7.2 of ASHRAE 62.2 at no less than the minimum airflow rate required by Section 150.0(o)1G.

EXCEPTION to Section 150.0(o)1Gvi: Kitchen range hoods may be rated for sound at 100 cfm at a static pressure determined at working speed as specified in HVI 916 section 7.2.

H. **Airflow Measurement of Whole-Dwelling Unit Ventilation**. The airflow required by sections 150.0(o)1C is the quantity of outdoor ventilation air supplied or indoor air exhausted by the mechanical ventilation system as installed and shall be measured by using a flow hood, flow grid, or other airflow measuring device at the mechanical ventilation fan's inlet terminals/grilles or outlet terminals/grilles in accordance with the procedures in Reference Residential Appendix RA3.7. Balanced mechanical ventilation system airflow shall be the average of the supply fan and exhaust fan flows.~~Compliance with ASHRAE 62.2 Section 6.5.2 (Space Conditioning System Ducts) shall not be required~~.

I. **Sound Ratings for Whole-Dwelling Unit Ventilation Systems.** Whole-Dwelling unit ventilation systems shall be rated for sound in accordance with Section 7.2 of ASHRAE 62.2 at no less than the minimum airflow rate required by Sections 150.0(o)1C or 150.0(o)1E as applicable.

~~I~~J. **Label for Whole-Dwelling Unit Ventilation System On-Off Control**. Compliance with ASHRAE 62.2 Section 4.4 (Control and Operation) shall require manual ON-OFF control switches associated with whole-dwelling unit ventilation systems to have a label clearly displaying the following text, or equivalent text: "This switch controls the indoor air quality ventilation for the home. Leave ~~it~~ switch in the "on" position at all times unless the outdoor air quality is very poor."

K. **Combustion Air and Compensating Outdoor Air or Makeup Air**

i. All dwelling units shall conform to the applicable requirements specified in California Mechanical Code Chapter 7, Combustion Air.

ii. Atmospherically vented or solid fuel burning appliances shall not be installed inside the pressure boundary in dwelling units with conditioned floor area less than 1,000 ft^2.

iii. All dwelling units shall conform to the requirements in ASHRAE 62.2 Section 6.4, Combustion and Solid-Fuel-Burning Appliances.

2. **Field Verification and Diagnostic Testing.**

A. **Whole-Dwelling Unit Ventilation Airflow Performance**. The whole-dwelling unit ventilation airflow required by Sections 150.0(o)1C, 150.0(o)1E, and 150.0(o)1F shall be confirmed through field verification and diagnostic testing in accordance with the applicable procedures specified in Reference Residential Appendix RA3.7. Balanced mechanical ventilation system airflow shall be the average of

the supply fan and exhaust fan flows. Ventilation airflow of systems with multiple operating modes shall be tested in all modes designed to comply with the required ventilation airflows.

B. **Kitchen Local Mechanical Exhaust - Vented Range Hoods**. ~~**Kitchen Range Hoods.** The installed kitchen~~ Vented range hoods installed to comply with local mechanical exhaust requirements specified in 150.0(o)1G shall be field verified in accordance with the procedures in Reference Residential Appendix RA3.7.4.3 to confirm the model is rated by HVI or AHAM to comply with the following requirements:

i. The minimum ventilation airflow rate as specified ~~in~~ by Section 150.0(o)1G, or alternatively the minimum capture efficiency as specified by Section 150.0(o)1G.~~5 of ASHRAE 62.2.~~

ii The maximum sound rating as specified in Section 150.0(o)1Gvi.

C. **Heat Recovery Ventilation (HRV) and Energy Recovery Ventilation (ERV) System Fan Efficacy**. Systems with heat or energy recovery serving a single dwelling unit shall have a fan efficacy of ≤1.0 W/cfm as confirmed by HERS field verification in accordance with Reference Appendix RA3.7.4.4.

(p) **Pool Systems and Equipment Installation.** Any residential pool system or equipment installed shall comply with the applicable requirements of Section 110.4, as well as the requirements listed in this section.

1. **Pump sizing and flow rate.**

A. All pumps and pump motors installed shall be listed in the Commission's directory of certified equipment and shall comply with the Appliance Efficiency Regulations.

B. All pump flow rates shall be calculated using the following system equation:

$$H = C \times F^2$$

WHERE:

H is the total system head in feet of water.

F is the flow rate in gallons per minute (gpm).

C is a coefficient based on the volume of the pool:

0.0167 for pools less than or equal to 17,000 gallons.

0.0082 for pools greater than 17,000 gallons.

C. Filtration pumps shall be sized, or if programmable, shall be programmed, so that the filtration flow rate is not greater than the rate needed to turn over the pool water volume in 6 hours or 36 gpm, whichever is greater; and

D. Pump motors used for filtration with a capacity of 1 hp or more shall be multispeed; and

E. Each auxiliary pool load shall be served by either separate pumps or the system shall be served by a multispeed pump; and

EXCEPTION to Section 150.0(p)1E: Pumps less than 1 hp may be single speed.

F. Multispeed pumps shall have controls which default to the filtration flow rate when no auxiliary pool loads are operating; and

G. For multispeed pumps, the controls shall default to the filtration flow rate setting within 24 hours and shall have an override capability for servicing.

2. **System piping.**

A. A length of straight pipe that is greater than or equal to at least 4 pipe diameters shall be installed before the pump; and

B. Pool piping shall be sized so that the velocity of the water at maximum flow for auxiliary pool loads does not exceed 8 feet per second in the return line and 6 feet per second in the suction line; and

C. All elbows shall be sweep elbows or of an elbow-type that has a pressure drop of less than the pressure drop of straight pipe with a length of 30 pipe diameters.

3. **Filters.** Filters shall be at least the size specified in NSF/ANSI 50 for public pool intended applications.

4. **Valves.** Minimum diameter of backwash valves shall be 2 inches or the diameter of the return pipe, whichever is greater.

(q) **Fenestration Products.** Fenestration separating conditioned space from unconditioned space or outdoors shall meet the requirements of either Item 1 or 2 below:

1. Fenestration, including skylight products, must have a maximum U-factor of 0.~~58~~45.

EXCEPTION 1 to Section 150.0(q)1: Up to 10 square feet of fenestration area or 0.5 percent of the Conditioned Floor Area, whichever is greater, is exempt from the maximum U-factor requirement.

EXCEPTION 2 to Section 150.0(q)1: For dual-glazed greenhouse or garden windows, up to 30 square feet of fenestration area is exempt from the maximum U-factor requirement.

2. The area-weighted average U-factor of all fenestration, including skylight products, shall not exceed 0.~~58~~45.

(r) **Solar Ready Buildings.** Shall meet the requirements of Section 110.10 applicable to the building project.

(s) **Energy Storage Systems (ESS) Ready.** All single-family residences, that include one or two dwelling units shall meet the following. All electrical components shall be installed in accordance with the *California Electrical Code*:

1. At least one of the following shall be provided:

A. ESS ready interconnection equipment with a minimum backed up capacity of 60 amps and a minimum of four ESS supplied branch circuits, or

B. A dedicated raceway from the main service to a panelboard (subpanel) that supplies the branch circuits in 150.0(s)(2). All branch circuits are permitted to be supplied by the main service panel prior to the installation of an ESS. The trade size of the raceway shall be not less than one inch. The panelboard that supplies the branch circuits (subpanel) must be labeled "Subpanel shall include all backed-up load circuits."

2. A minimum of four branch circuits shall be identified and have their source of supply collocated at a single panelboard suitable to be supplied by the ESS. At least one circuit shall supply the refrigerator, one lighting circuit near the primary egress, and at least one circuit shall supply a sleeping room receptacle outlet.

3. The main panelboard shall have a minimum busbar rating of 225 amps.

4. Sufficient space shall be reserved to allow future installation of a system isolation equipment/transfer switch within 3 feet of the main panelboard. Raceways shall be installed between the panelboard and the system isolation equipment/transfer switch location to allow the connection of backup power source.

(t) **Heat Pump Space Heater Ready.** Systems using gas or propane furnace to serve individual dwelling units shall include the following:

1. A dedicated 240 volt branch circuit shall be installed within 3 feet from the furnace and accessible to the furnace with no obstructions. The branch circuit shall be rated at 30 amps minimum. The blank cover shall be identified as "240V ready". All electrical components shall be installed in accordance with the *California Electrical Code*.

2. The main electrical service panel shall have a reserved space to allow for the installation of a double pole circuit breaker for a future heat pump space heater installation. The reserved space shall be permanently marked as "For Future 240V use".

(u) **Electric Cooktop Ready.** Systems using gas or propane cooktop to serve individual dwelling units shall include the following:

1. A dedicated 240 volt branch circuit shall be installed within 3 feet from the cooktop and accessible to the cooktop with no obstructions . The branch circuit shall be rated at 50 amps minimum. The blank cover shall be identified as "240V ready". All electrical components shall be installed in accordance with the *California Electrical Code*.

2. The main electrical service panel shall have a reserved space to allow for the installation of a double pole circuit breaker for a future electric cooktop installation. The reserved space shall be permanently marked as "For Future 240V use".

(v) **Electric Clothes Dryer Ready.** Systems using gas or propane clothes dryer to serve individual dwelling units shall include the following:

1. A dedicated 240 volt branch circuit shall be installed within 3 feet from the clothes dryer and accessible to the clothes dryer with no obstructions . The branch circuit shall be rated at 30 amps minimum. The blank cover shall be identified as "240V ready". All electrical components shall be installed in accordance with the *California Electrical Code*.

2. The main electrical service panel shall have a reserved space to allow for the installation of a double pole circuit breaker for a future electric clothes dryer installation. The reserved space shall be permanently marked as "For Future 240V use".

TABLE 150.0-A CLASSIFICATION OF HIGH LUMINOUS EFFICACY LIGHT SOURCES

Light sources in this column are classified as high luminous efficacy and are **not** required to comply with Reference Joint Appendix JA8	Light sources in this column are required to comply with Reference Joint Appendix JA8 and shall be certified and marked as required by JA8.
1. LED light sources installed outdoors. 2. Inseparable Solid State Lighting (SSL) luminaires and colored light sources that are installed to provide decorative, accent, display, utility, undercabinet or special effect lighting. 3. Dim-to-warm and tunable-white LED light sources with at least one light source controller setting of 4000K or less and color rendering index (CRI) rating of 90 or greater. 4. Color-tunable LED light sources with at least one light source controller setting of 4000K or less. 5. LED lamps compliant with Title 20 as general service lamps and with a correlated color temperature (CCT) of 4000K or less. 6. Pin-based linear fluorescent or compact fluorescent light sources using electronic ballasts. 7. High intensity discharge (HID) light sources including pulse start metal halide and high pressure sodium light sources. 8. Luminaires with hardwired high frequency generator and induction lamp. 9. Ceiling Fan Light Kits compliant with Title 20 requirements.	10. All light sources installed in ceiling recessed downlight luminaires other than those specified in items 3, 4, or 5. Note that ceiling recessed downlight luminaires shall not have screw base sockets regardless of lamp type as specified in Section 150.0(k)1C. 11. Any light source not otherwise listed in this table.

~~**High Efficacy Light Sources**~~ ~~Light sources shall comply with one of the columns below:~~	
~~Light sources in this column other than those installed in ceiling recessed downlight luminaires are classified as high luminousefficacy and are **not** required to comply with Reference Joint Appendix JA8~~	~~Light sources in this column are required to comply with Reference Joint Appendix JA8only considered to be high efficacy if they and they are certified to the Commission as High Efficacy Light Sources in accordance withshall be certified to the Commission for complying with Reference Joint Appendix JA8 and marked as required by JA8.~~
~~1. Pin-based linear fluorescent or compact fluorescent light sources using electronic ballasts.~~	~~810. All light sources installed in ceiling recessed downlight luminaires. Note that ceiling recessed downlight~~

~~2. Pulse-start metal halide light sources.~~ ~~3. High pressure sodium light sources.~~ ~~4. Luminaires with hardwired high frequency generator and induction lamp.~~ ~~5. LED light sources installed outdoors.~~ ~~6. Inseparable Solid State Lighting (SSL) luminaires containing and colored light sources that are installed to provide decorative, accent, display, or special effect lighting.~~ ~~3. Dim-to-warm and tunable-white LED light sources with at least one light source controller setting of 4000K or less and color rendering index (CRI) rating of 0 or greater.~~ ~~4. Color-tunable LED light sources.~~ ~~5. LED lamps compliant with Title 20 as general service lamps and with a correlated color temperature (CCT) of 4000K or less.~~ ~~6. Pin-based linear fluorescent or compact fluorescent light sources using electronic ballasts.~~ ~~7. High intensity discharge (HID) light sources including pulse start metal halide and high pressure sodium light sources.~~ ~~8. Luminaires with hardwired high frequency generator and induction lamp.~~	~~luminaires shall not have screw bases regardless of lamp type as described in Section 150.0(k)1C.~~ ~~911. Any light source not otherwise listed in this table.~~

TABLE 150.0-B: Return Duct Sizing for Single Return Duct Systems

Return duct length shall not exceed 30 feet and shall contain no more than 180° of bend. If the total bending exceeds 90°, one bend shall be a metal elbow.

Return grille devices shall be labeled in accordance with the requirements in Section 150.0(m)12Biv to disclose the grille's design airflow rate and a maximum allowable clean-filter pressure drop of 25 Pa (0.1 inches water) for the air filter when tested using ASHRAE Standard 52.2, or as rated in accordance with AHRI Standard 680 for the design airflow rate for the return grille.

System Nominal Cooling Capacity (Ton)*	Return Duct Minimum Nominal Diameter (inch)	Minimum Total Return Filter Grille Nominal Area ($inch^2$)
1.5	16	500
2.0	18	600
2.5	20	800

*****Not applicable to systems with nominal cooling capacity greater than 2.5 tons or less than 1.5 ton

TABLE 150.0-C: Return Duct Sizing for Multiple Return Duct Systems

Each return duct length shall not exceed 30 feet and shall contain no more than 180° of bend. If the total bending exceeds 90°, one bend shall be a metal elbow.

Return grille devices shall be labeled in accordance with the requirements in Section 150.0(m)12Biv to disclose the grille's design airflow rate and a maximum allowable clean-filter pressure drop of 25 Pa (0.1 inches water) for the air filter when tested using ASHRAE Standard 52.2, or as rated in accordance with AHRI Standard 680 for the design airflow rate for the return grille.

System Nominal Cooling Capacity (Ton)*	Return Duct 1 Minimum Nominal Diameter (inch)	Return Duct 2 Minimum Nominal Diameter (inch)	Minimum Total Return Filter Grille Nominal Area ($inch^2$)
1.5	12	10	500
2.0	14	12	600
2.5	14	14	800
3.0	16	14	900
3.5	16	16	1000
4.0	18	18	1200
5.0	20	20	1500

*****Not applicable to systems with nominal cooling capacity greater than 5.0 tons or less than 1.5 tons.

TABLE 150.0-D: Infiltration Effectiveness Weather and Shielding Factors [ASHRAE 62.2:Table B1]

TMY3	wsf	Weather Station	Latitude	Longitude	State
690150	0.50	Twentynine Palms	34.30	–116.17	California
722860	0.43	March AFB	33.90	–117.25	California
722868	0.45	Palm Springs Intl	33.83	–116.50	California
722869	0.42	Riverside Muni	33.95	–117.45	California
722880	0.39	Burbank–Glendale–Pasadena AP	34.20	–118.35	California
722885	0.39	Santa Monica Muni	34.02	–118.45	California
722886	0.39	Van Nuys Airport	34.22	–118.48	California
722895	0.55	Lompoc (AWOS)	34.67	–120.47	California
722897	0.51	San Luis Co Rgnl	35.23	–120.63	California
722899	0.45	Chino Airport	33.97	–117.63	California
722900	0.38	San Diego Lindbergh Field	32.73	–117.17	California
722903	0.39	San Diego/Montgomery	32.82	–117.13	California
722904	0.40	Chula Vista Brown Field NAAS	32.58	–116.98	California
722906	0.39	San Diego North Island NAS	32.70	–117.20	California
722926	0.40	Camp Pendleton MCAS	33.30	–117.35	California
722927	0.38	Carlsbad/Palomar	33.13	–117.28	California
722930	0.39	San Diego Miramar NAS	32.87	–117.13	California
722950	0.42	Los Angeles Intl Arpt	33.93	–118.40	California
722956	0.38	Jack Northrop Fld H	33.92	–118.33	California
722970	0.38	Long Beach Daugherty Fld	33.83	–118.17	California
722976	0.34	Fullerton Municipal	33.87	–117.98	California
722977	0.36	Santa Ana John Wayne AP	33.68	–117.87	California
723805	0.51	Needles Airport	34.77	–114.62	California
723810	0.59	Edwards AFB	34.90	–117.87	California
723815	0.58	Daggett Barstow–Daggett AP	34.85	–116.80	California
723816	0.62	Lancaster Gen Wm Fox Field	34.73	–118.22	California
723820	0.57	Palmdale Airport	34.63	–118.08	California
723830	0.68	Sandberg	34.75	–118.72	California
723840	0.43	Bakersfield Meadows Field	35.43	–119.05	California
723890	0.45	Fresno Yosemite Intl AP	36.78	–119.72	California
723895	0.42	Porterville (AWOS)	36.03	–119.07	California
723896	0.43	Visalia Muni (AWOS)	36.32	–119.40	California
723910	0.45	Point Mugu Nf	34.12	–119.12	California
723925	0.44	Santa Barbara Municipal AP	34.43	–119.85	California
723926	0.43	Camarillo (AWOS)	34.22	–119.08	California
723927	0.45	Oxnard Airport	34.20	–119.20	California
723940	0.52	Santa Maria Public Arpt	34.92	–120.47	California

TABLE 150.0-D: Infiltration Effectiveness Weather and Shielding Factors [ASHRAE 62.2:Table B1] (continued)

TMY3	wsf	Weather Station	Latitude	Longitude	State
723965	0.53	Paso Robles Municipal Arpt	35.67	–120.63	California
724800	0.55	Bishop Airport	37.37	–118.35	California
724815	0.46	Merced/Macready Fld	37.28	–120.52	California
724830	0.51	Sacramento Executive Arpt	38.50	–121.50	California
724837	0.45	Beale AFB	39.13	–121.43	California
724838	0.50	Yuba Co	39.10	–121.57	California
724839	0.51	Sacramento Metropolitan AP	38.70	–121.58	California
724915	0.49	Monterey Naf	36.60	–121.87	California
724917	0.54	Salinas Municipal AP	36.67	–121.60	California
724920	0.50	Stockton Metropolitan Arpt	37.90	–121.23	California
724926	0.47	Modesto City–County AP	37.63	–120.95	California
724927	0.53	Livermore Municipal	37.70	–121.82	California
724930	0.54	Oakland Metropolitan Arpt	37.72	–122.22	California
724935	0.47	Hayward Air Term	37.67	–122.12	California
724936	0.53	Concord–Buchanan Field	38.00	–122.05	California
724940	0.60	San Francisco Intl AP	37.62	–122.40	California
724945	0.48	San Jose Intl AP	37.37	–121.93	California
724955	0.55	Napa Co. Airport	38.22	–122.28	California
724957	0.49	Santa Rosa (AWOS)	38.52	–122.82	California
725845	0.44	Blue Canyon AP	39.30	–120.72	California
725846	0.66	Truckee–Tahoe	39.32	–120.13	California
725847	0.64	South Lake Tahoe	38.90	–120.00	California
725905	0.47	Ukiah Municipal AP	39.13	–123.20	California
725910	0.50	Red Bluff Municipal Arpt	40.15	–122.25	California
725920	0.47	Redding Municipal Arpt	40.52	–122.32	California
725945	0.56	Arcata Airport	40.98	–124.10	California
725946	0.60	Crescent City Faa Ai	41.78	–124.23	California
725955	0.55	Montague Siskiyou County AP	41.78	–122.47	California
725958	0.59	Alturas	41.50	–120.53	California
745090	0.45	Mountain View Moffett Fld NAS	37.40	–122.05	California
745160	0.67	Travis Field AFB	38.27	–121.93	California
746120	0.52	China Lake Naf	35.68	–117.68	California
747020	0.50	Lemoore Reeves NAS	36.33	–119.95	California
747185	0.46	Imperial	32.83	–115.58	California
747187	0.46	Palm Springs Thermal AP	33.63	–116.17	California
747188	0.48	Blythe Riverside Co Arpt	33.62	–114.72	California

Table 150.0-E Demand-Controlled Local Ventilation Exhaust Airflow Rates and Capture Efficiency

Application	Compliance Criteria
Enclosed Kitchen or Nonenclosed Kitchen	Vented range hood, including appliance-range hood combinations shall meet either the capture efficiency (CE) or the airflow rate specified in Table 150.0-G as applicable.
Enclosed Kitchen	Other kitchen exhaust fans, including downdraft: 300 cfm (150 L/s) or a capacity of 5 ACH
Nonenclosed Kitchen	Other kitchen exhaust fans, including downdraft: 300 cfm (150 L/s)
Bathroom	50 cfm (25 L/s)

Table 150.0-F Continuous Local Ventilation Exhaust Airflow Rates

Application	Airflow
Enclosed kitchen	5 ach, based on kitchen volume
Bathroom	20 cfm (10 L/s)

Table 150.0-G Kitchen Range Hood Airflow Rates (cfm) and ASTM E3087 Capture Efficiency (CE) Ratings According to Dwelling Unit Floor Area and Kitchen Range Fuel Type

Dwelling Unit Floor Area (ft^2)	Hood Over Electric Range	Hood Over Natural Gas Range
>1500	50% CE or 110 cfm	70% CE or 180 cfm
>1000 - 1500	50% CE or 110 cfm	80% CE or 250 cfm
750 - 1000	55% CE or 130 cfm	85% CE or 280 cfm
<750	65% CE or 160 cfm	85% CE or 280 cfm

Table 150.0-H Prescriptive Ventilation System Duct Sizing [ASHRAE 62.2:Table 5-3]

Fan Airflow Rating, cfm at minimum static pressure[f] 0.25 in. water (L/s at minimum 62.5 Pa)	≤50 (25)	≤80 (40)	≤100 (50)	≤125 (60)	≤150 (70)	≤175 (85)	≤200 (95)	≤250 (120)	≤350 (165)	≤400 (190)	≤450 (210)	≤700 (330)	≤800 (380)
Minimum Duct Diameter, in. (mm) [a,b] For Rigid duct	4 [e] (100)	5 (125)	5 (125)	6 (150)	6 (150)	7 (180)	7 (180)	8 (205)	9 (230)	10 (255)	10 (255)	12 (305)	12 [d] (305)
Minimum Duct Diameter, in. (mm) [a,b] For Flex duct [c]	4 (100)	5 (125)	6 (150)	6 (150)	7 (150)	7 (180)	8 (205)	8 (205)	9 (230)	10 (255)	NP	NP	NP

Footnotes for Table 150.0-H:

a. For noncircular ducts, calculate the diameter as four times the cross-sectional area divided by the perimeter.

b. NP = application of the prescriptive table is not permitted for this scenario.

c. Use of this table for verification of flex duct systems requires flex duct to be fully extended and any flex duct elbows to have a minimum bend radius to duct diameter ratio of 1.0.

d. For this scenario, use of elbows is not permitted.

e. For this scenario, 4 in. (100 mm) oval duct shall be permitted, provided the minor axis of the oval is greater than or equal to 3 in. (75 mm)

f. When a vented range hood utilizes a capture efficiency rating to demonstrate compliance with 150.0(o)1Giiib, a static pressure greater than or equal to 0.25 in. of water at the rating point shall not be required, and the

airflow listed in the approved directory corresponding to the compliant capture efficiency rating point shall be applied to Table 150.0-H for determining compliance.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SUBCHAPTER 8
~~LOW-RISE~~SINGLE-FAMILY RESIDENTIAL BUILDINGS - PERFORMANCE AND PRESCRIPTIVE COMPLIANCE APPROACHES

SECTION 150.1 – PERFORMANCE AND PRESCRIPTIVE COMPLIANCE APPROACHES FOR ~~LOW-RISE~~SINGLE-FAMILY RESIDENTIAL BUILDINGS

(a) **Basic Requirements.** ~~Low-rise~~ Single-family residential buildings shall meet all of the following:

1. The applicable requirements of Sections 110.0 through 110.10.
2. The applicable requirements of Section 150.0 (mandatory features).
3. Either the performance standards or the prescriptive standards set forth in this section for the Climate Zone in which the building is located. Climate zones are shown in Reference Joint Appendix JA2 – Weather/Climate Data.

   EXCEPTION to Section 150.1(a)3: If a single contiguous subdivision or tract falls in more than one Climate Zone, all buildings in the subdivision or tract may be designed to meet the performance or prescriptive standards for the Climate Zone that contains 50 percent or more of the dwelling units.

   NOTE: The Commission periodically updates, publishes, and makes available to interested persons and local enforcement agencies precise descriptions of the Climate Zones, as specified in Reference Joint Appendix JA2 – Weather/Climate Data.

NOTE: The requirements of Sections 150.0(a) through 150.0(r) apply to newly constructed buildings and Sections 150.2(a) and 150.2(b) specifies changes to the requirements of Sections 150.1(a) through 150.1(c) that apply to additions or alterations.

(b) **Performance Standards.** A building complies with the performance standards if the energy consumption calculated for the Proposed Design Building is no greater than the energy budget calculated for the Standard Design Building using Commission-certified compliance software as specified by the Alternative Calculation Methods Approval Manual.

1. Newly Constructed Buildings. The Energy Budget for newly constructed buildings is expressed in terms of the Energy Design Rating, which is based on time-dependent valuation (TDV) energy. The Energy Design Rating (EDR) has two components, the Energy Efficiency Design Rating, and the Solar Electric Generation and Demand Flexibility Design Rating. The Solar Electric Generation and Demand Flexibility Design Rating shall be subtracted from the Energy Efficiency Design Rating to determine the Total Energy Design Rating. The Proposed Building shall separately comply with the Energy Efficiency Design Rating and the Total Energy Design Rating.

EXCEPTION to Section 150.1(b)1. A community shared solar electric generation system, or other renewable electric generation system, and/or community shared battery storage system, which provides dedicated power, utility energy reduction credits, or payments for energy bill reductions, to the permitted building and is approved by the Energy Commission as specified in Title 24, Part 1, Section 10-115, may offset part or all of the solar electric generation system Energy Design Rating required to comply with the Standards, as calculated according to methods established by the Commission in the Residential ACM Reference Manual.

2. Additions and Alterations to Existing Buildings. The Energy Budget for additions and alterations is expressed in terms of TDV energy.

3. **Compliance Demonstration Requirements for Performance Standards**.

A. **Certificate of Compliance and Application for a Building Permit.** The application for a building permit shall include documentation pursuant to Sections 10-103(a)1 and 10-103(a)2 which demonstrates, using an approved calculation method, that the building has been designed so that its Energy Efficiency Design Rating and the total EDR meets or exceeds the Standard design EDR for the applicable Climate Zone.

EXCEPTION to Section 150.1(b)3A: Multiple Orientation: A permit applicant may demonstrate compliance with the energy budget requirements of Section 150.1(a) and (b) for any orientation of the same building model if the documentation demonstrates that the building model with its proposed designs and features would comply in each of the four cardinal orientations.

B. **Field Verification**. When performance of installed features, materials, components, manufactured devices or systems above the minimum specified in Section 150.1(c) is necessary for the building to comply with Section 150.1(b), or is necessary to achieve a more stringent local ordinance, field verification shall be performed in accordance with the applicable requirements in the following subsections, and the results of the verification(s) shall be documented on applicable Certificates of Installation pursuant to Section 10-103(a)3 and applicable Certificates of Verification pursuant to Section 10-103(a)5.

i. **EER/SEER/CEER/HSPF Rating.** When performance compliance requires installation of a space conditioning system with a ~~SEER~~ rating that is greater than the minimum ~~SEER~~ rating required by TABLE 150.1-A or B or specified for the standard design, the installed system shall be field verified in accordance with the procedures specified in the applicable sections of Reference Residential Appendix RA3.4~~.4.1~~.

ii. **Variable Capacity Heat Pump (VCHP) Compliance Option**. When performance compliance requires installation of a heat pump system that meets all the requirements of the VCHP compliance option specified in the ACM Reference Manual, the system shall be field verified in accordance with the procedures in Reference Residential Appendix RA3.4.4.3.~~**EER Rating.** When performance compliance requires installation of a space conditioning system with an EER rating greater than the standard design value for EER, the installed system shall be field verified in accordance with the procedures specified in Reference Residential Appendix RA3.4.4.1.~~

iii. **Low Leakage Air Handler.** When performance compliance requires installation of a low leakage air-handling unit, the installed air-handling unit shall be field verified in accordance with the procedures specified in Reference Residential Appendix RA3.1.4.3.9.

iv. RESERVED~~**HSPF Rating.** When performance compliance requires installation of a heat pump system with a Heating Seasonal Performance Factor (HSPF) rating that is greater than the minimum HSPF rating required by TABLE 150.1-A or B, the installed system shall be field verified in accordance with the procedures specified in Reference Residential Appendix RA3.4.4.1.~~

v. **Heat Pump** - **Rated Heating Capacity.** When performance compliance requires installation of a heat pump system, the heating capacity values at 47° F and 17° F shall be field verified in accordance with the procedures specified in Reference Residential Appendix RA3.4~~.4.2~~.

vi. **Whole-house fan**. When performance compliance requires installation of a whole-house fan, the whole-house fan ventilation airflow rate and fan efficacy shall be field verified in accordance with the procedures in Reference Residential Appendix RA3.9.

vii. **Central Fan Ventilation Cooling System**. When performance compliance requires installation of a central fan ventilation cooling system, the installed system shall be field verified in accordance with the procedures in Reference Residential Appendix RA3.3.4.

viii. **Building Enclosure Air Leakage**. When performance compliance requires a building enclosure leakage rate that is lower than the standard design, the building enclosure shall be field verified in accordance with the procedures specified in Reference Residential Appendix RA3.8.

ix. **Quality Insulation Installation (QII).** When performance compliance requires field verification of QII, the building insulation system shall be field verified in accordance with the procedures in Reference Residential Appendix RA3.5.

(c) **Prescriptive Standards/Component Packages.** Buildings that comply with the prescriptive standards shall be designed, constructed, and equipped to meet all of the requirements for the appropriate Climate Zone shown in TABLE 150.1-A or B. In TABLE 150.1-A and TABLE 150.1-B, NA (not allowed) means that feature is not permitted in a particular Climate Zone and NR (no requirement) means that there is no prescriptive requirement for that feature in a particular Climate Zone. Installed components shall meet the following requirements:

1. **Insulation.**

A. Roof and Ceiling insulation shall be installed in a ventilated attic with an R-value equal to or greater than that shown in TABLE 150.1-A or B meeting options ii or iii below.

i. Option A: RESERVED.

ii. Option B: A minimum R-value of insulation installed between the roof rafters in contact with the roof deck and an additional layer of ceiling insulation located between the attic and the conditioned space when meeting Section 150.1(c)9A; or

iii. Option C: A minimum R-value of ceiling insulation located between the attic and the conditioned space when meeting Section 150.1(c)9B.

NOTE: Low rise residential single-family and multifamily buildings with the ducts and air handler located in the conditioned space, as specified by Section 150.1(c)9B, need only comply with insulation requirements of Option C.

B. **Walls.**

i. Framed exterior walls shall be insulated such that the exterior wall has an assembly U-factor equal to or less than that shown in TABLE 150.1-A or B. The U-factors shown are maximum U-factors for the exterior wall assembly.

ii. Mass walls above grade and below grade shall be insulated such that the wall has an assembly U-factor equal to or less than that shown in TABLE 150.1-A or B, or walls shall be insulated with continuous insulation that has an R-value equal to or greater than that shown in TABLE 150.1-A or B. “Interior” denotes continuous insulation installed on the inside surface of the wall, and “exterior” denotes continuous insulation installed on the outside surface of the wall.

iii. Other unframed exterior walls, excluding mass walls, shall meet the requirements for framed walls shown in TABLE 150.1-A or B.

C. Raised-floors shall be insulated such that the floor assembly has an assembly U-factor equal to or less than shown in TABLE 150.1-A or B, or shall be insulated between wood framing with insulation having an R-value equal to or greater than that shown in TABLE 150.1-A or B.

EXCEPTION to Section 150.1(c)1C: Raised-floor insulation may be omitted if the foundation walls are insulated to meet the wall insulation minimums shown in TABLE 150.1-A or B, and a vapor retarder is placed over the entire floor of the crawl space, and the vents are fitted with automatically operated louvers, and the requirements of Reference Residential Appendix RA4.5.1 are met.

D. Slab floor perimeter insulation shall be installed with a U-factor equal to or less than or R-value equal to or greater than shown in TABLE 150.1-A or B. The minimum depth of concrete-slab floor perimeter insulation shall be 16 inches or the depth of the footing of the building, whichever is less.

EXCEPTION to Section 150.1(c)1: The insulation requirements of TABLEs 150.1-A and 150.1-B may also be met by ceiling, roof deck, wall, or floor assemblies that meet the required maximum U-factors using a U-factor calculation method that considers the thermal effects of all elements of the assembly and is approved by the Executive Director.

E. All buildings shall comply with the Quality Insulation Installation (QII) requirements shown in TABLE 150.1-A or B. When QII is required, insulation installation shall meet the criteria specified in Reference Appendix RA3.5.

2. **Radiant Barrier.** A radiant barrier required in TABLE 150.1-A or B shall meet the requirements specified in Section 110.8(j), and shall meet the installation criteria specified in the Reference Residential Appendix RA4.

3. **Fenestration.**

A. Installed fenestration products, including glazed doors, shall have an area-weighted average U-factor and Solar Heat Gain Coefficient (SHGC) meeting the applicable fenestration value in TABLE 150.1-A or B and shall be determined in accordance with Sections 110.6(a)2 and 110.6(a)3.

EXCEPTION 1 to Section 150.1(c)3A: For each dwelling unit up to 3 square feet of new glazing area installed in doors and up to 3 square feet of new tubular skylights area with dual-pane diffusers shall not be required to meet the U-factor and SHGC requirements of TABLE 150.1-A or B.

EXCEPTION 2 to Section 150.1(c)3A: For each dwelling unit up to 16 square feet of new skylight area with a maximum U-factor of 0.55 and a maximum SHGC of 0.30.

EXCEPTION 3 to Section 150.1(c)3A For fenestration containing chromogenic type glazing:

i. The lower-rated labeled U-factor and SHGC shall be used with automatic controls to modulate the amount of solar gain and light transmitted into the space in multiple steps in response to daylight levels or solar intensity;

ii. Chromogenic glazing shall be considered separately from other fenestration; and

iii. Area-weighted averaging with other fenestration that is not chromatic shall not be permitted and shall be determined in accordance with Section 110.6(a).

EXCEPTION 4 to Section 150.1(c)3A: For dwelling units containing unrated site-built fenestration that meets the maximum area restriction, the U-factor and SHGC can be determined in accordance with the Nonresidential Reference Appendix NA6 or use default values in TABLE 110.6-A and TABLE 110.6-B.

B. The maximum total fenestration area shall not exceed the percentage of conditioned floor area, CFA, as indicated in TABLE 150.1-A or B. Total fenestration includes skylights and west-facing glazing.

C. The maximum west-facing fenestration area shall not exceed the percentage of conditioned floor area as indicated in TABLE 150.1-A or B. West-facing fenestration area includes skylights tilted in any direction when the pitch is less than 1:12.

4. **Shading.** Where TABLE 150.1-A or B requires a Maximum SHGC, the requirements shall be met by one of the following:

A. Complying with the required SHGC pursuant to Section 150.1(c)3A; or

B. An exterior operable shading louver or other exterior shading device that meets the required SHGC; or

C. A combination of Items A and B to achieve the same performance as achieved in Section 150.1(c)3A.

D. For south-facing glazing only, optimal overhangs shall be installed so that the south-facing glazing is fully shaded at solar noon on August 21 and substantially exposed to direct sunlight at solar noon on December 21.

E. Exterior shading devices must be permanently secured with attachments or fasteners that are not intended for removal.

EXCEPTION to Section 150.1(c)4E: Where the California Building Code (CBC) requires emergency egress or where compliance would conflict with Health and Safety regulations.

5. **Doors.** Installed swinging door products separating conditioned space from outside or adjacent unconditioned space, but not including glazed door products, shall have an area-weighted average U-factor no greater than the applicable door value in TABLE 150.1-A or B and shall be determined in accordance with Section 110.6(a)2. Glazed door products are treated as fenestration products in Sections 150.1(c)3 and 150.1(c)4.

EXCEPTION to Section 150.1(c)5: Swinging doors between the garage and conditioned space that are required to have fire protection are not required to meet the applicable door value in TABLE 150.1-A or B.

6. **Heating System Type.** Heating system types shall be installed as required in TABLE 150.1-A or B.

   EXCEPTION to Section 150.1(c)6: A supplemental heating unit may be installed in a space served directly or indirectly by a primary heating system, provided that the unit thermal capacity does not exceed 2 kW or 7,000 Btu/hr and is controlled by a time-limiting device not exceeding 30 minutes.

7. **Space Heating and Space Cooling.** All space heating and space cooling equipment shall comply with minimum Appliance Efficiency Regulations as specified in Sections 110.0 through 110.2 and meet all applicable requirements of Sections 150.0 and 150.1(c)7A. <u>For climate zones 3, 4, 10, 13 and 14, the space conditioning system shall be a heat pump, or shall meet the performance compliance requirements of Section 150.1(b)1.</u>

   A. **Refrigerant Charge**. When refrigerant charge verification or fault indicator display is shown as required by TABLE 150.1-A or B, the system shall comply with either Section 150.1(c)7Ai or 150.1(c)7Aii:

      i. air-cooled air conditioners and air-source heat pumps, including but not limited to ducted split systems, ducted packaged systems, small duct high velocity systems, and mini-split systems, shall comply with subsections a, b and c, unless the system is of a type that cannot be verified using the specified procedures:

         a. Have measurement access holes (MAH) installed according to the specifications in Reference Residential Appendix Section RA3.2.2.3; and

            EXCEPTION to Section 150.1(c)7Aia: Systems that cannot conform to the specifications for hole location in Reference Residential Appendix Figure RA3.2-1, shall not be required to provide holes as described in Figure RA3.2-1.

         b. System airflow rate in accordance with subsection I or II shall be confirmed through field verification and diagnostic testing in accordance with all applicable procedures specified in Reference Residential Appendix Section RA3. 3 or an approved alternative procedure as specified by Section RA1; and

            I. For small duct high velocity systems the system airflow rate shall be greater than or equal to 250 cfm per ton; or

            II. For all other air-cooled air conditioner or air-source heat pump systems the system airflow rate shall be greater than or equal to 350 cfm per ton.

            EXCEPTION to Section 150.1(c)7Aib: Standard ducted systems without zoning dampers may comply with the minimum airflow rate by meeting the applicable requirements in TABLE-150.0-B or 150.0-C as confirmed by field verification and diagnostic testing in accordance with the procedures in Reference Residential Appendix Section RA3.1.4.4 and RA3.1.4.5. The design clean-filter pressure drop requirements of Section 150.0(m)12D for the system air filter device(s) shall conform to the requirements given in TABLES 150.0-B and 150.0-C.

         c. The installer shall charge the system according to manufacturer's specifications. Refrigerant charge shall be verified according to one of the following options, as applicable:

            I. The installer and rater shall perform the standard charge procedure as specified by Reference Residential Appendix Section RA3.2.2 or an approved alternative procedure as specified by Section RA1; or

            II. The system shall be equipped with a fault indicator display (FID) device that meets the specifications of Reference Joint Appendix JA6. The installer shall verify the refrigerant charge and FID device in accordance with the procedures in Reference Residential Appendix Section RA3.4.2. The HERS Rater shall verify FID device in accordance with the procedures in Section RA3.4.2; or

            III. The installer shall perform the weigh-in charging procedure as specified by Reference Residential Appendix Section RA3.2.3.1 provided the system is of a type that can be verified using the

Section RA3.2.2 standard charge verification procedure and Section RA3.3 airflow rate verification procedure or approved alternatives in Section RA1. The HERS Rater shall verify the charge using Sections RA3.2.2 and RA3.3 or approved alternatives in Section RA1.

EXCEPTION 1 to Section 150.1(c)7Aic: When the outdoor temperature is less than 55° F and the installer utilizes the weigh-in charging procedure in Reference Residential Appendix Section RA3.2.3.1 to verify the refrigerant charge, the installer may elect to utilize the HERS Rater verification procedure in Reference Residential Appendix Section RA3.2.3.2. If the HERS Rater verification procedure in Section RA3.2.3.2 is used for compliance, the system's thermostat shall conform to the specifications in Section 110.12. Ducted systems shall comply with minimum system airflow rate requirement in Section 150.1(c)7Aib.

ii. Air-cooled air conditioners and air-source heat pumps, including but not limited to ducted split systems, ducted packaged systems, small duct high velocity systems and mini-split systems, which are of a type that cannot comply with the requirements of Section 150.1(c)7Ai shall comply with subsections a and b, as applicable.

a. The installer shall confirm the refrigerant charge using the weigh-in charging procedure specified in Reference Residential Appendix Section RA3.2.3.1, as verified by a HERS Rater according to the procedures specified in Reference Residential Appendix Section RA3.2.3.2; and

b. Systems that utilize forced air ducts shall comply with the minimum system airflow rate requirement in Section 150.1(c)7Aib provided the system is of a type that can be verified using the procedures in Section RA3.3 or an approved alternative procedure in Section RA1.

EXCEPTION to Section 150.1(c)7A: Packaged systems for which the manufacturer has verified correct system refrigerant charge prior to shipment from the factory are not required to have refrigerant charge confirmed through field verification and diagnostic testing. The installer of these packaged systems shall certify on the Certificate of Installation that the packaged system was pre-charged at the factory and has not been altered in a way that would affect the charge. Ducted systems shall comply with minimum system airflow rate requirements in Section 150.1(c)7Aib, provided that the system is of a type that can be verified using the procedure specified in Section RA3.3 or an approved alternative in Section RA1.

8. **Domestic Water-Heating Systems.** Water-heating systems shall meet the requirements of A, B, C, or shall meet the performance compliance requirements of Section 150.1(b)1~~C~~. For recirculation distribution systems~~ serving individual dwelling unit~~, only Demand Recirculation Systems with manual on/off control as specified in the Reference Appendix RA4.4.9 shall be used:

A. ~~A. For systems serving individual dwelling units, the water heating system shall meet the requirement of i, ii, iii, iv, or v:~~

~~A. i. One or more gas or propane instantaneous water heater with an input of 200,000 Btu per hour or less and no storage tank.~~

~~B. ii. A single gas or propane storage type water heater with an input of 75,000 Btu per hour or less, rated volume less than or equal to 55 gallons and that meets the requirements of Sections 110.1 and 110.3. The dwelling unit shall have installed fenestration products with a weighted average U-factor no greater than 0.24, and in addition one of the following shall be installed:~~

~~C. a. A compact hot water distribution system that is field verified as specified in the Reference Appendix RA4.4.16; or~~

~~D. b. A drain water heat recovery system that is field verified as specified in the Reference Appendix RA3.6.9.~~

~~iii. A single gas or propane storage type water heater with an input of 75,000 Btu per hour or less, rated volume of more than 55 gallons.~~

~~iv.~~ A single 240 volt heat pump water heater (HPWH). The storage tank shall be located in the garage or conditioned space. In addition, ~~one of~~meet the following:

ia. A compact hot water distribution system as specified in the Reference Appendix RA4.4.6 and in climate zone 1 and 16; and

ii aA drain water heat recovery system that is field verified as specified in the Reference Appendix RA3.6.9 in climate 16; or

b. For Climate Zones 2 through 15, a photovoltaic system capacity of 0.3 kWdc larger than the requirement specified in Section 150.1(c)14; or

c. For Climate Zones 1 and 16, a photovoltaic system capacity of 1.1 kWdc larger than the requirement specified in Section 150.1(c)14.

B. v. A single 240 volt heat pump water heaterHPWH that meets the requirements of NEEA Advanced Water Heater Specification Tier 3 or higher. The storage tank shall be located in the garage or conditioned space. In addition, for Climate Zones 1 and 16, a photovoltaic system capacity of 0.3 kWdc larger than the requirement specified in Section 150.1(c)14 or a compact hot water distribution system as specified in the Reference Appendix RA4.4.6. a drain water heat recovery system that is field verified as specified in the Reference Appendix RA3.6.9 and the storage tank shall be located in the garage or conditioned space.

C. A solar water-heating system with electric backup meeting the installation criteria specified in Reference Residential Appendix RA4 and with a minimum annual solar savings fraction of 0.7.

EXCEPTION 1 to Section 150.1(c)8: For climate zones 3, 4, 10, 13 and 14, a gas or propane instantaneous water heater with an input of 200,000 Btu per hour or less and no storage tank may be installed.

NOTE: The space conditioning system shall be a heat pump as specified in Section 150.1(c)7.

EXCEPTION 2 to Section 150.1(c)8: An instantaneous electric water heater with point of use distribution as specified in RA4.4.5 may be installed for a junior accessory dwelling unit (JADU).

EXCEPTION 3 to Section 150.1(c)8A and B: A 120V HPWH may be installed in place of a 240V HPWH for new dwelling unit with 1 bedroom or less. B. For systems serving multiple dwelling units, a central water-heating system that includes the following components shall be installed:

i. Gas or propane water heating system.

ii. A recirculation system that meets the requirements of Sections 110.3(c)2 and 110.3(c)4, includes two or more separate recirculation loops serving separate dwelling units, and is capable of automatically controlling the recirculation pump operation based on measurement of hot water demand and hot water return temperature.

EXCEPTION to Section 150.1(c)8Bii: Buildings with eight or fewer dwelling units may use a single recirculation loop.

iii. A solar water-heating system meeting the installation criteria specified in Reference Residential Appendix RA4 and with a minimum solar savings fraction of either a or b:

a. A minimum solar savings fraction of 0.20 in Climate Zones 1 through 9 or a minimum solar savings fraction of 0.35 in Climate Zones 10 through 16.

b. A minimum solar savings fraction of 0.15 in Climate Zones 1 through 9 or a minimum solar savings fraction of 0.30 in Climate Zones 10 through 16. In addition, a drain water heat recovery system that is field verified as specified in the Reference Appendix RA3.6.9.

C. A water-heating system serving multiple dwelling units determined by the Executive Director to use no more energy than the one specified in subsection B.

9. **Space Conditioning Distribution Systems.** All space conditioning systems shall meet all applicable requirements of A or B below:

A. High performance attics. Air handlers or ducts are allowed to be in ventilated attic spaces when the roof and ceiling insulation level meet Option B in TABLE 150.1-A or B. Duct insulation levels shall meet the requirements in TABLE 150.1-A or B.

B. Duct and air handlers located in conditioned space. Duct systems and air handlers of HVAC systems shall be located in conditioned space, and confirmed by field verification and diagnostic testing to meet the criterion of Reference Residential Appendix Section RA3.1.4.3.8. Duct insulation levels shall meet the requirements in TABLE 150.1-A or B.

NOTE: Gas heating appliances installed in conditioned spaces must meet the combustion air requirements of the California Mechanical Code Chapter 7, as applicable.

10. **Central Fan Integrated Ventilation Systems.** Central forced air system fans used to provide outside air, shall have an air-handling unit fan efficacy less than or equal to the maximum W/~~CFM~~ cfm specified in A, ~~or~~ B, or C. The airflow rate and fan efficacy requirements in this section shall be confirmed through field verification and diagnostic testing in accordance with all applicable procedures specified in Reference Residential Appendix RA3.3. Central Fan Integrated Ventilation Systems shall be certified to the Energy Commission as Intermittent Ventilation Systems as specified in Reference Residential Appendix RA3.7.4.2.

    A. 0.45 W/~~CFM~~ cfm for gas furnace air-handling units.~~; or~~

    B. 0.58 W/~~CFM~~ cfm for air-handling units that are not gas furnaces.

    C. 0.62 W/cfm for small duct high velocity air-handling units.

    EXCEPTION to Section ~~151.0~~150.1(c)10A: Gas furnace air-handling units manufactured prior to July 3, 2019 shall comply with a fan efficacy value less than or equal to 0.58 w/cfm as confirmed by field verification and diagnostic testing in accordance with the procedures given in Reference Residential Appendix RA3.3.

11. **Roofing products.** All roofing products shall meet the requirements of Section 110.8 and the applicable requirements of Subsection A or B:

    A. ~~Low-rise~~Single-family residential buildings with steep-sloped roofs, in Climate Zones 10 through 15 shall have a minimum aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16.

    B. ~~Low-rise~~Single-family residential buildings with low-sloped roofs; in Climate Zones 13 and 15 shall have a minimum aged solar reflectance of 0.63 and a minimum thermal emittance of 0.75 or a minimum SRI of 75.

    EXCEPTION 1 to Section 150.1(c)11: Building integrated photovoltaic panels and building integrated solar thermal panels are exempt from the minimum requirements for aged solar reflectance and thermal emittance or SRI.

    EXCEPTION 2 to Section 150.1(c)11: Roof constructions with a weight of at least 25 lb/ft² are exempt from the minimum requirements for aged solar reflectance and thermal emittance, or SRI.

12. **Ventilation Cooling**. Single~~-~~family homes shall comply with the Whole-house fan (WHF) requirements shown in TABLE 150.1-A. When a WHF is required, comply with Subsections A. ~~through~~ B. and C. below.~~:~~

    A. Have installed one or more WHFs whose total Airflow ~~CFM~~ cfm is equal to or greater than 1.5 ~~CFM~~cfm/ft^2 of conditioned floor area. Airflow ~~CFM~~ cfm for WHF's shall be determined based on the Airflow listed in the Home Ventilating Institute Certified Products Directory. ~~Energy Commission's database of certified appliances, which is available at ; and~~

    B. Have at least 1 square foot of attic vent free area for each 750 ~~CFM~~ cfm of rated whole-house fan Airflow ~~CFM~~cfm, or if the manufacturer has specified a greater free vent area, the manufacturers' free vent area specifications~~; and~~.

    EXCEPTION to Section 150.1(c)12B: WHFs that are directly vented to the outside.

    C. Provide homeowners who have WHFs with a one page "How to operate your whole-house fan" informational sheet.

Exception to 150.1(c)12: A detached JADU shall not be required to comply with the WHF requirements.

13. **HVAC System Bypass Ducts.** Bypass ducts that deliver conditioned supply air directly to the space conditioning system return duct airflow shall not be used.

14. **Photovoltaic Requirements.** All ~~low-rise~~single-family residential buildings shall have a photovoltaic (PV) system meeting the minimum qualification requirements ~~as~~ specified in Joint Appendix JA11~~, with annual electrical output equal to or greater than the dwelling's annual electrical usage as determined by Equation 150.1-C:~~The annual electrical output of the PV system shall be no less than the smaller of a PV system size determined using Equation 150.1-C, or the maximum PV system size that can be installed on the building's Solar Access Roof Area (SARA).

    A. SARA includes the area of the building's roof space capable of structurally supporting a PV system, and the area of all roof space on covered parking areas, carports, and all other newly constructed structures on the site that are compatible with supporting a PV system per Title 24, Part 2, Section 1511.2.

    B. SARA does NOT include:

        i. Any roof area that has less than 70 percent annual solar access. Annual solar access is determined by dividing the total annual solar insolation, accounting for shading obstructions, by the total annual solar insolation if the same areas were unshaded by obstructions. For steep slope roofs only shading from existing permanent natural or manmade obstructions that are external to the dwelling, including but not limited to trees, hills, and adjacent structures, shall be considered for annual solar access calculations. For low slope roofs, all obstructions including those that are external to the dwelling unit, and obstructions that are part of the building design and elevation features shall be considered for the annual solar access calculations.

        ii. Occupied roof areas as specified by CBC Section 503.1.4.

        iii. Roof area that is otherwise not available due to compliance with other building code requirements if confirmed by the Executive Director.

    EQUATION 150.1-C ANNUAL PHOTOVOLTAIC ELECTRICAL OUTPUT

    $$kW_{PV} = (CFA \times A)/1000 + (\text{~~NDwell~~} N_{DU} \times B)$$

    WHERE:

    kW_{PV} = kW_{dc} size of the PV system

    CFA ____ = Conditioned floor area

    ~~NDwell~~N_{DU} = Number of dwelling units

    A = CFA a~~A~~djustment factor from Table 150.1-C

    B = Dwelling unit adjustment factor from Table 150.1-C

    EXCEPTION 1 to Section 150.1(c)14: ~~No PV is required if the effective annual solar access is restricted to less than 80 contiguous square feet by shading from existing permanent natural or manmade barriers external to the dwelling, including but not limited to trees, hills, and adjacent structures. The effective annual solar access shall be 70 percent or greater of the output of an unshaded PV array on an annual basis.~~ For steep slope roofs, SARA shall not consider roof areas with a northerly azimuth that lies between 300 degrees and 90 degrees from true north. No PV system is required if the SARA is less than 80 contiguous square feet.

    EXCEPTION 2 to Section 150.1(c)14: ~~In climate zone 15, the PV system size shall be the smaller of a size that can be accommodated by the effective annual solar access or a PV system size required by the Equation 150.1-C, but no less than 1.5 Watt DC per square foot of conditioned floor area.~~No PV system is required when the minimum PV system size specified by section 150.0(c)14 is less than 1.8 kW_{dc}.

EXCEPTION 3 to Section 150.1(c)14: Buildings with enforcement-authority-approved roof designs, where the enforcement authority determines it is not possible for the PV system, including panels, modules and components and supports and attachments to the roof structure, to meet the requirements of the American Society of Civil Engineers (ASCE), Standard 7-16, Chapter 7, Snow Loads.

~~**EXCEPTION 3 to Section 150.1(c)14:** In all climate zones, for dwelling units with two habitable stories, the PV system size shall be the smaller of a size that can be accommodated by the effective annual solar access or a PV system size required by the Equation 150.1-C, but no less than 1.0 Watt DC per square foot of conditioned floor area~~

~~EXCEPTION 4 to Section 150.1(c)14: In all climate zones, for low-rise residential dwellings with three habitable stories and single family dwellings with three or more habitable stories, the PV system size shall be the smaller of a size that can be accommodated by the effective annual solar access or the PV system size required by the Equation 150.1-C, but no less than 0.8 Watt DC per square foot of conditioned floor area.~~

~~EXCEPTION 5 to Section 150.1(c)14: For a dwelling unit plan that is approved by the planning department prior to January 1, 2020 with available solar ready zone between 80 and 200 square feet, the PV system size is limited to the lesser of the size that can be accommodated by the effective annual solar accessor the size that is required by the Equation 150.1-C.~~ **EXCEPTION 4 to Section 150.1(c)14:** For buildings that are approved by the local planning department prior to January 1, 2020 shading from roof designs and configurations and roof areas that are not allowed to have PVs, which are required by mandatory conditions of approval, may be considered in determining the SARA.

EXCEPTION ~~6~~ 5 to Section 150.1(c)14: PV system sizes ~~from~~ determined using Equation 150.1-C may be reduced by 25 percent if installed in conjunction with a battery storage system. The battery storage system shall meet the qualification requirements specified in Joint Appendix JA12 and have a minimum capacity of 7.5 kWh.

Table 150.1-C – CFA and Dwelling Unit Adjustment Factors

Climate Zone	A - CFA	B - Dwelling Units
1	0.793	1.27
2	0.621	1.22
3	0.628	1.12
4	0.586	1.21
5	0.585	1.06
6	0.594	1.23
7	0.572	1.15
8	0.586	1.37
9	0.613	1.36
10	0.627	1.41
11	0.836	1.44
12	0.613	1.40
13	0.894	1.51
14	0.741	1.26
15	1.56	1.47
16	0.59	1.22

TABLE 150.1-A COMPONENT PACKAGE – Single-Family Standard Building Design

Single-Family				Climate Zone														
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Building Envelope Insulation																			
Building Envelope	Roofs/Ceilings	Option B (meets § 150.1(c)9A)	Below Roof Deck Insulation[1,2] (With Air Space)	NR	NR	NR	R 19	NR	NR	NR	R 19	R 19	R 19	R 19	R 19	R 19	R 19	R 19	R 19
			Ceiling Insulation	R 38	R 38	R 30	R 38	R 30	R 30	R 30	R 38	R 38	R 38	R 38	R 38	R 38	R 38	R 38	R 38
			Radiant Barrier	NR	REQ	REQ	NR	REQ	REQ	REQ	NR	NR	NR	NR	NR	NR	NR	NR	NR
		Option C (meets § 150.1(c)9B)	Ceiling Insulation	R 38	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 38	R 38	R 38	R 38	R 38	R 38
			Radiant Barrier	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR
	Walls	Above Grade	Framed[3]	U 0.048	U 0.048	U 0.048	U 0.048	U 0.048	U 0.065	U 0.065	U 0.048	U 0.048	U 0.048	U 0.048	U 0.048	U 0.048	U 0.048	U 0.048	U 0.048
			Mass Wall Interior[4,5]	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.059 R 17
			Mass Wall Exterior[4,5]	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.077 R 13
		Below Grade	Below Grade Interior[6]	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.067 R 15
			Below Grade Exterior[6]	U 0.200 R 5.0	U 0.200 R 5.0	U 0.200 R 5.0	U 0.200 R 5.0	U 0.200 R 5.0	U 0.200 R 5.0	U 0.200 R 5.0	U 0.200 R 5.0	U 0.200 R 5.0	U 0.200 R 5.0	U 0.200 R 5.0	U 0.200 R 5.0	U 0.200 R 5.0	U 0.100 R 10	U 0.100 R 10	U 0.053 R 19

TABLE 150.1-A COMPONENT PACKAGE – Single-Family Standard Building Design (continued)

				Climate Zone															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Building Envelope	Floors	Slab Perimeter		NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	U-0.58 R-7.0
		Raised		U- 0.037 R-19	U- 0.037 R-19	U- 0.037 R-19	U- 0.037 R-19	U- 0.037 R-19	U- 0.037 R-19	U- 0.037 R-19	U-0.037 R-19	U- 0.037 R-19	U- 0.037 R-19	U- 0.037 R-19	U- 0.037 R-19	U-0.037 R-19	U-0.037 R-19	U-0.037 R-19	U- 0.037 R-19
		Concrete Raised		U 0.092 R-8.0	U 0.092 R-8.0	U 0.269 R-0	U 0.269 R-0	U 0.269 R-0	U 0.269 R-0	U 0.269 R-0	U 0.269 R-0	U 0.269 R-0	U 0.269 R-0	U 0.092 R-8.0	U 0.138 R-4.0	U 0.092 R-8.0	U 0.092 R-8.0	U 0.138 R-4.0	U 0.092 R-8.0
	Quality Insulation Installation (QII)			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Roofing Product	Low-Sloped	Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.63	NR	0.63	NR
			Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.75	NR	0.72	NR
		Steep-Sloped	Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.20	0.20	0.20	0.20	0.20	0.20	NR
			Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.75	0.75	0.75	0.75	0.75	0.75	NR
	Fenestration	Maximum U-factor		0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
		Maximum SHGC		NR	0.23	NR	0.23	NR	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	NR
		Maximum Total Area		20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
		Maximum West Facing Area		NR	5%	NR	5%	NR	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
	Door	Maximum U-factor		0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20

TABLE 150.1-A COMPONENT PACKAGE – Single-Family Standard Building Design (continued)

				Climate Zone															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
HVAC System	Space Heating[9]	Electric-Resistance Allowed		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
		If gas, AFUE		MIN	MIN	~~MIN~~NA	~~MIN~~NA	MIN	MIN	MIN	MIN	MIN	~~MIN~~NA	MIN	MIN	~~MIN~~NA	~~MIN~~NA	MIN	MIN
		If Heat Pump, HSPF[7]		MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
	Space Cooling	SEER		MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
		Refrigerant Charge Verification or Fault Indicator Display		NR	REQ	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR
		Whole-house fan[8]		NR	NR	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR	NR
	Central System Air Handlers	Central Fan Integrated Ventilation System Fan Efficacy		REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
	Ducts[10]	Roof/Ceiling Options B	Duct Insulation	R-8	R-8	R- 6	R-8	R- 6	R- 6	R- 6	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8
			§150.1(c)9A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Roof/Ceiling Option C	Duct Insulation	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R- 6	R-6	R-6	R- 6	R- 6	R- 6
			§150.1(c)9B	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
Water Heating	All Buildings			System Shall meet Section 150.1(c)8															

Footnote requirements to TABLE 150.1-A:

1. Install the specified R-value with an air space present between the roofing and the roof deck. Such as standard installation of concrete or clay tile.
2. R-values shown for below roof deck insulation are for wood-frame construction with insulation installed between the framing members. Alternatives including insulation above rafters or above roof deck shall comply with the performance standards.
3. Assembly U-factors for exterior framed walls can be met with cavity insulation alone or with continuous insulation alone, or with both cavity and continuous insulation that results in an assembly U-factor equal to or less than the U-factor shown. Use Reference Joint Appendices JA4 Table 4.3.1, 4.3.1(a), or Table 4.3.4 to determine alternative insulation products to be less than or equal to the required maximum U-factor.
4. Mass wall has a heat capacity greater than or equal to 7.0 Btu/h-ft^2. “
5. “Interior” denotes insulation installed on the inside surface of the wall. “Exterior” denotes insulation installed on the exterior surface of the wall.
6. Below grade “interior” denotes insulation installed on the inside surface of the wall, and below grade “exterior” denotes insulation installed on the outside surface of the wall.
7. HSPF means "heating seasonal performance factor."
8. When whole-house fans are required (REQ), only those whole-house fans that are listed in the Appliance Efficiency Directory may be installed. Compliance requires installation of one or more WHFs whose total airflow ~~CFM~~ cfm is capable of meeting or exceeding a minimum 1.5 cfm/square foot of conditioned floor area as specified by Section 150.1(c)12.
9. A supplemental heating unit may be installed in a space served directly or indirectly by a primary heating system, provided that the unit thermal capacity does not exceed 2 kilowatts or 7,000 Btu/hr and is controlled by a time-limiting device not exceeding 30 minutes.
10. For duct and air handler location: REQ denotes location in conditioned space. When the table indicates ducts and air handlers are in conditioned space, a HERS verification is required as specified by Reference Residential Appendix RA3.1.4.3.8.

TABLE 150.1-B COMPONENT PACKAGE – Multifamily Standard Building Design

Multifamily				Climate Zone															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Building Envelope Insulation																			
Building Envelope Insulation	Roofs/Ceilings	Option B (meets § 150.1(c)9A)	Below Roof Deck Insulation [1,2] (With Air Space)	NR	NR	NR	R19	NR	NR	NR	R19	R19	R13	R19	R19	R19	R19	R19	R13
			Ceiling Insulation	R 38	R 38	R 30	R 38	R 30	R 30	R 30	R 38	R 38	R 38	R 38	R 38	R 38	R 38	R 38	R 38
			Radiant Barrier	NR	REQ	REQ	NR	REQ	REQ	REQ	NR	NR	NR	NR	NR	NR	NR	NR	NR
		Option C (meets § 150.1(c)9B)	Ceiling Insulation	R38	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 38	R 38	R 38	R 38	R 38	R 38
			Radiant Barrier	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR
Building Envelope Insulation	Walls	Above Grade	Framed [3]	U 0.051	U 0.051	U 0.051	U 0.051	U 0.051	U 0.065	U 0.065	U 0.051	U 0.051	U 0.051	U 0.051	U 0.051	U 0.051	U 0.051	U 0.051	U 0.051
			Mass Wall Interior [4,5]	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.059 R 17
			Mass Wall Exterior [5]	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.077 R 13
		Below Grade [6]	Below Grade Interior	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.067 R 15
			Below Grade Exterior	U 0.200 R 5.0	U 0.200 R 5.0	U 0.200 R 5.0	U 0.200 R 5.0	U 0.200 R 5.0	U 0.200 R 5.0	U 0.200 R 5.0	U 0.200 R 5.0	U 0.200 R 5.0	U 0.200 R 5.0	U 0.200 R 5.0	U 0.200 R 5.0	U 0.200 R 5.0	U 0.100 R 10	U 0.100 R 10	U 0.053 R 19

TABLE 150.1-B COMPONENT PACKAGE – Multifamily Standard Building Design (continued)

Building Envelope	Floors	Slab Perimeter	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	U 0.58 R 7.0
		Raised	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19
		Concrete Raised	U 0.092 R 8.0	U 0.092 R 8.0	U 0.269 R 0	U 0.269 R 0	U 0.269 R 0	U 0.269 R 0	U 0.269 R 0	U 0.269 R 0	U 0.269 R 0	U 0.269 R 0	U 0.092 R 8.0	U 0.138 R4.0	U 0.092 R 8.0	U 0.092 R 8.0	U 0.138 R4.0	U 0.092 R 8.0
	Quality Insulation Installation (QII)		Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Roofing Products	Low-Sloped	Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.63	NR	0.63	NR
			Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.75	NR	0.75	NR
		Steep-Sloped	Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.20	0.20	0.20	0.20	0.20	0.20	NR
			Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.75	0.75	0.75	0.75	0.75	0.75	NR
	Fenestration	Maximum U-factor		0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
		Maximum SHGC		NR	0.23	NR	0.23	NR	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	NR
		Maximum Total Area		20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
		Maximum West Facing Area		NR	5%	NR	5%	NR	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	NR
	Door	Maximum U-factor		0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.2	0.20	0.20	0.20	0.2	0.20

TABLE 150.1-B COMPONENT PACKAGE – Multifamily Standard Building Design (continued)

				Climate Zone															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
HVAC SYSTEM	Space Heating[8]	Electric Resistance Allowed		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
		If gas, AFUE		MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
		If Heat Pump, HSPF[7]		MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
	Space cooling	SEER		MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
		Refrigerant Charge Verification or Fault Indicator Display		NR	REQ	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR
	Central System Air Handlers	Central Fan Integrated Ventilation System Fan Efficacy		REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
	Ducts[9]	Roof/Ceiling	Duct Insulation	R-8	R-8	R-6	R-8	R-6	R-6	R-6	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8
			§150.1(c)9A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Roof/Ceiling Option C	Duct Insulation	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6
			§150.1(c)9B	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
Water Heating	All Buildings			System Shall meet Section 150.1(c)8															

~~Footnote requirements to TABLE 150.1-B:~~

~~1. Install the specified R-value with an air space present between the roofing and the roof deck. Such as standard installation of concrete or clay tile.~~

~~2. R-values shown for below roof deck insulation are for wood-frame construction with insulation installed between the framing members. Alternatives including insulation above rafters or above roof deck shall comply with the performance standards.~~

~~3. Assembly U-factors for exterior framed walls can be met with cavity insulation alone or with continuous insulation alone, or with both cavity and continuous insulation that results in an assembly U-factor equal to or less than the U-factor shown. Use Reference Joint Appendices JA4 Table 4.3.1, 4.3.1(a), or Table 4.3.4 to determine alternative insulation products to be less than or equal to the required maximum U-factor.~~

~~4. Mass wall has a heat capacity greater than or equal to 7.0 Btu/h-ft^2.~~

~~5. "Interior" denotes insulation installed on the inside surface of the wall. "Exterior" denotes insulation installed on the exterior surface of the wall.~~

~~6. Below grade "interior" denotes insulation installed on the inside surface of the wall, and below grade "exterior" denotes insulation installed on the outside surface of the wall.~~

~~7. HSPF means "heating seasonal performance factor."~~

~~8. A supplemental heating unit may be installed in a space served directly or indirectly by a primary heating system, provided that the unit thermal capacity does not exceed 2 kilowatts or 7,000 Btu/hr and is controlled by a time-limiting device not exceeding 30 minutes.~~

~~9. For duct and air handler location: REQ denotes location in conditioned space. When the table indicates ducts and air handlers are in conditioned space, a HERS verification is required as specified by Reference Residential Appendix RA3.1.4.3.8.~~

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402, 25402.1, and 25605, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, 25605, and 25943, Public Resources Code.

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SUBCHAPTER 9
~~LOW-RISE~~ SINGLE-FAMILY RESIDENTIAL BUILDINGS - ADDITIONS AND ALTERATIONS TO EXISTING ~~LOW-RISE~~ RESIDENTIAL BUILDINGS

SECTION 150.2 – ENERGY EFFICIENCY STANDARDS FOR ADDITIONS AND ALTERATIONS TO EXISTING ~~LOW-RISE~~SINGLE-FAMILY RESIDENTIAL BUILDINGS

(a) **Additions.** Additions to existing ~~low-rise~~single-family residential buildings shall meet the requirements of Sections 110.0 through 110.9, Sections 150.0(a) through (n), (p), (q), and either Section 150.2(a)1 or 2.

~~**EXCEPTION 1 to Section 150.2(a):** Additions 1,000 square feet or less are exempt from the requirements to provide dwelling unit mechanical ventilation airflow as specified by Section 150.0(o)1C, 150.0(o)1E, or 150.0(o)1F, however all other applicable requirements specified by Section 150.0(o) shall be met by the addition.~~

EXCEPTION 2 to Section 150.2(a): Additions of 300 square feet or less are exempt from the roofing requirements of Section 150.1(c)11.

EXCEPTION 3 to Section 150.2(a): Existing inaccessible piping shall not require insulation as defined under Section 150.0(j)2Aiii.

EXCEPTION 4 to Section 150.2(a): Space-Conditioning System. When heating or cooling will be extended to an addition from the existing system(s), the existing heating and cooling equipment need not comply with Part 6. The heating system capacity must be adequate to meet the minimum requirements of CBC Section 1204.1.

EXCEPTION 5 to Section 150.2(a): Space-Conditioning System Ducts. When any length of ducts are extended from an existing duct system to serve the addition, the existing duct system and the extended ducts shall meet the applicable requirements specified in Section 150.2(b)1Di and 150.2(b)1Dii.~~.~~

EXCEPTION 6 to Section 150.2(a): Additions 1,000 square feet or less are exempt from the Ventilation Cooling requirements of Section 150.1(c)12.

EXCEPTION 7 to Section 150.2(a): Photovoltaic systems, as specified in Section 150.1(c)14, are not required for additions.

1. **Prescriptive approach.** Additions to existing buildings shall meet the following additional requirements:
   A. Additions that are greater than 700 square feet shall meet the requirements of Section 150.1(c), with the following modifications:
      i. Extensions of existing wood-framed walls may retain the dimensions of the existing walls and shall install cavity insulation of R-15 in a 2x4 framing and R-21 in a 2x6 framing.
      ii. The maximum allowed fenestration area shall be the greater of 175 square feet or 20 percent of the addition floor area, and the maximum allowed west-facing fenestration area shall be the greater of 70 square feet or the requirements of Section 150.1(c).
      iii. When existing siding of a wood-framed wall is not being removed or replaced, cavity insulation of R-15 in a 2x4 framing and R-21 in a 2x6 framing shall be installed and continuous insulation is not required.

iv. Additions that consist of the conversion of existing spaces from unconditioned to conditioned space shall not be required to perform the following as part of QII:

a. Existing window and door headers shall not be required to be insulated.

b. Air sealing shall not be required when the existing air barrier is not being removed or replaced.

B. Additions that are 700 square feet or less shall meet the requirements of Section 150.1(c), with the following modifications:

i. ~~Roof and Ceiling insulation in an attic shall be insulated to R-38 in climate zones 1 and 11-16 or R-30 in climate zones 2-10.~~Roof and ceiling insulation in a ventilated attic shall meet one of the following requirements:

a. In Climate Zones 1, 2, 4, and 8 through 16, achieve an overall assembly U-factor not exceeding 0.025. In wood framed assemblies, compliance with U-factors may be demonstrated by installing insulation with an R-value of R-38 or greater.

b. In Climate Zones 3, and 5 through 7, achieve an overall assembly U-factor not exceeding 0.031. In wood framed assemblies, compliance with U-factors may be demonstrated by installing insulation with an R-value of R-30 or greater.

ii. Radiant barriers shall be installed in climate zones 2-15.

iii. Extensions of existing wood-framed walls may retain the dimensions of the existing walls and shall install cavity insulation of R-15 in a 2×4 framing and R-21 in a 2×6 framing.

iv. In Climate Zones 2, 4 and 6-15; the maximum allowed west-facing fenestration area shall not be greater than 60 square feet; and shall also comply with either a or b below:

a. For additions that are 700 square feet or less but greater than 400 square feet, the maximum allowed fenestration area limit is the greater of 120 square feet or 25 percent of the conditioned floor area of the addition; or

b. For additions that are 400 square feet or less, the maximum allowed fenestration area is the greater of 75 square feet or 30 percent of the conditioned floor area of the addition.

v. Quality Insulation Installation (QII) requirements of Section 150.1(c)1E do not apply.

vi. When existing siding of a wood-framed wall is not being removed or replaced, cavity insulation of R-15 in a 2×4 framing and R-21 in a 2×6 framing shall be installed and continuous insulation is not required.

EXCEPTION to Section 150.2(a)1B: Insulation in an enclosed rafter ceiling shall meet the requirements of Section 150.0.

C. **Mechanical Ventilation for Indoor Air Quality**. Additions to existing buildings shall comply with Section 150.0(o) subject to the requirements specified in subsections i and ii below.

i. **Whole-dwelling Unit Mechanical Ventilation**.

a. Dwelling units that meet the conditions in subsections 1, or 2 below shall not be required to comply with the whole-dwelling unit ventilation airflow specified in Sections 150.0(o)1C, 150.0(o)1E, or 150.0(o)1F.

1. Additions to an existing dwelling unit that increase the conditioned floor area of the existing dwelling unit by less than or equal to 1000 square feet.

2. Junior Accessory Dwelling Units (JADU) that are additions to an existing building.

b. Additions to an existing dwelling unit that increase the conditioned floor area of the existing dwelling unit by more than 1,000 square feet shall have mechanical ventilation airflow in accordance with Sections 150.0(o)1C, 150.0(o)1E, or 150.0(o)1F as applicable. The

mechanical ventilation airflow rate shall be based on the conditioned floor area of the entire dwelling unit comprised of the existing dwelling unit conditioned floor area plus the addition conditioned floor area.

c. ~~ii.~~ New dwelling units that are additions to an existing building shall have mechanical ventilation airflow provided in accordance with Sections 150.0(o)1C, 150.0(o)1E, or 150.0(o)1F as applicable. The mechanical ventilation airflow rate shall be based on the conditioned floor area of the new dwelling unit.

ii. **Local Mechanical Exhaust**. Additions to existing buildings shall comply with all applicable requirements specified in 150.0(o)1G and 150.0(o)2.

D. **Water Heater**. When a second water heater is installed as part of the addition, one of the following types of water heaters shall be installed:

i. A water-heating system that meets the requirements of Section 150.1(c)8; or

ii. A water-heating system determined by the Executive Director to use no more energy than the one specified in Item i.

2. **Performance approach.** Performance calculations shall meet the requirements of Section 150.1(a) through (c), pursuant to the applicable requirements in Items A, B, and C below.

A. **For additions alone.** The addition complies if the addition alone meets the energy budgets as specified in Section 150.1(b).

B. **Existing plus alteration plus addition.** The standard design for existing plus alteration plus addition energy use is the combination of the existing building's unaltered components to remain; existing building altered components that are the more efficient, in TDV energy, of either the existing conditions or the requirements of Section 150.2(b)2; plus the proposed addition's energy use meeting the requirements of Section 150.2(a)1. The proposed design energy use is the combination of the existing building's unaltered components to remain and the altered components' energy features, plus the proposed energy features of the addition.

EXCEPTION to Section 150.2(a)2B: Existing structures with a minimum R-11 insulation in framed walls showing compliance with Section 150.2(a)2 are exempt from showing compliance with Section 150.0(c).

C. **Mechanical Ventilation for Indoor Air Quality**. Additions to existing buildings shall comply with Section 150.0(o) subject to the requirements specified in subsections i, ii below.

i. **Whole-dwelling Unit Mechanical Ventilation**.

a. Dwelling units that meet the conditions in subsections 1, or 2 below shall not be required to comply with the whole-dwelling unit ventilation airflow specified in Sections 150.0(o)1C, 150.0(o)1E, or 150.0(o)1F.

1. Additions to an existing dwelling unit that increase the conditioned floor area of the existing dwelling unit by less than or equal to 1000 square feet.

2. Junior Accessory Dwelling Units (JADU) that are additions to an existing building.

~~i~~b. Additions to an existing dwelling unit that increase the conditioned floor area of the existing dwelling unit by more than 1,000 square feet shall have mechanical ventilation airflow in accordance with Section 150.0(o)1C, 150.0(o)1E, or 150.0(o)1F as applicable. The mechanical ventilation airflow rate shall be based on the conditioned floor area of the entire dwelling unit comprised of the existing dwelling unit conditioned floor area plus the addition conditioned floor area.

~~ii~~c. New dwelling units that are additions to an existing building shall have mechanical ventilation airflow provided in accordance with Section 150.0(o)1C, 150.0(o)1E, or 150.0(o)1F as applicable. The mechanical ventilation airflow rate shall be based on the conditioned floor area of the new dwelling unit.

ii. **Local Mechanical Exhaust** . Additions to existing buildings shall comply with all applicable requirements specified in 150.0(o)1G and 150.0(o)2.

(b) **Alterations.** Alterations to existing ~~low-rise~~single-family residential buildings or alterations in conjunction with a change in building occupancy to a ~~low-rise~~ single-family residential occupancy shall meet either Item 1 or 2 below.

1. **Prescriptive approach.** The altered component and any newly installed equipment serving the alteration shall meet the applicable requirements of Sections 110.0 through 110.9 and all applicable requirements of Sections 150.0(a) through (l), 150.0(m)1 through 150.0 (m)10, and 150.0(~~o~~p) through (q); and

A. **Added Fenestration**. Alterations that add vertical fenestration and skylight area shall meet the total fenestration area and west facing fenestration area, U-factor, and Solar Heat Gain Coefficient requirements of Section 150.1(c) and TABLE 150.1-A or B.

EXCEPTION 1 to Section 150.2(b)1A: Alterations that add fenestration area of up to 75 square feet shall not be required to meet the total fenestration area and west-facing fenestration area requirements of Sections 150.1(c)3B and C.

EXCEPTION 2 to Section 150.2(b)1A: Alterations that add up to 16 square feet of new skylight area with a maximum U-factor of 0.55 and a maximum SHGC of 0.30 area shall not be required to meet the total fenestration area and west-facing fenestration area requirements of Sections 150.1(c)3B and C.

B. **Replacement Fenestration.** New manufactured fenestration products installed to replace existing fenestration products of the same total area shall meet the U-factor and Solar Heat Gain Coefficient requirements of Sections 150.1(c)3A, and 150.1(c)4.

EXCEPTION 1 to Section 150.2(b)1B: Replacement of vertical fenestration no greater than 75 square feet with a U-factor no greater than 0.40 in Climate Zones 1-16, and a SHGC value no greater than 0.35 in Climate Zones 2, 4, and 6-15.

EXCEPTION 2 to Section 150.2(b)1B: Replaced skylights must meet a U-factor no greater than 0.55, and a SHGC value no greater than 0.30.

NOTE: Glass replaced in an existing sash and frame or sashes replaced in an existing frame are considered repairs, provided that the replacement is at least equivalent to the original in performance.

C. **Entirely New or Complete Replacement Space-Conditioning Systems** installed as part of an alteration, shall include all the system heating or cooling equipment, including but not limited to: condensing unit ~~and~~, cooling or heating coil, and air handler for split systems; or complete replacement of a packaged unit; plus entirely new or replacement duct system (Section 150.2(b)1Diia)~~; plus a new or replacement air handler~~. Entirely new or complete replacement space-conditioning systems shall~~:~~

~~i. M~~ meet the requirements of Sections 150.0(h), 150.0(i), 150.0(j)2, 150.0(j)3, 150.0(m)1 through 150.0(m)10; 150.0(m)12; 150.0(m)13, 150.1(c)6, 150.1(c)7, and 150.1(c)10, and TABLE 150.2-A; and

~~ii. Be limited to natural gas, liquefied petroleum gas, or the existing fuel type.~~

~~**EXCEPTION to Section 150.2(b)1Cii:** When the fuel type of the replaced heating system was natural gas or liquefied petroleum gas, the new or complete replacement space-conditioning system may be a heat pump.~~

D. **Altered Duct Systems - Duct Sealing**: In all Climate Zones, when more than ~~40~~ 25 feet of new or replacement space-conditioning system ducts are installed, the ducts shall comply with the applicable

requirements of subsections i and ii below. Additionally, when altered ducts, air-handling units, cooling or heating coils, or plenums are located in garage spaces, the system shall comply with subsection 150.2(b)1Diic regardless of the length of any new or replacement space-conditioning ducts installed in the garage space.

i. New ducts located in unconditioned space shall meet the applicable requirements of Sections 150.0(m)1 through 150.0(m)10~~1~~, and the duct insulation requirements of TABLE 150.2-A, and

TABLE 150.2-A DUCT INSULATION R-VALUE

Climate Zone	~~1 through 10, 12&13~~3, 5 through 7	~~11, 14 through 16~~1, 2, 4, 8 through 16
Duct R-Value	R-6	R-8

ii. The altered duct system, regardless of location, shall be sealed as confirmed through field verification and diagnostic testing in accordance with all applicable procedures for duct sealing of altered existing duct systems as specified in ~~the~~ Reference Residential Appendix Section RA3.1, utilizing the leakage compliance criteria specified in Subsection a or b below.

a. **Entirely New or Complete Replacement Duct System.** If the new ducts form an entirely new or complete replacement duct system directly connected to the air handler, the duct system shall meet one of the following requirements:

I. For single~~-~~family dwellings, the measured duct leakage shall be equal to or less than 5 percent of the system air handler airflow as confirmed by field verification and diagnostic testing utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1.

II. For multifamily dwellings, regardless of duct system location,

A. The total leakage of the duct system shall not exceed 12 percent of the nominal system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1, or

B. The duct system leakage to outside shall not exceed 6 percent of the nominal system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.4.

Entirely new or complete replacement duct systems installed as part of an alteration shall be constructed of at least 75 percent new duct material, and up to 25 percent may consist of reused parts from the dwelling unit's existing duct system, including but not limited to registers, grilles, boots, air handler, coil, plenums, duct material; if the reused parts are accessible and can be sealed to prevent leakage.

Entirely new or complete replacement duct systems shall also conform to the requirements of Sections 150.0(m)12 and 150.0(m)13. If the air handler and ducts are located within a vented attic the requirements of Section 150.2(b)1J shall also be met.

b. **Extension of an Existing Duct System**. If the new ducts are an extension of an existing duct system serving single~~-~~family or multifamily dwellings, the combined new and existing duct system shall meet one of the following requirements:

I. The measured duct leakage shall be equal to or less than ~~15~~ 10 percent of ~~nominal~~ system air handler airflow as confirmed by field verification and diagnostic testing utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1; or

II. The measured duct leakage to outside shall be equal to or less than ~~10~~ 7 percent of ~~nominal~~ system air handler airflow as confirmed by field verification and diagnostic testing utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.4; or

III. If it is not possible to meet the duct sealing requirements of either Section 150.2(b)1DiibI, or 150.2(b)1DiibII, then all accessible leaks shall be sealed and verified through a visual inspection and a smoke test by a certified HERS Rater utilizing the methods specified in Reference Residential Appendix RA3.1.4.3.5.

EXCEPTION to Section 150.2(b)1Diib: Duct Sealing. Existing duct systems that are extended, which are constructed, insulated or sealed with asbestos.

c. **Altered Ducts and Duct System Components in Garage Spaces.** When new or replacement space-conditioning ducts, air-handling units, cooling or heating coils, or plenums are located in a garage space, compliance with either I or II below is required.

I. The measured system duct leakage shall be less than or equal to 6 percent of system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1, or

II. All accessible leaks located in the garage space shall be sealed and verified through a visual inspection and a smoke test by a certified HERS Rater utilizing the methods specified in Reference Residential Appendix RA3.1.4.3.5.

E. **Altered space-conditioning system - duct sealing.** In all Climate Zones, when a space-conditioning system serving a single~~-~~family or multifamily dwelling is altered by the installation or replacement of space-conditioning system equipment, including replacement of the air handler, outdoor condensing unit of a split system air conditioner or heat pump, or cooling or heating coil; the duct system that is connected to the altered space-conditioning system equipment shall be sealed, as confirmed through field verification and diagnostic testing in accordance with the applicable procedures for duct sealing of altered existing duct systems as specified in Reference Residential Appendix RA3.1 and the leakage compliance criteria specified in subsection i, ii, or iii below. Additionally, when altered ducts, air-handling units, cooling or heating coils, or plenums are located in garage spaces, the system shall comply with Section 150.2(b)1Diic regardless of the length of any new or replacement space-conditioning ducts installed in the garage space.

i. The measured duct leakage shall be equal to or less than ~~15~~ 10 percent of system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1; or

ii. The measured duct leakage to outside shall be equal to or less than ~~10~~ 7 percent of system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.4; or

iii. If it is not possible to meet the duct sealing requirements of either Section 150.2(b)1Ei or Section 150.2(b)1Eii, then, all accessible leaks shall be sealed and verified through a visual inspection and a smoke test by a certified HERS Rater utilizing the methods specified in Reference Residential Appendix Section RA3.1.4.3.5.

EXCEPTION 1 to Section 150.2(b)1E: Duct sealing. Duct systems that are documented to have been previously sealed as confirmed through field verification and diagnostic testing in accordance with procedures in the Reference Residential Appendix RA3.1.

EXCEPTION 2 to Section 150.2(b)1E: Duct sealing. Duct systems with less than 40 linear feet as determined by visual inspection.

EXCEPTION 3 to Section 150.2(b)1E: Duct sealing. Existing duct systems constructed, insulated or sealed with asbestos.

F. **Altered space-conditioning system - mechanical cooling.** When a space-conditioning system is an air conditioner or heat pump that is altered by the installation or replacement of refrigerant-containing system components such as the compressor, condensing coil, evaporator coil, refrigerant metering device or refrigerant piping, the altered system shall comply with the following requirements:

i. All thermostats associated with the system shall be replaced with setback thermostats meeting the requirements of Section 110.2(c).

ii. In Climate Zones 2, 8, 9, 10, 11, 12, 13, 14, and 15, air-cooled air conditioners and air-source heat pumps, including but not limited to ducted split systems, ducted package systems, small duct high velocity air systems, and minisplit systems, shall comply with subsections a and b, unless the system is of a type that cannot be verified using the specified procedures. Systems that cannot comply with the requirements of 150.2(b)1Fii shall comply with 150.2(b)1Fiii.

EXCEPTION to Section 150.2(b)1Fii: Entirely new or complete replacement packaged systems for which the manufacturer has verified correct system refrigerant charge prior to shipment from the factory are not required to have refrigerant charge confirmed through field verification and diagnostic testing. The installer of these packaged systems shall certify on the Certificate of Installation that the packaged system was pre-charged at the factory and has not been altered in a way that would affect the charge. Ducted systems shall comply with minimum system airflow rate requirement in Section 150.2(b)1Fiia, provided that the system is of a type that can be verified using the procedure specified in RA3.3 or an approved alternative in RA1.

a. Minimum system airflow rate shall comply with the applicable subsection I or II below as confirmed through field verification and diagnostic testing in accordance with the procedures specified in Reference Residential Appendix Section RA3.3 or an approved alternative procedure as specified in Section RA1.

I. Small duct high velocity systems shall demonstrate a minimum system airflow rate greater than or equal to 250 cfm per ton of nominal cooling capacity; or

II. All other air-cooled air conditioner or air-source heat pump systems shall demonstrate a minimum system airflow rate greater than or equal to 300 cfm per ton of nominal cooling capacity; and

EXCEPTION 1 to Section 150.2(b)1Fiia: Systems unable to comply with the minimum airflow rate requirement shall demonstrate compliance using the procedures in Section RA3.3.3.1.5; and the system's thermostat shall conform to the specifications in Section 110.12.

EXCEPTION 2 to Section 150.2(b)1Fiia: Entirely new or complete replacement space conditioning systems, as specified by section 150.2(b)1C, without zoning dampers may comply with the minimum airflow rate by meeting the applicable requirements in TABLE-150.0-B or 150.0-C as confirmed by field verification and diagnostic testing in accordance with the procedures in Reference Residential Appendix Section RA3.1.4.4 and RA3.1.4.5. The design clean-filter pressure drop requirements of Section 150.0(m)12C for the system air filter device(s) shall conform to the requirements given in TABLES 150.0-B and 150.0-C.

b. The installer shall charge the system according to manufacturer's specifications. Refrigerant charge shall be verified according to one of the following options, as applicable.

I. The installer and rater shall perform the standard charge verification procedure as specified in Reference Residential Appendix Section RA3.2.2, or an approved alternative procedure as specified in Section RA1; or

II. The system shall be equipped with a fault indicator display (FID) device that meets the specifications of Reference Joint Appendix JA6. The installer shall verify the refrigerant charge and FID device in accordance with the procedures in Reference Residential Appendix Section RA3.4.2. The HERS Rater shall verify FID device in accordance with the procedures in Section RA3.4.2; or

III. The installer shall perform the weigh-in charging procedure as specified by Reference Residential Appendix Section RA3.2.3.1 provided the system is of a type that can be verified using the RA3.2.2 standard charge verification procedure and RA3.3 airflow rate

verification procedure or approved alternatives in RA1. The HERS Rater shall verify the charge using RA3.2.2 and RA3.3 or approved alternatives in RA1.

EXCEPTION 1 to Section 150.2(b)1Fiib: When the outdoor temperature is less than 55° F and the installer utilizes the weigh-in charging procedure in Reference Residential Appendix Section RA3.2.3.1to demonstrate compliance, the installer may elect to utilize the HERS Rater verification procedure in Reference Residential Appendix Section RA3.2.3.2. If the HERS Rater verification procedure in Section RA3.2.3.2 is used for compliance, the system's thermostat shall conform to the specifications in Section 110.12. Ducted systems shall comply with the minimum system airflow rate requirements in Section 150.2(b)1Fiia.

iii. In climate Zones 2, 8, 9, 10, 11, 12, 13, 14, and 15, air-cooled air conditioners or air-source heat pumps, including but not limited to ducted split systems, ducted package systems, small duct high velocity, and minisplit systems, which are of a type that cannot comply with the requirements of 150.2(b)1Fiib shall comply with subsections a and b, as applicable.

a. The installer shall confirm the refrigerant charge using the weigh-in charging procedure specified in Reference Residential Appendix Section RA3.2.3.1, as verified by a HERS Rater according to the procedures specified in Reference Residential Appendix RA3.2.3.2; and

b. Systems that utilize forced air ducts shall comply with the minimum system airflow rate requirement in Section 150.2(b)1Fiia provided the system is of a type that can be verified using the procedures in Section RA3.3 or an approved alternative procedure in Section RA1.

EXCEPTION to Section 150.2(b)1Fiii: Entirely new or complete replacement packaged systems for which the manufacturer has verified correct system refrigerant charge prior to shipment from the factory are not required to have refrigerant charge confirmed through field verification and diagnostic testing. The installer of these packaged systems shall certify on the Certificate of Installation that the packaged system was pre-charged at the factory and has not been altered in a way that would affect the charge. Ducted systems shall comply with minimum system airflow rate requirement in Section 150.2(b)1Fiiib, provided that the system is of a type that can be verified using the procedure specified in Section RA3.3 or an approved alternative in Section RA1.

G. **Altered Space ~~Conditioning~~ Heating System.** Altered or r~~R~~eplacement space~~-conditioning~~ heating systems shall ~~be limited to natural gas, liquefied petroleum gas, or the existing fuel type.~~comply with Section 150.1(c)6.

EXCEPTION 1 to Section 150.2(b)1G: Non-ducted electric resistance space heating systems, if the existing space heating system is electric resistance.~~When the fuel type of the replaced heating system was natural gas or liquefied petroleum gas, the replacement space-conditioning system may be a heat pump~~

EXCEPTION 2 to Section 150.2(b)1G: Ducted electric resistance space heating systems, if the electric resistance heating system is the only portion of the building being replaced.

EXCEPTION 3 to Section 150.2(b)1G: Electric resistance space heating systems, if the existing space heating system is electric resistance and the building is located in Climate Zones 7 or 15.

H. **Water-Heating System**. Altered or replacement service water-heating systems or components shall meet the applicable requirements below:

i. **Pipe Insulation.** For newly installed ad existing accessible piping, the insulation requirements of Section 150.0(j)2 shall be met. ~~For existing accessible piping the applicable requirements of Section 150.0(j)2Ai and iii shall be met.~~

ii. **Distribution System.** For recirculation distribution systems serving individual dwelling units, only Demand Recirculation Systems with manual on/off control as specified in the Reference Appendix RA4.4.9 shall be installed.

iii. **Water heating system.** The water heating system shall meet one of the following:

a. A natural gas or propane water-heating system; or

b. ~~For Climate Zones 1 through 15, a~~A single heat pump water heater. The storage tank shall not be located outdoors and be placed on an incompressible, rigid insulated surface with a minimum thermal resistance of R-10. The water heater shall be installed with a communication interface that meets either the requirements of 110.12(a) or has a ANSI/CTA-2045-A communication port; or

c. ~~For Climate Zones 1 through 15, a~~A single heat pump water heater that meets the requirements of NEEA Advanced Water Heater Specification Tier 3 or higher~~. The storage tank shall not be located outdoors~~; or

d. If ~~no natural gas is connected to the existing water heater location~~the existing water heater is an electric resistance water heater, a consumer electric water heater; or

e. A water-heating system determined by the ~~e~~Executive ~~d~~Director to use no more energy than the one specified in Item a above; or if no natural gas is connected to the existing water heater location, a water-heating system determined by the executive director to use no more energy than the one specified in Item d above.

l. **Roofs.** Replacements of the exterior surface of existing roofs, including adding a new surface layer on top of the existing exterior surface, shall meet the requirements of Section 110.8 and the applicable requirements of Subsections i and ii where more than 50 percent of the roof is being replaced.

i. ~~**Low-rise residential buildings with**~~ **Steep-sloped roofs.** Steep-sloped roofs shall meet the following~~.~~:

New roofing products in Climate Zones ~~10~~4 and 8 through 15 ~~-~~shall have a minimum aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16.

EXCEPTION 1 to Section 150.2(b)1Ii: The following shall be considered equivalent to Subsection i:

~~a. Air space of 1.0 inch (25 mm) is provided between the top of the roof deck to the bottom of the roofing product; or~~

~~b. The installed roofing product has a profile ratio of rise to width of 1 to 5 for 50 percent or greater of the width of the roofing product; or~~

~~c. Existing ducts in the attic are insulated and sealed according to Section 150.1(c)9; or~~

~~d~~a. Buildings with ceiling assemblies with a U-factor lower than or equal to 0.025 or that are insulated with at least R-38 ceiling insulation; or

~~e~~b. Buildings with a radiant barrier in the attic, where the radiant barrier is not installed directly above spaced sheathing, meeting the requirements of Section 150.1(c)2; or

~~f~~c. In Climate Zones 2, 4, 9, 10, 12 and 14, buildings that have no ducts in the attic; or

~~g~~d. ~~In Climate Zones 10-15,~~Buildings with R-2 or greater continuous insulation above or below the roof deck.

EXCEPTION 2 to Section 150.2(b)1Ii: Roof area covered by building integrated photovoltaic panels or building integrated solar thermal panels are not required to meet minimum requirements for aged solar reflectance, thermal emittance, or SRI.

EXCEPTION 3 to Section 150.2(b)1Ii: Roof constructions with a weight of at least 25 lb/ft^2 are exempt from minimum requirements for aged solar reflectance and thermal emittance, or SRI.

ii. **Low-sloped roofs.** Low-sloped roofs shall meet the following~~.~~:

a. New roofing products in Climate Zones ~~13~~4, and 6 through 15 shall have an ~~3-year~~ aged solar reflectance equal or greater than 0.63 and a thermal emittance equal or greater than 0.75, or a minimum SRI of 75.

~~**EXCEPTION 1 to Section 150.2(b)1Iii:** Buildings with no ducts in the attic.~~

EXCEPTION ~~2~~1 to Section 150.2(b)1Iia: The aged solar reflectance can be met by using insulation at the roof deck specified in TABLE 150.2-B.

TABLE 150.2-B AGED SOLAR REFLECTANCE INSULATION TRADE OFF TABLE

Minimum Aged Solar Reflectance	Roof Deck Continuous Insulation R-value (Climate Zones 6-7)	Roof Deck Continuous Insulation R-value (Climate Zones 2, 4, & 8-15)
0.60	2	16
0.55	4	18
0.50	6	20
0.45	8	22
No Requirement	10	24

EXCEPTION 2 to Section 150.2(b)1Iia: Roof area covered by building integrated photovoltaic panels or building integrated solar thermal panels are not required to meet the minimum requirements for aged solar reflectance, thermal emittance, or SRI.

EXCEPTION 3 to Section 150.2(b)1Iia: Roof constructions with a weight of at least 25 lb/ft^2 are exempt from the minimum requirements for aged solar reflectance and thermal emittance, or SRI.

b. Roofs shall be insulated to the levels specified in Table 150.2-C.

TABLE 150.2-C INSULATION REQUIREMENTS FOR ROOF ALTERATIONS

Climate Zone	Continuous Insulation R-value	Roof Assembly U-factor
3, 5-7	NR	NR
1, 2, 4, 8-16	R-14	0.039

EXCEPTIONS to Section 150.2(b)1Iiib:

i. Existing roofs with R-10 or greater continuous insulation above or below the roof deck; or

ii. Existing roofs with an assembly U-factor of 0.056 or less or that are insulated with at least R-19 insulation between the roof rafters and in contact with the roof deck in Climate Zones 1, 2, 4, and 8 through 10; or

iii. The continuous insulation requirements of Table 150.2-C may be reduced to R-4 where the following conditions are met:

1. Mechanical equipment is located on the roof and will not be temporarily disconnected and lifted as part of the roof replacement and the addition of insulation required by Table 150.2-C would reduce the height from the roof surface to the top of the base flashing to less than that set forth in the manufacturer's installation instructions as per the California Residential Code Section R900; or

2. Replaced roofing abuts sidewall or parapet walls and the addition of insulation required by Table 150.2-C would reduce the height from the roof surface to the top of the base flashing to less than that set forth in manufacturer's installation instructions as per California Residential Code Section R900, provided that the following conditions apply:

    a. The sidewall or parapet walls are finished with an exterior cladding material other than the roof covering membrane material; and

    b. The sidewall or parapet walls have exterior cladding material that must be removed to install the new roof covering membrane to maintain the minimum base flashing height; and

    c. The ratio of the replaced roof area to the linear dimension of affected sidewall or parapet walls is less than 25 square feet per linear foot; or

iv. The continuous insulation requirements per Table 150.2-C may be reduced where increasing the thickness of above deck insulation would reduce the flashing around an existing exterior wall opening below what is permitted by the fenestration or door manufacturer's installation instructions, or registered design professionals approved flashing design, as per the California Residential Code Section R703.4, or by California Residential Code Section R905.2.8.3.

v. Tapered insulation with thermal resistance less than prescribed at the drains and other low points may be used provided that the thickness of insulation is increased at the high points of the roof so that the average thermal resistance equals or exceeds the required value.

J. **Ceiling.** Vented attics shall meet the following:

i. In Climate Zones 1 through 4, 6, and 8 through 16 insulation shall be installed to achieve a weighted U-factor of 0.020 or insulation installed at the ceiling level shall result in an insulated thermal resistance of R-49 or greater for the insulation alone; and

EXCEPTION to Section 150.2(b)1Ji: In Climate Zones 1, 3, and 6, dwelling units with at least R-19 existing insulation installed at the ceiling level with third party verification of existing conditions.

ii. In Climate Zones 2, 4, and 8 through 16 air seal all accessible areas of the ceiling plane between the attic and the conditioned space in accordance with Section 110.7; and

EXCEPTION 1 to Section 150.2(b)1Jii: Dwelling units with at least R-19 existing insulation installed at the ceiling level.

EXCEPTION 2 to Section 150.2(b)1Jii: Dwelling units with atmospherically vented space heating or water heating combustion appliances located inside the pressure boundary of the dwelling unit.

iii. In Climate Zones 1 through 4 and 8 through 16 recessed downlight luminaires in the ceiling shall be covered with insulation to the same depth as the rest of the ceiling. Luminaires not rated for insulation contact must be replaced or retrofitted with a fire-proof cover that allows for insulation to be installed directly over the cover; and

EXCEPTION 1 to Section 150.2(b)1Jiii: In Climate Zones 1 through 4 and 8 through 10, dwelling units with at least R-19 existing insulation installed at the ceiling level with third party verification of existing conditions.

iv. Attic ventilation shall comply with the California Building Code requirements.

EXCEPTION 1 to Section 150.2(b)1J: Dwelling units with at least R-38 existing insulation installed at the ceiling level.

EXCEPTION 2 to Section 150.2(b)1J: Dwelling units where the alteration would directly cause the disturbance of asbestos.

EXCEPTION 3 to Section 150.2(b)1J: Dwelling units with knob and tube wiring located in the vented attic.

EXCEPTION 4 to Section 150.2(b)1J: Where the accessible space in the attic is not large enough to accommodate the required R-value, the entire accessible space shall be filled with insulation provided such installation does not violate Section 806.3 of Title 24, Part 2.5.

EXCEPTION 5 to Section 150.2(b)1J: Where the attic space above the altered dwelling unit is shared with other dwelling units and the requirements of Section 150.2(b)1J are not triggered for the other dwelling units.

K. **Lighting**. The altered lighting system shall meet the lighting requirements of Section 150.0(k). The altered luminaires shall meet the luminaire efficacy requirements of Section 150.0(k) and TABLE 150.0-A. Where existing screw base sockets are present in ceiling-recessed luminaires, removal of these sockets is not required provided that new JA8 compliant trim kits or lamps designed for use with recessed downlights or luminaires are installed.

L. **Mechanical Ventilation for Indoor Air Quality - Entirely New or Complete Replacement Ventilation Systems.** Entirely new or complete replacement ventilation systems shall comply with all applicable requirements in Section 150.0(o). Entirely new or complete replacement ventilation systems shall include a new ventilation fan component and an entirely new duct system. An entirely new duct system shall be constructed of at least 75 percent new duct material, and up to 25 percent may consist of reused parts from the dwelling unit's existing duct system, including but not limited to registers, grilles, boots, air filtration devices, and duct material, if the reused parts are accessible and can be sealed to prevent leakage.

M. **Mechanical Ventilation for Indoor Air Quality - Altered Ventilation Systems**. Altered ventilation system components or newly installed ventilation equipment serving the alteration shall comply with Section 150.0(o) as applicable subject to the requirements specified in subsections i and ii below.

i. **Whole-dwelling Unit Mechanical Ventilation**.

a. **Whole-dwelling unit airflow**. If the whole-dwelling ventilation fan is altered or replaced, then one of the following subsections 1 or 2 shall be used for compliance as applicable.

1. Dwellings that were required by a previous building permit to comply with the whole-dwelling unit airflow requirements in 150.0(o) shall meet or exceed the whole-dwelling unit mechanical ventilation airflow specified in Sections 150.0(o)1C, 150.0(o)1E, or 150.0(o)1F as confirmed through field verification and diagnostic testing in accordance with the applicable procedures specified in Reference Residential Appendix RA3.7.

2. Dwellings that were not required by a previous building permit to have a whole-dwelling unit ventilation system shall not be required to comply with the whole-dwelling unit ventilation airflow specified in Sections 150.0(o)1C, 150.0(o)1E, or 150.0(o)1F.

b. **Replacement Ventilation Fans.** Whole-dwelling unit replacement ventilation fans shall be rated for airflow and sound in accordance with the requirements of ASHRAE 62.2 Sections 7.1 and 7.2. Additionally, when conformance to a specified whole-dwelling unit airflow rate is required for compliance, the replacement fans shall be rated at no less than the airflow rate required for compliance.

c. **Air Filters**. If the air filtration device for a whole-dwelling unit ventilation system is altered or replaced, then one of the following subsections 1 or 2 shall be used for compliance as applicable.

1. Dwellings that were required by a previous building permit to comply with the ventilation system air filtration requirements in 150.0(m)12 shall comply with the air filtration requirements in 150.0(m)12.

2. Dwellings that were not required by a previous building permit to comply with the ventilation system air filtration requirements in 150.0(m)12 shall not be required to comply with the air filtration requirements specified in Section 150.0(m)12.

ii. **Local Mechanical Exhaust**.

a. **Bathroom Local Mechanical Exhaust**. Altered bathroom local mechanical exhaust systems shall comply with the applicable requirements specified in Section 150.0(o)1G.

b. **Kitchen Local Mechanical Exhaust**. If the kitchen local ventilation fan is altered or replaced, then one of the following subsections 1, 2, or 3 shall be used for compliance as applicable.

1. Dwellings that were required by a previous building permit to comply with the kitchen local exhaust requirements in 150.0(o)1G shall meet or exceed the applicable airflow or capture efficiency requirements in Section 150.0(o)1G.

2. Dwellings that were required by a previous building permit to install a vented kitchen range hood or other kitchen exhaust fan, shall install a replacement fan that meets or exceeds the airflow required by the previous building permit, or 100 cfm, whichever is greater.

3. Dwellings that were not required to have a kitchen local ventilation exhaust system according to the conditions in either subsection 1 or 2 above shall not be required to comply with the requirements of Section 150.0(o)1G.

c. Replacement Ventilation Fans. New or replacement local mechanical exhaust fans shall be rated for airflow and sound in accordance with the requirements of ASHRAE 62.2 Section 7.1 and Title 24, Part 6 Section 150.0(o)1Gvi. Additionally, when compliance with a specified exhaust airflow rate is required, the replacement fan shall be rated at no less than the airflow rate required for compliance.

N. **Exterior doors.** Alterations that add exterior door area shall meet the U-factor requirement of Section 150.1(c)5.

2. **Performance approach.**

The altered component(s) and any newly installed equipment serving the alteration shall meet the applicable requirements of subsections A, B, and C below.

A. The altered components shall meet the applicable requirements of Sections 110.0 through 110.9, Sections 150.0(a) through (l), Sections 150.0(m)1 through 150.0 (m)10, and Sections 150.0(~~o~~p) through (q). Entirely new or complete replacement mechanical ventilation systems as these terms are used in Section 150.2(b)1L, shall comply with the requirements in Section 150.2(b)1L. Altered mechanical ventilation systems shall comply with the requirements of sections 150.2(b)1M. Entirely new or complete replacement space-conditioning systems, and entirely new or complete replacement duct systems, as these terms are used in Sections 150.2(b)1C, and 150.2(b)1Diia, shall comply with the requirements of Sections 150.0(m)12 and 150.0(m)13.

B. The standard design for an altered component shall be the higher efficiency of existing conditions or the requirements stated in TABLE 150.2-~~C~~D. For components not being altered, the standard design shall be based on the existing conditions. When the third party verification option is specified as a requirement, all components proposed for alteration for which the additional credit is taken, must be verified.

~~*TABLE 150.2-B AGED SOLAR REFLECTANCE INSULATION TRADE OFF TABLE*~~

~~Aged Solar Reflectance~~	~~Roof Deck Insulation R-value~~	~~Aged Solar Reflectance~~	~~Roof Deck Insulation R-value~~
~~0.62 0.60~~	~~2~~	~~0.44 0.40~~	~~12~~
~~0.59 0.55~~	~~4~~	~~0.39 0.35~~	~~16~~
~~0.54 0.50~~	~~6~~	~~0.34 0.30~~	~~20~~
~~0.49 0.45~~	~~8~~	~~0.29 0.25~~	~~24~~

TABLE 150.2-~~C~~D STANDARD DESIGN FOR AN ALTERED COMPONENT

Altered Component	Standard Design Without Third Party Verification of Existing Conditions Shall be Based On	Standard Design With Third Party Verification of Existing Conditions Shall be Based On
Ceiling Insulation, Wall Insulation, and Raised-floor Insulation	The requirements of Sections 150.0(a), (c), and (d)	The existing insulation R-value
Fenestration	The U-factor of 0.40 and SHGC value of 0.35. The glass area shall be the glass area of the existing building.	If the proposed U-factor is £ 0.40 and SHGC value is £ 0.35, the standard design shall be based on the existing U-factor and SHGC values as verified. Otherwise, the standard design shall be based on the U-factor of 0.40 and SHGC value of 0.35. The glass area shall be the glass area of the existing building.
Window Film	The U-factor of 0.40 and SHGC value of 0.35.	The existing fenestration in the alteration shall be based on Table 110.6-A and Table 110.6-B.
Doors	The U-factor of 0.20. The door area shall be the door area of the existing building.	If the proposed U-factor is < 0.20, the standard design shall be based on the existing U-factor value as verified. Otherwise, the standard design shall be based on the U-factor of 0.20. The door area shall be the door area of the existing building.
Space-Heating and Space-Cooling Equipment	TABLE 150.1-A or B for equipment efficiency requirements; Section 150.2(b)1C for entirely new or complete replacement systems; Section 150.2(b)1F for refrigerant charge verification requirements.	The existing efficiency levels.
Air Distribution System – Duct Sealing	The requirements of Sections 150.2(b)1D and 150.2(b)1E	
Air Distribution System – Duct Insulation	The proposed efficiency levels.	The existing efficiency levels.
Water Heating Systems	The requirements of Section 150.2(b)1Hii	The existing efficiency level.
Roofing Products	The requirements of Section 150.2(b)1I.	
All Other Measures	The proposed efficiency levels.	The existing efficiency levels.

B. The proposed design shall be based on the actual values of the altered components.

NOTES TO SECTION 150.2(b)2:

1. If an existing component must be replaced with a new component, that component is considered an altered component for the purpose of determining the standard design altered component energy budget and must meet the requirements of Section 150.2(b)2B.
2. The standard design shall assume the same geometry and orientation as the proposed design.

3. The "existing efficiency level" modeling rules, including situations where nameplate data is not available, are described in the Residential ACM Approval Manual.

EXCEPTION 1 to Section 150.2(b): Any dual-glazed greenhouse or garden window installed as part of an alteration complies with the U-factor requirements in Section 150.1(c)3.

EXCEPTION 2 to Section 150.2(b): Where the space in the attic or rafter area is not large enough to accommodate the required R-value, the entire space shall be filled with insulation provided such installation does not violate Section 1203.2 of Title 24, Part 2.

(c) **Whole Building.** Any addition or alteration may comply with the requirements of Title 24, Part 6 by meeting the requirements for the entire building.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, 25910, and 25943, Public Resources Code.

SUBCHAPTER 10
MULTIFAMILY BUILDINGS—MANDATORY REQUIREMENTS

SECTION 160.0 – GENERAL

Multifamily buildings shall comply with the applicable requirements of Sections 160.1 through 160.8. Sections 160.1 through 160.8 apply to dwelling units and common use areas in multifamily buildings. Nonresidential occupancies in a mixed occupancy building shall comply with nonresidential requirements in Sections 120.0 through 141.1.

NOTE: The requirements of Sections 160.1 through 160.8 apply to newly constructed buildings. Sections 180.1 through 180.4 specify which requirements of Sections 160.1 through 160.8 apply to additions or alterations.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 160.1 – MANDATORY REQUIREMENTS FOR BUILDING ENVELOPES

(a) Ceiling and Roof Insulation. The opaque portions of ceilings and roofs separating conditioned spaces from unconditioned spaces or ambient air shall meet the requirements of Item1 or 2, and 3 below:

1. Attic Roof. Roofs with an attic space shall meet the requirements of A through C below:

   A. Shall be insulated to achieve an area-weighted average U-factor not exceeding U-0.043 or shall be insulated between wood-framing members with insulation resulting in an installed thermal resistance of R-22 or greater for the insulation alone. For vented attics, the mandatory insulation shall be installed at the ceiling level; for unvented attics, the mandatory insulation shall be placed at either ceiling or roof level;

   B. Attic access doors shall have permanently attached insulation using adhesive or mechanical fasteners. The attic access shall be gasketed to prevent air leakage; and

   C. When loose-fill insulation is installed, the minimum installed weight per square foot shall conform with the insulation manufacturer's installed design weight per square foot at the manufacturer's labeled R-value.

2. Non Attic Roof. Roofs without attic spaces shall meet the applicable requirements of A through C below:

   A. Metal Building- The area-weighted average U-factor of the roof assembly shall not exceed 0.098.

   B. Wood Framed and Others- The area-weighted average U-factor of the roof assembly shall not exceed 0.075.

   C. Insulation Placement- When insulation is installed at the roof, fixed vents or openings to the outdoors or to unconditioned spaces shall not be installed. When the space between the ceiling and the roof is either directly or indirectly conditioned space, it shall not be considered an attic for the purposes of complying with CBC attic ventilation requirements.

   Exception to Section 160.1(a)2C: Vents that do not penetrate the roof deck and are instead designed for wind resistance for roof membranes are not within the scope of Section 160.1(a)2C.

3. Insulation shall be installed in direct contact with a roof or ceiling which is sealed to limit infiltration and exfiltration as specified in Section 110.7, including but not limited to placing insulation either above or below the roof deck or on top of a drywall ceiling.

(b) **Wall Insulation.** Opaque portions of above grade walls separating conditioned spaces from unconditioned spaces or ambient air shall meet the following applicable requirements:

1. Metal Building- The area-weighted average U-factor of the wall assembly shall not exceed 0.113.

2. Metal Framed- The area-weighted average U-factor of the wall assembly shall not exceed 0.151.

3. Wood Framed and Others-

   A. Nominal 2x4 inch framing shall have an area-weighted average U-factor of the wall assembly not exceeding 0.102.

   B. Nominal 2x6 inch framing shall have an area-weighted average U-factor of the wall assembly not exceeding 0.071.

   C. Other wall assemblies shall have an area-weighted average U-factor of the wall assembly not exceeding 0.102.

4. Light Mass Walls- A 6 inch or greater Hollow Core Concrete Masonry Unit shall have a U-factor not to exceed 0.440.

5. Heavy Mass Walls- An 8 inch or greater Hollow Core Concrete Masonry Unit shall have a U-factor not to exceed 0.690.

6. Spandrel Panels and Curtain Wall- The area-weighted average U-factor of the spandrel panels and curtain wall assembly shall not exceed 0.280.

7. Demising Walls-. The opaque portions of framed demising walls shall meet the requirements of Item A or B below:

A. Wood framed walls shall be insulated to meet a U-factor not greater than 0.099.

B. Metal Framed walls shall be insulated to meet a U-factor not greater than 0.151.

8. Bay or Bow Window roofs and floors. Shall be insulated to meet the wall insulation requirements of TABLE 170.2-A.

(c) Floor and Soffit Insulation. The opaque portions of floors and soffits that separate conditioned spaces from unconditioned spaces or ambient air shall meet the applicable requirements of Items 1 through 3 below:

1. Raised Mass Floors - Shall have a minimum of 3 inches of lightweight concrete over a metal deck or the area-weighted average U-factor of the floor assembly shall not exceed 0.269.

2. Raised Wood Floor - shall have an overall assembly U-factor not exceeding U-0.037. In a wood framed assembly, compliance with the U-factor may be demonstrated by installing insulation with an R-value of 19 or greater.

3. Other Floors -The area-weighted average U-factor of the floor assembly shall not exceed 0.071.

4. Heated Slab On Grade Floor-A heated slab on grade floor shall be insulated to meet the requirements of Section 110.8(g)

EXCEPTION to Section 160.1(**c):** A building with a controlled ventilation or unvented crawlspace may omit raised floor insulation if all of the following are met:

A. The foundation walls are insulated to meet the wall insulation minimums as shown in Table170.2-A; and

B. A Class I or Class II vapor retarder is placed over the entire floor of the crawlspace; and

C. Vents between the crawlspace and outside air are fitted with automatically operated louvers that are temperature actuated; and

D. The requirements in Reference Residential Appendix RA4.5.1.

(d) Vapor Retarder.

1. In Climate Zones 1-16, the earth floor of unvented crawl space shall be covered with a Class I or Class II vapor retarder. This requirement shall also apply to controlled ventilation crawl space for buildings complying with the Exception to **Section 160.1(c).**

2. In Climate Zones 14 and 16, a Class I or Class II vapor retarder shall be installed on the conditioned space side of all insulation in all exterior walls, vented attics and unvented attics with air-permeable insulation.

(e) Fenestration Products. Fenestration separating conditioned space from unconditioned space or outdoors shall meet the requirements of either Item 1 or 2 below:

1. Fenestration, including skylight products, must have a maximum U-factor of 0.58.

EXCEPTION 1 to Section 160.1(e)1: Up to 0.5 percent of the Conditioned Floor Area is exempt from the maximum U-factor requirement.

EXCEPTION 2 to Section 160.1(e)1: For dual-glazed greenhouse or garden windows, up to 30 square feet of fenestration area per dwelling unit is exempt from the maximum U-factor requirement.

2. The area-weighted average U-factor of all fenestration, including skylight products, shall not exceed 0.58.

(f) Installation of Fireplaces, Decorative Gas Appliances and Gas Logs. If a masonry or factory-built fireplace is installed, it shall comply with Section 110.5, Section 4.503 of Part 11, and shall have the following:

1. Closeable metal or glass doors covering the entire opening of the firebox; and

2. A combustion air intake to draw air from the outside of the building, which is at least 6 square inches in area and is equipped with a readily accessible, operable, and tight-fitting damper or combustion-air control device; and

EXCEPTION to Section 160.1(f)2: An outside combustion-air intake is not required if the fireplace will be installed over concrete slab flooring and the fireplace will not be located on an exterior wall.

3. A flue damper with a readily accessible control.

EXCEPTION to Section 160.1(f)3: When a gas log, log lighter, or decorative gas appliance is installed in a fireplace, the flue damper shall be blocked open if required by the CMC or the manufacturer's installation instructions.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 160.2 – MANDATORY REQUIREMENTS FOR VENTILATION AND INDOOR AIR QUALITY

(a) General Requirements.

1. Attached dwellings units in multifamily buildings shall comply with the applicable requirements of subsection 160.2(b) below. Occupiable spaces in multifamily buildings other than attached dwelling units shall comply with the applicable requirements of section 160.2(c). When HERS field verification and diagnostic testing of attached dwelling units is required by Section 160.2, buildings with three habitable stories or less shall use the applicable procedures in the Residential Appendices, and buildings with four or more habitable stories shall use the applicable procedures in Nonresidential Appendices NA1 and NA2.

   NOTE: Section 160.2 is not applicable to townhouses or dwellings that contain two dwelling units.

2. The required outdoor air-ventilation rate and the air-distribution system design shall be clearly identified on the building design plans submitted to the enforcement agency in accordance with Section 10-103 of Title 24, Part 1.

(b) Attached Dwelling Units. Attached dwellings units shall comply with the requirements of subsections 1 and 2 below**.**

1. Air Filtration.

A. System types specified in Subsections i, ii, and iii shall be provided with air filters in accordance with Sections 160.2(b)1B, 160.2(b)1C, and 160.2(b)1D. System types specified in subsection i shall also comply with Section 160.2(b)1E.

i. Mechanical space conditioning systems that supply air to an occupiable space through ductwork exceeding 10 ft (3 m) in length.

ii. Mechanical supply-only ventilation systems and makeup air systems that provide outside air to an occupiable space.

iii. The supply side of mechanical balanced ventilation systems, including heat recovery ventilation systems, and energy recovery ventilation systems that provide outside air to an occupiable space.

B. System Design and Installation.

i. The system shall be designed to ensure that all recirculated air and all outdoor air supplied to the occupiable space is filtered before passing through any system's thermal conditioning components.

EXCEPTION to 160.2(b)1Bi: For heat recovery ventilators and energy recovery ventilators the location of the filters required by Section 160.2(b)1 may be downstream of a system thermal conditioning component, provided the system is equipped with ancillary filtration upstream of the system's thermal conditioning component.

ii. All systems shall be designed to accommodate the clean-filter pressure drop imposed by the system air filter(s). The design airflow rate, and maximum allowable clean-filter pressure drop at the design airflow rate applicable to each air filter shall be determined and reported on labels according to subsection iv below.

Systems specified in Section 160.2(b)1Ai shall be equipped with air filters that meet either subsection a or b below:

a. Nominal two-inch minimum depth filter(s) shall be sized by the system designer, or

b. Nominal one-inch minimum depth filter(s) shall be allowed if the filter(s) are sized according to Equation 160.2-A, based on a maximum face velocity of 150 ft per minute, and according to the maximum allowable clean-filter pressure drop specified in Section 160.2(b)1Dii.

$A_{face} = Q_{filter} / V_{face}$ (Equation 160.2-A)

Where:

A_{face} = air filter face area, the product of air filter nominal length x nominal width, ft^2

Q_{filter} = design airflow rate for the air filter, ft^3/min

V_{face} = air filter face velocity ≤ 150, ft/min

iii. All system air filters shall be located and installed in such a manner as to be accessible for regular service by the system owner.

iv. All system air filter installation locations shall be labeled to disclose the applicable design airflow rate and the maximum allowable clean-filter pressure drop. The labels shall be permanently affixed to the air filter installation location, readily legible, and visible to a person replacing the air filter.

v. Filter racks or grilles shall be gasketed or sealed to eliminate any gaps around the filter to prevent air from bypassing the filter.

C. Air Filter Efficiency**. T**he system shall be provided with air filters having a designated efficiency equal to or greater than MERV 13 when tested in accordance with ASHRAE Standard 52.2, or a particle size efficiency rating equal to or greater than 50 percent in the 0.30-1.0 µm range, and equal to or greater than 85 percent in the 1.0-3.0 µm range when tested in accordance with AHRI Standard 680.

D. A**ir Filter Pressure Drop**. All systems shall be provided with air filters that conform to the applicable maximum allowable clean-filter pressure drop specified in subsections i, ii, iii, or iv below, when tested using ASHRAE Standard 52.2, or as rated using AHRI Standard 680, for the applicable design airflow rates for the system air filters.

i. The maximum allowable clean-filter pressure drop shall be determined by the system design for the nominal two-inch minimum depth air filter required by Section 160.2(b)1Biia, or

ii. A maximum of 25 PA (0.1 inches water) clean-filter pressure drop shall be allowed for a nominal one-inch depth air filter sized according to Section 160.2(b)1Biib, or

iii. For systems specified in 160.2(b)1Aii, and 160.2(b)1Aiii, the maximum allowable clean filter pressure drop shall be determined by the system design.

iv. If EXCEPTION 1 to **Section** 160.3(b)5Lii or iv is utilized for compliance with cooling system airflow rate and fan efficacy requirements, the clean-filter pressure drop for the system air filter shall conform to the requirements given in TABLE 160.3-A or 160.3-B.

E. Air Filter Product Labeling**.** Systems described in 160.2(b)1Ai shall be equipped with air filters that have been labeled by the manufacturer to disclose the efficiency and pressure drop ratings that demonstrate conformance with Sections 160.2(b)1C and 160.2(b)1D.

EXCEPTION to 160.2(b)1: Evaporative coolers are exempt from the air filtration requirements in Section 160.2(b)1.

2. Ventilation and Indoor Air Quality for Attached Dwelling Units. All attached dwelling units shall meet the requirements of ASHRAE Standard 62.2, Ventilation and Acceptable Indoor Air Quality in Residential Buildings subject to the amendments specified in Section 160.2(b)2A below. All dwelling units shall comply with Section 160.2(b)2B below.

Exception to Section 160.2(b)2 The following sections of ASHRAE 62.2 shall not be required for compliance: Section 4.1.1, Section 4.1.2; Section 4.1.4; Section 4.3; Section 4.6, Section 5, Section 6.1.1, Section 6.5.2, and Normative Appendix A.

A. Amendments to ASHRAE 62.2 Requirements.

i. **Window Operation**. Window operation is not a permissible method of providing the dwelling unit ventilation airflow specified in subsections iv or v below.

ii. **Central Fan Integrated (CFI) Ventilation Systems**.

a. Continuous Operation Prohibition. Continuous operation of a dwelling unit's central forced air system air handlers used in CFI ventilation systems is not a permissible method of providing the whole-dwelling unit ventilation airflow required by Section 160.2(b)2Aiv.

EXCEPTION to Section 160.2(b)2Aii: The Energy Commission may approve continuous operation of central fan integrated ventilation systems pursuant to Section 10-109(h).

b. Outdoor Air Damper(s). A motorized damper(s) shall be installed on the connected ventilation duct(s) of CFI systems that prevents all airflow into or out of the space conditioning duct system when the damper(s) is closed.

c. Damper Control. The required motorized damper(s) shall be controlled to be in an opened position when outdoor air ventilation is required for compliance, and shall be in the closed position when ventilation air is not required. The damper(s) shall be closed whenever the space conditioning system air handling unit is not operating. If the outdoor airflow for the CFI ventilation system is fan-powered, then the outdoor air fan shall not operate when the required motorized damper(s) on the outdoor air ventilation duct(s) is closed.

d. Variable Ventilation. CFI ventilation systems shall incorporate controls that track outdoor air ventilation run time, and either open or close the required motorized damper(s) depending on whether or not outdoor air ventilation is required for compliance with sections 160.2(b)2Aiv. During periods when comfort conditioning is not called for by the space conditioning thermostat, the CFI ventilation system controls shall operate the space conditioning system central fan and outdoor air damper(s) when necessary to ensure compliance with the minimum outdoor air ventilation required by sections 160.2(b)2Aiv in accordance with applicable variable mechanical ventilation methods specified in ASHRAE 62.2 section 4.5.

iii. **Air Filtration.** Air filtration shall conform to the specifications in 160.2(b)1. Compliance with ASHRAE 62.2 Sections 6.7 (Minimum Filtration) and 6.7.1 (Filter Pressure Drop) shall not be required.

iv. **Whole-Dwelling Unit Mechanical Ventilation**. Multifamily attached dwelling units shall comply with subsections a and b below.

a. Mechanical ventilation airflow shall be provided at rates greater than or equal to the value determined in accordance with Equation 160.2-B.

Total Required Ventilation Rate [ASHRAE 62.2:4.1.1].

$$Q_{tot} = 0.03A_{floor} + 7.5(N_{br} + 1) \quad \text{(Equation 160.2-B)}$$

WHERE:

Q_{tot} = total required ventilation rate, cfm

A_{floor} = dwelling-unit floor area, ft^2

N_{br} = number of bedrooms (not to be less than 1)

b. All dwelling units in a multifamily building shall use the same ventilation system type. The system type installed throughout the building shall be only one of the following three types: supply, exhaust, or balanced. The dwelling unit shall comply with one of the following subsections 1 or 2 below.

1. **Balanced Ventilation**. A balanced ventilation system shall provide the required whole-dwelling-unit ventilation airflow. Systems with heat recovery or energy recovery that serve a single dwelling unit shall have a fan efficacy of ≤1.0 W/cfm; or

2. **Supply or Exhaust Ventilation with Compartmentalization Testing**. Continuously operating supply ventilation systems, or continuously operating exhaust ventilation systems shall be allowed to be used to provide the required whole-dwelling unit ventilation airflow only if the

dwelling unit envelope leakage is less than or equal to 0.3 cubic feet per minute at 50 Pa (0.2 inch water) per ft^2 of dwelling unit envelope surface area as confirmed by HERS field verification and diagnostic testing in accordance with the procedures specified in Reference Appendix RA3.8 or NA2.3 as applicable.

v. **Multifamily Building Central Ventilation System Airflow Rate Tolerance.** Multifamily building central ventilation systems that serve multiple dwelling units shall have airflow rates in each dwelling unit served that meet or exceed a design ventilation airflow rate specification.

a. Designers shall specify a design ventilation airflow rate for each dwelling unit that is equal to or greater than the rate specified by Equation 160.2-B.

b. The design ventilation airflow rate for each dwelling unit shall be stated on the building design plans approved by the enforcement agency.

c. Airflow in each dwelling unit shall be no more than twenty percent greater than the specified design ventilation airflow rate. Ventilation systems shall utilize mechanical or software airflow control means to ensure each of the dwelling-unit airflows can be maintained at the design ventilation airflow within this tolerance at all times. System airflow control-means may include but are not limited to: constant air regulation devices, orifice plates, and variable speed central fans.

vi. **Local Mechanical Exhaust.** A local mechanical exhaust system shall be installed in each kitchen and bathroom. Systems shall be rated for airflow in accordance with ASHRAE 62.2 section 7.1.

a. **Nonenclosed kitchens** shall have a demand-controlled mechanical exhaust system meeting the requirements of Section 160.2(b)2Avic.

b **Enclosed kitchens and all bathrooms** shall have either one of the following alternatives 1 or 2:

1. A demand-controlled mechanical exhaust system meeting the requirements of Section 160.2(b)2Avic; or

2. A continuous mechanical exhaust system meeting the requirements of Section 160.2(b)2Avid.

c **Demand-Controlled Mechanical Exhaust.** A local mechanical exhaust system shall be designed to be operated as needed.

1. **Control and Operation.** Demand-controlled mechanical exhaust systems shall be provided with at least one of the following controls:

A. A readily accessible occupant-controlled ON-OFF control.

B. An automatic control that does not impede occupant ON control.

2. **Ventilation Rate and Capture Efficiency.** The system shall meet or exceed either the minimum airflow in accordance with Table 160.2-E or the minimum capture efficiency in accordance with Table 160.2-E, and Table 160.2-G. Capture efficiency ratings shall be determined in accordance with ASTM E3087, and listed in a product directory approved by the Energy Commission.

d. **Continuous Mechanical Exhaust.** A mechanical exhaust system shall be installed to operate continuously. The system may be part of a balanced mechanical ventilation system.

1. **Control and Operation**. A manual ON-OFF control shall be provided for each continuous mechanical exhaust system. The system shall be designed to operate during all occupiable hours. For multifamily dwelling units, the manual ON-OFF control may be accessible to the dwelling unit occupant, however the manual ON-OFF control shall not be required to be accessible to the dwelling unit occupant.

2. **Ventilation Rate.** The minimum delivered ventilation shall be at least the amount indicated in Table 160.2-F during each hour of operation.

e. **Airflow Measurement of Local Mechanical Exhaust by the System Installer.** The airflow required by section 160.2(b)2Avi is the quantity of indoor air exhausted by the ventilation system as installed in the dwelling unit. When a vented range hood utilizes a capture efficiency rating to demonstrate compliance with 160.2(b)2Avic2, the airflow listed in the approved directory corresponding to the compliant capture efficiency rating point shall be met by the installed system. The as-installed airflow shall be verified by the system installer to ensure compliance by use of either subsection 1 or 2 below:

1. The system installer shall measure the airflow by using a flow hood, flow grid, or other airflow measuring device at the mechanical ventilation fan's inlet terminals/grilles or outlet terminals/grilles in accordance with the procedures in Reference Appendix RA3.7 or NA2.2 as applicable.

2. As an alternative to performing an airflow measurement of the system as installed in the dwelling unit, compliance may be demonstrated by installing an exhaust fan and duct system that conforms to the specifications of Table 160.2-H. Visual inspection shall verify the installed system conforms to the requirements of Table 160.2-H.

   When using Table 160.2-H for demonstrating compliance, the airflow rating shall be greater than or equal to the value required by Section 160.2(b)2Avi at a static pressure greater than or equal to 0.25 in. of water (62.5 Pa). When a vented range hood utilizes a capture efficiency rating to demonstrate compliance with 160.2(b)2Avic2, a static pressure greater than or equal to 0.25 in. of water at the rating point shall not be required, and the airflow listed in the approved directory corresponding to the compliant capture efficiency rating point shall be applied to Table 160.2-H for determining compliance.

   Use of Table 160.2-H is limited to ventilation systems that conform to all of the following three specifications:

   A. total duct length is less than or equal to 25 ft (8 m),

   B. duct system has no more than three (3) elbows, and

   C. duct system has exterior termination fitting with a hydraulic diameter greater than or equal to the minimum duct diameter and not less than the hydraulic diameter of the fan outlet.

f. **Sound Ratings for Local Mechanical Exhaust**. Local mechanical exhaust systems shall be rated for sound in accordance with Section 7.2 of ASHRAE 62.2 at no less than the minimum airflow rate required by Section 160.2(b)2Avi.

EXCEPTION to Section 160.2(b)2Avif: Kitchen range hoods may be rated for sound at a static pressure determined at working speed as specified in HVI 916 Section 7.2.

vii. **Airflow Measurement of Whole-Dwelling Unit Ventilation**. The airflow required by Sections 160.2(b)2Aiv or 160.2(b)2Av is the quantity of outdoor ventilation air supplied or indoor air exhausted by the mechanical ventilation system as installed and shall be measured by using a flow hood, flow grid, or other airflow measuring device at the mechanical ventilation fan's inlet terminals/grilles or outlet terminals/grilles in accordance with the procedures in Reference Appendix Section RA3.7.4.1.1 or NA2.2.4.1.1 as applicable for supply and exhaust systems or RA3.7.4.1.2 or NA2.2.4.1.2 as applicable for balanced systems. Balanced mechanical ventilation system airflow shall be the average of the supply fan and exhaust fan flows.

viii. **Sound Ratings for Whole-Dwelling Unit Ventilation Systems.** Whole-Dwelling unit ventilation systems shall be rated for sound in accordance with Section 7.2 of ASHRAE 62.2 at no less than the minimum airflow rate required by 160.2(b)2Aiv or 160.2(b)2Av as applicable.

ix. **Label for Whole-Dwelling Unit Ventilation System On-Off Control**. Compliance with ASHRAE 62.2 Section 4.4 (Control and Operation) shall require manual ON-OFF control switches associated with whole-dwelling unit ventilation systems to have a label clearly displaying the following text, or equivalent text: "This switch controls the indoor air quality ventilation for the home. Leave switch in the "on" position at all times unless the outdoor air quality is very poor."

x. **Combustion Air and Compensating Outdoor Air or Makeup Air**

a. All dwelling units shall conform to the applicable requirements specified in California Mechanical Code Chapter 7, Combustion Air.

b. Atmospherically vented or solid fuel burning appliances shall not be installed inside the pressure boundary in dwelling units with conditioned floor area less than 1,000 ft2.

c. All dwelling units shall conform to the requirements in ASHRAE 62.2 Section 6.4, Combustion and Solid-Fuel-Burning Appliances.

B**. Dwelling Unit HERS Field Verification and Diagnostic Testing.**

i. **Whole-Dwelling Unit Ventilation Airflow Performance**. The whole-dwelling unit ventilation airflow required by Section 160.2(b)2Aiv or 160.2(b)2Av shall be confirmed through HERS field verification and diagnostic testing in accordance with Reference Appendix RA3.7.4.1.1 or NA2.2.4.1.1 as applicable for supply and exhaust systems or RA3.7.4.1.2 or NA2.2.4.1.2 as applicable for balanced systems. Balanced mechanical ventilation system airflow shall be the average of the supply fan and exhaust fan flows. Ventilation airflow of systems with multiple operating modes shall be tested in all modes designed to comply with the required ventilation airflows.

ii. **Kitchen Local Mechanical Exhaust - Vented Range Hoods.** Vented range hoods installed to comply with local mechanical exhaust requirements specified in section 160.2(b)2Avi shall be HERS field verified in accordance with Reference Appendix RA3.7.4.3 or NA2.2.4.1.4 as applicable to confirm the model is rated by HVI or AHAM to comply with the following requirements:

a. The minimum ventilation airflow rate as specified by Section 160.2(b)2Avi, or alternatively the minimum capture efficiency as specified by Section 160.2(b)2Avi; and

b. The maximum sound rating as specified in Section 160.2(b)2Avif.

iii. **Heat Recovery Ventilation (HRV) and Energy Recovery Ventilation (ERV) System Fan Efficacy.** At a minimum, systems with heat or energy recovery serving a single dwelling unit shall have a fan efficacy of ≤1.0 W/cfm as confirmed by HERS field verification in accordance with Reference Appendix RA3.7.4.4 or NA2.2.4.1.5 as applicable. If Section 170.2(c)3Bva requirements are applicable to the dwelling unit, then HERS field verification shall instead confirm compliance with the maximum fan efficacy and minimum sensible recovery efficiency specified in Section 170.2(c)3Bva in accordance with the procedures specified in Reference Appendix RA3.7.4.4 or NA2.2.4.1.5 as applicable.

C. **Multifamily Building Central Ventilation System Field Verification**

i. **Central Ventilation System Duct Sealing.** Ventilation ducts that conform to subsections a and b below shall meet the duct sealing requirements in the California Mechanical Code Section 603.10 and have leakage that is no greater than six percent of the rooftop fan or central fan design airflow rate as confirmed by field verification in accordance with the procedures in Reference Appendix NA7.18.3. The leakage test shall be conducted using a test pressure of 25 Pa (0.1 inches) for ducts serving six or fewer dwelling units and 50 Pa (0.2 inches) for ducts serving more than six dwelling units, and shall measure the leakage of all ductwork between the central fan and the connection point to the in-unit grille or fan.

a. The ventilation ducts serve multiple dwelling units.

b. The ventilation ducts provide continuous airflows or airflows to provide balanced ventilation to meet the requirements specified in Sections 160.2(b)2Aiv or 160.2(b)2Av as applicable.

(c) Common Services Areas. All occupiable spaces shall comply with the requirements of subsection 1 and shall also comply with either subsection 2 or subsection 3:

1. Air Filtration

A. Mechanical system types specified in subsections i, ii, and iii below shall be designed to ensure that all recirculated air and all outdoor air supplied to the occupiable space is filtered before passing through any system's thermal conditioning components. Air Filters shall conform to the requirements of Sections 160.2(c)1B, 160.2(c)1C and 160.2(c)1D.

i. Mechanical space conditioning systems that supply air to an occupiable space through ductwork exceeding 10 ft (3 m) in length.

ii. Mechanical supply-only ventilation systems and makeup air systems that provide outside air to an occupiable space.

iii. The supply side of mechanical balanced ventilation systems, including heat recovery ventilation systems and energy recovery ventilation systems that provide outside air to an occupiable space.

EXCEPTION to Section 160.2(c)1A: For heat recovery ventilators and energy recovery ventilators the location of the filters required by Section 160.2(c)1A may be downstream of a system's thermal conditioning component, provided the system is equipped with ancillary filtration upstream of the system's thermal conditioning component.

B. Air Filter Efficiency. The filters shall have a designated efficiency equal to or greater than MERV 13 when tested in accordance with ASHRAE Standard 52.2, or a particle size efficiency rating equal to or greater than 50 percent in the 0.30-1.0 µm range, and equal to or greater than 85 percent in the 1.0-3.0 µm range when tested in accordance with AHRI Standard 680; and

C. Systems shall be equipped with air filters that meet either subsection i or ii below.

i. Nominal two inch minimum depth filter(s); or

ii. Nominal one inch minimum depth filter(s) shall be allowed if the filter(s) are sized according to Equation 160.2-A, based on a maximum face velocity of 150 ft per minute.

D. Filter racks or grilles shall be gasketed or sealed to eliminate any gaps around the filter to prevent air from bypassing the filter.

2. Natural Ventilation. Naturally ventilated spaces shall be designed in accordance with 160.2(c)2A through 160.2(c)2C and include a mechanical ventilation system designed in accordance with 160.2(c)3:

EXCEPTION 1 to 160.2(c)2: The mechanical ventilation system shall not be required where natural ventilation openings complying with 160.2(c)2 are either permanently open or have controls that prevent the openings from being closed during periods of expected occupancy.

EXCEPTION 2 to Section 160.2(c)2: The mechanical ventilation system shall not be required where the zone is not served by a space conditioning system.

A. Floor area to be ventilated. Spaces or portions of spaces to be naturally ventilated shall be located within a distance based on the ceiling height, as specified in i, ii and iii. The ceiling height (H) to be used in i, ii or iii shall be the minimum ceiling height in the space, or for ceilings that are increasing in height as distance from

the operable openings is increased, the ceiling height shall be determined as the average height of the ceiling within 20 ft from the operable opening. [ASHRAE 62.1:6.4.1]

i. Single Side Opening. For spaces with operable opening on one side of the space, the maximum distance from the operable opening shall be not more than 2H. [ASHRAE 62.1:6.4.1.1]

ii. Double Side Opening. For spaces with operable openings on two opposite sides of the space, the maximum distance from the operable opening shall be not more than 5H. [ASHRAE 62.1:6.4.1.2]

iii. Corner Opening. For spaces with operable openings on two adjacent sides of a space, the maximum distance from the operable openings shall be not more than 5H along a line drawn between the two openings that are the farthest apart. Floor area outside that line shall comply with i or ii. [ASHRAE 62.1:6.4.1.3]

iv. Ceiling Height. The ceiling height (h) to be used in Section 160.2(c)2Ai through 160.2 (c)2Aiii shall be the minimum ceiling height in the space.

EXCEPTION to Section 160.2(c)2Aiv: For ceilings that are increasing in height as distance from the opening is increased, the ceiling height shall be determined as the average height of the ceiling within 20 feet from the operable openings. [ASHRAE 62.1:6.4.1.4]

B. Location and Size of Openings. Spaces or portions of spaces to be naturally ventilated shall be permanently open to operable wall openings directly to the outdoors. The openable area shall be not less than 4 percent of the net occupiable floor area. Where openings are covered with louvers or otherwise obstructed, the openable area shall be based on the net free unobstructed area through the opening. Where interior rooms, or portions of rooms, without direct openings to the outdoors are ventilated through adjoining rooms, the opening between rooms shall be permanently unobstructed and have a free area of not less than 8 percent of the area of the interior room or less than 25 square feet. [ASHRAE 62.1:6.4.2]

C. Control and Accessibility. The means to open the required operable opening shall be readily accessible to building occupants whenever the space is occupied. Controls shall be designed to coordinate operation of the natural and mechanical ventilation systems. [ASHRAE 62.1:6.4.3]

3. Mechanical Ventilation. Occupiable spaces shall be ventilated with a mechanical ventilation system capable of providing an outdoor airflow rate (V_z) to the zone no less than the larger of A or B as described below:

A. The outdoor airflow rate to the zone (Vz) shall be determined in accordance with Equation 160.2-G; or

$V_z = R_a \times A_z$ (Equation 160.2-G)

Where:

R_a = Outdoor airflow rate required per unit area as determined from Table 160.2-B.

A_z = Zone floor area is the net occupiable floor area of the ventilation zone in square feet.

B. For spaces designed for an expected number of occupants, the outdoor airflow rate to the zone (V_z) shall be determined in accordance with Equation 160.2-H;

$V_z = R_p \times P_z$ (Equation 160.2-H)

Where:

R_p = 15 cubic feet per minute of outdoor airflow per person

P_z = The expected number of occupants. The expected number of occupants shall be the expected number specified by the building designer. For spaces with fixed seating, the expected number of occupants shall be determined in accordance with the California Building Code.

EXCEPTION to Section 160.2(c)3: Transfer air. The rate of outdoor air required by Section 160.2(c)3 may be provided with air transferred from other ventilated space if:

i. Use of transfer air is in accordance with Section 160.2(c)8; and

ii. The outdoor air that is supplied to all spaces combined, is sufficient to meet the requirements of Section 160.2(c)3 for each space individually.

4. Exhaust Ventilation. The design exhaust airflow shall be determined in accordance with the requirements in Table 160.2-C. Exhaust makeup air shall be permitted to be any combination of outdoor air, recirculated air, or transfer air. [ASHRAE 62.1:6.5.1]

5. Operation and Control Requirements for Minimum Quantities of Outdoor Air.

A. Times of occupancy. The minimum rate of outdoor air required by Section 160.2(c) shall be supplied to each space at all times when the space is usually occupied.

EXCEPTION 1 to Section 160.2(c)5A: Demand control ventilation. In intermittently occupied spaces that do not have processes or operations that generate dusts, fumes, mists, vapors or gasses and are not provided with local exhaust ventilation (such as indoor operation of internal combustion engines or areas designated for unvented food service preparation), the rate of outdoor air may be reduced if the ventilation system serving the space is controlled by a demand control ventilation device complying with Section 160.2(c)5D or by an occupant sensor ventilation control device complying with Section 160.2(c)5E.

EXCEPTION 2 to Section 160.2(c)5A: Temporary reduction. The rate of outdoor air provided to a space may be reduced below the level required by Section 160.2(c) for up to 30 minutes at a time if the average rate for each hour is equal to or greater than the required ventilation rate.

B. Pre-occupancy. The lesser of the minimum rate of outdoor air required by Section 160.2(c) or three complete air changes shall be supplied to the entire building during the 1-hour period immediately before the building is normally occupied.

C. Required Demand Control Ventilation. Demand ventilation controls complying with 160.2(c)5D are required for a space with a design occupant density, or a maximum occupant load factor for egress purposes in the CBC, greater than or equal to 25 people per 1000 square feet (40 square feet or less per person) if the system serving the space has one or more of the following:

i. an air economizer; or

ii. modulating outside air control; or

iii. design outdoor airflow rate > 3,000 cfm.

EXCEPTION 1 to Section 160.2(c)5C: Where space exhaust is greater than the design ventilation rate specified in Section 160.2(c)3 minus 0.2 cfm per ft² of conditioned area.

EXCEPTION 2 to Section 160.2(c)5C: Spaces that have processes or operations that generate dusts, fumes, mists, vapors, or gases and are not provided with local exhaust ventilation, such as indoor operation of internal combustion engines or areas designated for unvented food service preparation, daycare sickrooms, science labs, barber shops or beauty and nail salons shall not install demand control ventilation.

EXCEPTION 3 to Section 160.2(c)5C: Spaces with an area of less than 150 square feet, or a design occupancy of less than 10 people as specified by Section 160.2(c)3.

D. Demand Control Ventilation Devices.

i. For each system with demand control ventilation (DCV), CO_2 sensors shall be installed in each room that meets the criteria of Section 160.2(c)5C with no less than one sensor per 10,000 ft² of floor space. When a zone or a space is served by more than one sensor, a signal from any sensor indicating that CO_2 is near or at the setpoint within the zone or space shall trigger an increase in ventilation.

ii. CO_2 sensors shall be located in the room between 3 ft and 6 ft above the floor or at the anticipated height of the occupants' heads.

iii. Demand ventilation controls shall maintain CO_2 concentrations less than or equal to 600 ppm plus the outdoor air CO_2 concentration in all rooms with CO_2 sensors.

EXCEPTION to Section 160.2(c)5Diii: The outdoor air ventilation rate is not required to be larger than the design outdoor air ventilation rate required by Section 160.2(c)3 regardless of CO_2 concentration.

iv. Outdoor air CO_2 concentration shall be determined by one of the following:

a. CO_2 concentration shall be assumed to be 400 ppm without any direct measurement; or

b. CO_2 concentration shall be dynamically measured using a CO_2 sensor located within 4 ft of the outdoor air intake.

v. When the system is operating during hours of expected occupancy, the controls shall maintain system outdoor air ventilation rates no less than the rate listed in Table 160.2-B for DCV, times the conditioned floor area for spaces with CO_2 sensors, plus the rate required by Section 160.2(c)3 for other spaces served by the system, or the exhaust air rate whichever is greater.

vi. CO_2 sensors shall be certified by the manufacturer to be accurate within plus or minus 75 ppm at a 600 and 1000 ppm concentration when measured at sea level and 25°C, factory calibrated, and certified by the manufacturer to require calibration no more frequently than once every 5 years. Upon detection of sensor failure, the system shall provide a signal which resets to supply the minimum quantity of outside air to levels required by Section 160.2(c)3 to the zone serviced by the sensor at all times that the zone is occupied.

vii. The CO_2 sensor(s) reading for each zone shall be displayed continuously, and shall be recorded on systems with digital direct controls (DDC) to the zone level.

E. Occupant Sensor Ventilation Control Devices. When occupancy sensor ventilation devices are required by Section 160.3(a)2Diii, occupant sensors shall be used to reduce the rate of outdoor air flow when occupants are not present in accordance with the following:

i. Occupant sensors shall meet the requirements in Section 110.9(b)4 and shall have suitable coverage and placement to detect occupants in the entire space ventilated. If occupant sensors controlling lighting are used for ventilation, the ventilation signal shall be independent of daylighting, manual lighting overrides or manual control of lighting. When a single zone damper or a single zone system serves multiple rooms, there shall be an occupancy sensor in each room and the zone is not considered vacant until all rooms in the zone are vacant.

ii. One hour prior to normal scheduled occupancy, the occupancy sensor ventilation control shall allow pre-occupancy purge as described in Section 160.2(c)5B.

6. Ducting for Zonal Heating and Cooling Units. Where a return plenum is used to distribute outdoor air to a zonal heating or cooling unit which then supplies the air to a space in order to meet the requirements of Section 160.2(c)3, the outdoor air shall be ducted to discharge either:

A. Within 5 feet of the unit; or

B. Within 15 feet of the unit, substantially toward the unit, and at a velocity not less than 500 feet per minute.

7. Design and Control Requirements for Quantities of Outdoor Air.

A. All mechanical ventilation and space-conditioning systems shall be designed with and have installed ductwork, dampers, and controls to allow outside air rates to be operated at the minimum levels specified in Section 160.2(c)3 or the rate required for make-up of exhaust systems that are required for an exempt or covered process, for control of odors, or for the removal of contaminants within the space.

B. All variable air volume mechanical ventilation and space-conditioning systems shall include dynamic controls that maintain measured outside air ventilation rates within 10 percent of the required outside air ventilation rate at both full and reduced supply airflow conditions. Fixed minimum damper position is not considered to be dynamic and is not an allowed control strategy.

C. Measured outdoor air rates of constant volume mechanical ventilation and space-conditioning systems shall be within 10 percent of the required outside air rate.

8. Air Classification and Recirculation Limitations. Air classification and recirculation limitations of air shall be based on the air classification as listed in Table 160.2-B or Table 160.2-D, in accordance with the following:

A. Class 1 Air is air with significant contaminant concentration, significant sensory-irritation intensity, or offensive odor. Recirculation or transfer of Class 1 air to any space shall be permitted; [ASHRAE 62.1:5.16.3.1]

B. Class 2 Air is air with moderate contaminant concentration, mild sensory-irritation intensity, or mildly offensive odors (Class 2 air also includes air that is not necessarily harmful or objectionable but that is inappropriate for transfer or recirculation to spaces used for different purposes). Recirculation or transfer of Class 2 air shall be permitted in accordance with 160.2(c)8Bi through 160.2(c)8Bv:

i. Recirculation of Class 2 air within the space of origin shall be permitted [ASHRAE 62.1:5.16.3.2.1]:

ii. Recirculation or transfer of Class 2 to other Class 2 or Class 3 spaces shall be permitted, provided that the other spaces are used for the same or similar purpose or task and involve the same or similar pollutant sources as the Class 2 space [ASHRAE 62.1:5.16.3.2.2]; or

iii. Transfer of Class 2 air to toilet rooms [ASHRAE 62.1:5.16.3.2.3]; or

iv. Recirculation or transfer of Class 2 air to Class 4 spaces [ASHRAE 62.1:5.16.3.2.4]; or

v. Class 2 air shall not be recirculated or transferred to Class 1 spaces. [ASHRAE 62.1:5.16.3.2.5]

EXCEPTION to Section 160.2(c)8Bv: When using any energy recovery device, recirculation from leakage, carryover, or transfer from the exhaust side of the energy recovery device is permitted. Recirculated Class 2 air shall not exceed 10% of the outdoor air intake flow.

C. Class 3 Air is air with significant contaminant concentration, significant sensory-irritation intensity, or offensive odor. Recirculation or transfer of Class 3 air shall be permitted in accordance with 160.2(c)8Ci and 160.2(c)8Cii:

i. Recirculation of Class 3 air within the space of origin shall be permitted. [ASHRAE 62.1:5.16.3.3.1]

ii. Class 3 air shall not be recirculated or transferred to any other space. [ASHRAE 62.1:5.16.3.3.2].

EXCEPTION to Section 160.2(c)8Cii: When using any energy recovery device, recirculation from leakage, carryover, or transfer from the exhaust side of the energy recovery device is permitted. Recirculated Class 3 air shall not exceed 5% of the outdoor air intake flow.

D. Class 4 Air is air with highly objectionable fumes or gases or with potentially dangerous particles, bioaerosols, or gases at concentrations high enough to be considered as harmful. Class 4 air shall not be recirculated or transferred to any space or recirculated within the space of origin. [ASHRAE 62.1:5.16.3.4]

E. Ancillary spaces. Redesignation of Class 1 air to Class 2 air shall be permitted for Class 1 spaces that are ancillary to Class 2 spaces. [ASHRAE 62.1:5.16.2.3]

F. Transfer. A mixture of air that has been transferred through or returned form spaces or locations with different air classes shall be redesignated with the highest classification among the air classes mixed. [ASHRAE 62.1:5.16.2.2]

G. Classification. Air leaving each space or location shall be designated at an expected air-quality classification not less than that shown in Tables 160.2-B, 160.2-C or 160.2-D. Air leaving spaces or locations that are not listed in Tables 160.2-B, 160.2-C or 160.2-D shall be designated with the same classification as air from the most similar space or location listed in terms of occupant activities and building construction.

(d) Parking Garages. Mechanical ventilation systems for enclosed parking garages in multifamily buildings shall comply with Section 120.6(c).

TABLE 160.2-A: Infiltration Effectiveness Weather and Shielding Factors [ASHRAE 62.2:Table B1]

TMY3	wsf	Weather Station	Latitude	Longitude	State
690150	0.50	Twentynine Palms	34.30	–116.17	California
722860	0.43	March AFB	33.90	–117.25	California
722868	0.45	Palm Springs Intl	33.83	–116.50	California
722869	0.42	Riverside Muni	33.95	–117.45	California
722880	0.39	Burbank–Glendale–Pasadena AP	34.20	–118.35	California
722885	0.39	Santa Monica Muni	34.02	–118.45	California
722886	0.39	Van Nuys Airport	34.22	–118.48	California
722895	0.55	Lompoc (AWOS)	34.67	–120.47	California
722897	0.51	San Luis Co Rgnl	35.23	–120.63	California
722899	0.45	Chino Airport	33.97	–117.63	California
722900	0.38	San Diego Lindbergh Field	32.73	–117.17	California
722903	0.39	San Diego/Montgomery	32.82	–117.13	California
722904	0.40	Chula Vista Brown Field NAAS	32.58	–116.98	California
722906	0.39	San Diego North Island NAS	32.70	–117.20	California
722926	0.40	Camp Pendleton MCAS	33.30	–117.35	California
722927	0.38	Carlsbad/Palomar	33.13	–117.28	California
722930	0.39	San Diego Miramar NAS	32.87	–117.13	California
722950	0.42	Los Angeles Intl Arpt	33.93	–118.40	California
722956	0.38	Jack Northrop Fld H	33.92	–118.33	California
722970	0.38	Long Beach Daugherty Fld	33.83	–118.17	California
722976	0.34	Fullerton Municipal	33.87	–117.98	California
722977	0.36	Santa Ana John Wayne AP	33.68	–117.87	California
723805	0.51	Needles Airport	34.77	–114.62	California
723810	0.59	Edwards AFB	34.90	–117.87	California
723815	0.58	Daggett Barstow–Daggett AP	34.85	–116.80	California
723816	0.62	Lancaster Gen Wm Fox Field	34.73	–118.22	California
723820	0.57	Palmdale Airport	34.63	–118.08	California
723830	0.68	Sandberg	34.75	–118.72	California
723840	0.43	Bakersfield Meadows Field	35.43	–119.05	California
723890	0.45	Fresno Yosemite Intl AP	36.78	–119.72	California
723895	0.42	Porterville (AWOS)	36.03	–119.07	California
723896	0.43	Visalia Muni (AWOS)	36.32	–119.40	California
723910	0.45	Point Mugu Nf	34.12	–119.12	California
723925	0.44	Santa Barbara Municipal AP	34.43	–119.85	California
723926	0.43	Camarillo (AWOS)	34.22	–119.08	California
723927	0.45	Oxnard Airport	34.20	–119.20	California
723940	0.52	Santa Maria Public Arpt	34.92	–120.47	California

TABLE 160.2-A: Infiltration Effectiveness Weather and Shielding Factors [ASHRAE 62.2:Table B1] (continued)

TMY3	wsf	Weather Station	Latitude	Longitude	State
723965	0.53	Paso Robles Municipal Arpt	35.67	–120.63	California
724800	0.55	Bishop Airport	37.37	–118.35	California
724815	0.46	Merced/Macready Fld	37.28	–120.52	California
724830	0.51	Sacramento Executive Arpt	38.50	–121.50	California
724837	0.45	Beale AFB	39.13	–121.43	California
724838	0.50	Yuba Co	39.10	–121.57	California
724839	0.51	Sacramento Metropolitan AP	38.70	–121.58	California
724915	0.49	Monterey Naf	36.60	–121.87	California
724917	0.54	Salinas Municipal AP	36.67	–121.60	California
724920	0.50	Stockton Metropolitan Arpt	37.90	–121.23	California
724926	0.47	Modesto City–County AP	37.63	–120.95	California
724927	0.53	Livermore Municipal	37.70	–121.82	California
724930	0.54	Oakland Metropolitan Arpt	37.72	–122.22	California
724935	0.47	Hayward Air Term	37.67	–122.12	California
724936	0.53	Concord–Buchanan Field	38.00	–122.05	California
724940	0.60	San Francisco Intl AP	37.62	–122.40	California
724945	0.48	San Jose Intl AP	37.37	–121.93	California
724955	0.55	Napa Co. Airport	38.22	–122.28	California
724957	0.49	Santa Rosa (AWOS)	38.52	–122.82	California
725845	0.44	Blue Canyon AP	39.30	–120.72	California
725846	0.66	Truckee–Tahoe	39.32	–120.13	California
725847	0.64	South Lake Tahoe	38.90	–120.00	California
725905	0.47	Ukiah Municipal AP	39.13	–123.20	California
725910	0.50	Red Bluff Municipal Arpt	40.15	–122.25	California
725920	0.47	Redding Municipal Arpt	40.52	–122.32	California
725945	0.56	Arcata Airport	40.98	–124.10	California
725946	0.60	Crescent City Faa Ai	41.78	–124.23	California
725955	0.55	Montague Siskiyou County AP	41.78	–122.47	California
725958	0.59	Alturas	41.50	–120.53	California
745090	0.45	Mountain View Moffett Fld NAS	37.40	–122.05	California
745160	0.67	Travis Field AFB	38.27	–121.93	California
746120	0.52	China Lake Naf	35.68	–117.68	California
747020	0.50	Lemoore Reeves NAS	36.33	–119.95	California
747185	0.46	Imperial	32.83	–115.58	California
747187	0.46	Palm Springs Thermal AP	33.63	–116.17	California
747188	0.48	Blythe Riverside Co Arpt	33.62	–114.72	California

TABLE 160.2-B – Minimum Ventilation Rates for Multifamily Common Use Areas

Occupancy Category[3]	**Area Outdoor Air Rate[1] R_a** cfm/ft²	**Min Air Rate for DC** cfm/ft²**V²**	**Air Class**	**Notes**
Daycare (through age 4)	0.21	0.15	2	
Multiuse assembly	0.50	0.15	1	F
Dining rooms	0.50	0.15	2	
Bars, cocktail lounges	0.50	0.20	2	
Kitchen (cooking)	0.15		2	
Break rooms	0.50	0.15	1	F
Coffee stations	0.50	0.15	1	F
Conference/meeting	0.50	0.15	1	F
Corridors	0.15		1	F
Occupiable storage rooms for liquids or gels	0.15		2	B
Laundry rooms, central	0.15		2	
Lobbies/pre-function	0.50	0.15	1	F
Breakrooms	0.50	0.15		
Occupiable storage rooms for dry materials	0.15			
Office space	0.15		1	
Reception areas	0.15		1	F
Telephone/data entry	0.15		1	F
Computer (not printing)	0.15			
Freezer and refrigerated spaces (<50°F)	-		1	F
Shipping/receiving	0.15			
All others	0.15			

Gym, sports arena (play area)	0.50	0.15	2	E
Swimming (pool)	0.15		2	C
Swimming (deck)	0.50	0.15	2	C
Disco/dance floors	1.50	0.15	2	F
Health club/aerobics room/weight rooms	0.15		2	
Game arcades	0.68	0.15	1	

General:

1 Ra was determined as being the larger of the area method and the default per person method. The occupant density used in the per person method was assumed to be one half of the maximum occupant load assumed for egress purposes in the CBC.

2 If this column specifies a minimum cfm/ft^2 then it shall be used to comply with Section160.2(c)5E.

3 For spaces not included in this table, the spaces in Table 120.1-A shall apply.

Specific Notes:

A – RESERVEDB – Rate may not be sufficient where stored materials include those having potentially harmful emissions.

C – Rate does not allow for humidity control. “Deck area” refers to the area surrounding the pool that is capable of being wetted during pool use or when the pool is occupied. Deck area that is not expected to be wetted shall be designated as an occupancy category.

D – RESREVED.

E – Where combustion equipment is intended to be used on the playing surface or in the space, additional dilution ventilation, source control, or both shall be provided.

F – Ventilation air for this occupancy category shall be permitted to be reduced to zero when the space is in occupied-standby mode.

TABLE 160.2-C – Minimum Exhaust Rates

[ASHRAE 62.1: TABLE 6.5]

Occupancy Category[3]	Exhaust Rete, cfm/unit	Exhaust Rate, cfm/ft²	Air Class	Notes
Copy, printing rooms	-	0.50	2	
Janitor closets, trash rooms, recycling	-	1.00	3	
Kitchenettes	-	0.30	2	
Kitchens – commercial	-	0.70	2	
Locker rooms for athletic or industrial facilities	-	0.50	2	
All other locker rooms	-	0.25	2	
Shower rooms	20/50	-	2	G, H
Parking garages	-	0.75	2	C
Pet shops (animal areas)	-	0.90	2	
Soiled laundry storage rooms	-	1.00	3	F
Storage rooms, chemical	-	1.50	4	F
Toilets – private	25/50	-	2	E
Toilets – public	50/70	-	2	D

General:

[3]For spaces not included in this table, the spaces in Table 120.1-B shall apply.

Notes:

A –Reserved

B –Reserved

C – Exhaust shall not be required where two or more sides comprise walls that are at least 50% open to the outside.

D – Rate is per water closet, urinal, or both. Provide the higher rate where periods of heavy use are expected to occur. The lower rate shall be permitted to be used otherwise.

E – Rate is for a toilet room intended to be occupied by one person at a time. For continuous systems operation during hours of use, the lower rate shall be permitted to be used. Otherwise the higher rate shall be used.

F – See other applicable standards for exhaust rate.

G – For continuous system operation, the lower rate shall be permitted to be used. Otherwise the higher rate shall be used.

H – Rate is per showerhead.

TABLE 160.2-D – Airstreams or Sources

[ASHRAE 62.1:Table 5.16.1]

Description	Air Class
Commercial kitchen grease hoods	4
Commercial kitchen hoods other than grease	3
Hydraulic elevator machine room	2

Table 160.2-E: Demand-Controlled Local Ventilation Exhaust Airflow Rates and Capture Efficiency

Application	**Compliance Criteria**
Enclosed Kitchen or Nonenclosed Kitchen	Vented range hood, including appliance-range hood combinations shall meet either the capture efficiency (CE) or the airflow rate specified in Table 160.2-G as applicable.
Enclosed Kitchen	Other kitchen exhaust fans, including downdraft: 300 cfm (150 L/s) or a capacity of 5 ACH
Nonenclosed Kitchen	Other kitchen exhaust fans, including downdraft: 300 cfm (150 L/s)
Bathroom	50 cfm (25 L/s)

Table 160.2-F: Continuous Local Ventilation Exhaust Airflow Rates

Application	**Airflow**
Enclosed kitchen	5 ach, based on kitchen volume
Bathroom	20 cfm (10 L/s)

Table 160.2-G: Kitchen Range Hood Airflow Rates (cfm) and ASTM E3087 Capture Efficiency (CE) Ratings According to Dwelling Unit Floor Area and Kitchen Range Fuel Type

Dwelling Unit Floor Area (ft^2)	**Hood Over Electric Range**	**Hood Over Natural Gas Range**
>1500	50% CE or 110 cfm	70% CE or 180 cfm
>1000 - 1500	50% CE or 110 cfm	80% CE or 250 cfm
750 - 1000	55% CE or 130 cfm	85% CE or 280 cfm
<750	65% CE or 160 cfm	85% CE or 280 cfm

Table 160.2-H: Prescriptive Ventilation System Duct Sizing [ASHRAE 62.2:Table 5-3]

Fan Airflow Rating, cfm at minimum static pressure[f] 0.25 in. water (L/s at minimum 62.5 Pa)	≤50 (25)	≤80 (40)	≤100 (50)	≤125 (60)	≤150 (70)	≤175 (85)	≤200 (95)	≤250 (120)	≤350 (165)	≤400 (190)	≤450 (210)	≤700 (330)	≤800 (380)
Minimum Duct Diameter, in. (mm) [a,b] For Rigid duct	4 [e] (100)	5 (125)	5 (125)	6 (150)	6 (150)	7 (180)	7 (180)	8 (205)	9 (230)	10 (255)	10 (255)	12 (305)	12 [d] (305)
Minimum Duct Diameter, in. (mm) [a,b] For Flex duct [c]	4 (100)	5 (125)	6 (150)	6 (150)	7 (150)	7 (180)	8 (205)	8 (205)	9 (230)	10 (255)	NP	NP	NP

Footnotes for Table 150.0-H:

a. For noncircular ducts, calculate the diameter as four times the cross-sectional area divided by the perimeter.

b. NP = application of the prescriptive table is not permitted for this scenario.

c. Use of this table for verification of flex duct systems requires flex duct to be fully extended and any flex duct elbows to have a minimum bend radius to duct diameter ratio of 1.0.

d. For this scenario, use of elbows is not permitted.

e. For this scenario, 4 in. (100 mm) oval duct shall be permitted, provided the minor axis of the oval is greater than or equal to 3 in. (75 mm)

f. When a vented range hood utilizes a capture efficiency rating to demonstrate compliance with 160.2(b)2Avic2, a static pressure greater than or equal to 0.25 in. of water at the rating point shall not be required, and the airflow listed in the approved directory corresponding to the compliant capture efficiency rating point shall be applied to Table 160.2-H for determining compliance.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 160.3 – MANDATORY REQUIREMENTS FOR SPACE CONDITIONING SYSTEMS IN MULTIFAMILY BUILDINGS

Space conditioning systems serving multifamily dwelling units and common use areas shall comply with the applicable requirements of Sections 160.3(a) through 160.3(c).

(a) Controls – Space conditioning systems serving dwelling units and common use areas in multifamily buildings shall comply with applicable requirements of Sections 160.3(a)1 or 160.3(a)2.

1. **Dwelling Unit and common living area Thermostats.** All heating or cooling systems, including heat pumps, not controlled by a central energy management control system (EMCS) shall have a setback thermostat, as specified in Section 110.2(c).
2. **Common Services Area Controls**. Heating or cooling systems serving common services areas of multifamily buildings shall comply with application requirements of Sections 160.3(a)2A through 160.3(a)2J.

   A. Thermostatic Controls for Each Zone. The supply of heating and cooling energy to each space-conditioning zone shall be controlled by an individual thermostatic control that responds to temperature within the zone and that meets the applicable requirements of Section 160.3(a)2B. An Energy Management Control System (EMCS) may be installed to comply with the requirements of one or more thermostatic controls if it complies with all applicable requirements for each thermostatic control.

   EXCEPTION to Section 160.3(a)2A: An independent perimeter heating or cooling system may serve more than one zone without individual thermostatic controls if:

   i. All zones are also served by an interior cooling system; and

   ii. The perimeter system is designed solely to offset envelope heat losses or gains; and

   iii. The perimeter system has at least one thermostatic control for each building orientation of 50 feet or more; and

   iv. The perimeter system is controlled by at least one thermostat located in one of the zones served by the system.

   B. Criteria for Zonal Thermostatic Controls. The individual thermostatic controls required by Section 160.3(a)2A shall meet the following requirements as applicable:

   i. Where used to control comfort heating, the thermostatic controls shall be capable of being set, locally or remotely, down to 55°F or lower.

   ii. Where used to control comfort cooling, the thermostatic controls shall be capable of being set, locally or remotely, up to 85°F or higher.

   iii. Where used to control both comfort heating and comfort cooling, the thermostatic controls shall meet Items i and ii and shall be capable of providing a temperature range or dead band of at least 5°F within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum.

   EXCEPTION to Section 160.3(a)2Biii: Systems with thermostats that require manual changeover between heating and cooling modes.

   iv. Thermostatic controls for all single zone air conditioners and heat pumps shall comply with the requirements of Section 110.2(c) and 110.12(a) and, if equipped with DDC to the Zone level, with the Automatic Demand Shed Controls of Section 110.12(b).

   EXCEPTION Section 160.3(a)2Biv: Package terminal air conditioners, package terminal heat pumps, room air conditioners, and room air-conditioner heat pumps.

   C. Heat Pump Controls. All heat pumps with supplementary electric resistance heaters shall be installed with controls that comply with Section 110.2(b).

D. Shut-off and Reset Controls for Space-conditioning Systems. Each space-conditioning system shall be installed with controls that comply with the following:

i. The control shall be capable of automatically shutting off the system during periods of nonuse and shall have:

a. An automatic time switch control device complying with Section 110.9, with an accessible manual override that allows operation of the system for up to 4 hours; or

b. An occupancy sensor; or

c. A 4-hour timer that can be manually operated.

ii. The control shall automatically restart and temporarily operate the system as required to maintain:

a. A setback heating thermostat setpoint if the system provides mechanical heating; and

EXCEPTION to Section 160.3(a)2Diia: Thermostat setback controls are not required in multifamily buildings in areas where the Winter Median of Extremes outdoor air temperature determined in accordance with Section 170.2(c)1C is greater than 32°F.

b. A setup cooling thermostat setpoint if the system provides mechanical cooling.

EXCEPTION to Section 160.3(a)2Diib: Thermostat setup controls are not required in multifamily buildings in areas where the Summer Design Dry Bulb 0.5 percent temperature determined in accordance with Section 170.2(c)1C is less than 100°F.

iii. Occupancy Sensing Zone Controls. Space conditioning system zones serving only space(s) that are required to have occupant sensing controls in accordance with Section 160.5(b)4C, and where the Table 160.2-B occupancy category permits ventilation air to be reduced to zero when the space is in occupied-standby mode, shall meet the following:

a. Occupancy sensing zone controls shall comply with the Occupant Sensor Ventilation Control Device requirements of Section 160.3(c)5E and allow preoccupancy ventilation requirements of Section 160.3(c)5B; and

b. Occupancy sensing zone controls shall comply with Section 110.9(b)4 and be capable of indicating a space is unoccupied no more than 20 minutes after a space has been vacated; and

c. When a zone is scheduled to be occupied, and occupancy sensing controls in all space(s) served by the zone indicate the spaces are unoccupied, the zone shall be placed in occupied standby mode; and

d. Within 5 minutes of entering occupied-standby mode:

I. Automatically setup the operating cooling temperature set point by 2°F or more and setback the operating heating temperature set point by 2°F or more; or

II. For multiple zone systems with Direct Digital Controls (DDC) to the zone level, setup the operating cooling temperature setpoint by 0.5°F or more and setback the operating heating temperature setpoint by 0.5°F or more.

e. Within 5 minutes of entering occupied-standby mode, all airflow to the zone shall be shut off whenever the space temperature is between the active heating and cooling setpoints.

EXCEPTION to Section 160.3(a)2Diii: Zones which are only ventilated by a natural ventilation system in accordance with Section 120.1(c)2.

EXCEPTION 1 to Sections 160.3(a)2Di, ii, and iii: Where it can be demonstrated to the satisfaction of the enforcing agency that the system serves an area that must operate continuously.

EXCEPTION 2 to Sections 160.3(a)2Di, ii, and iii: Systems with full load demands of 2 kW or less, if they have a readily accessible manual shut-off switch.

E. Dampers for Air Supply and Exhaust Equipment. Outdoor air supply and exhaust equipment shall be installed with dampers that automatically close upon fan shutdown.

EXCEPTION 1 to Section 160.3(a)2E: Equipment that serves an area that must operate continuously.

EXCEPTION 2 to Section 160.3(a)2E: Gravity and other nonelectrical equipment that has readily accessible manual damper controls.

EXCEPTION 3 to Section 160.3(a)2E: At combustion air intakes and shaft vents.

EXCEPTION 4 to Section 160.3(a)2E: Where prohibited by other provisions of law.

F. Isolation Area Devices. Each space-conditioning system serving multiple zones with a combined conditioned floor area of more than 25,000 square feet shall be designed, installed, and controlled to serve isolation areas.

i. Each zone, or any combination of zones not exceeding 25,000 square feet, shall be a separate isolation area.

ii. Each isolation area shall be provided with isolation devices, such as valves or dampers that allow the supply of heating or cooling to be reduced or shut-off independently of other isolation areas.

iii. Each isolation area shall be controlled by a device meeting the requirements of Section 160.3(a)2Di.

EXCEPTION to Section 160.3(a)2F: Zones designed to be conditioned continuously.

G. Automatic Demand Shed Controls. See Section 110.12 for requirements for Automatic Demand Shed Controls.

H. Economizer Fault Detection and Diagnostics (FDD). All newly-installed air handlers with a mechanical cooling capacity over33,000 Btu/hr and an installed air economizer shall include a stand-alone or integrated Fault Detection and Diagnostics (FDD) system in accordance with Subsections 160.3(a)2Hi through 160.3(a)2Hviii

i. The following temperature sensors shall be permanently installed to monitor system operation: outside air, supply air, and when required for differential economizer operation, a return air sensor; and

ii. Temperature sensors shall have an accuracy of ±2°F over the range of 40°F to 80°F; and

iii. The controller shall have the capability of displaying the value of each sensor; and

iv. The controller shall provide system status by indicating the following conditions:

a. Free cooling available;

b. Economizer enabled;

c. Compressor enabled;

d. Heating enabled, if the system is capable of heating; and

e. Mixed air low limit cycle active.

v. The unit controller shall allow manual initiation of each operating mode so that the operation of cooling systems, economizers, fans, and heating systems can be independently tested and verified; and

vi. Faults shall be reported in one of the following ways:

a. Reported to an Energy Management Control System regularly monitored by facility personnel.

b. Annunciated locally on one or more zone thermostats, or a device within five (5) feet of zone thermostat(s), clearly visible, at eye level, and meeting the following requirements:

I. On the thermostat, device, or an adjacent written sign, display instructions to contact appropriate building personnel or an HVAC technician; and

II. In buildings with multiple tenants, the annunciation shall either be within property management offices or in a common space accessible by the property or building manager.

c. Reported to a fault management application which automatically provides notification of the fault to remote HVAC service provider.

vi. The FDD system shall detect the following faults:

a. Air temperature sensor failure/fault;

b. Not economizing when it should;

c. Economizing when it should not;

d. Damper not modulating; and

e. Excess outdoor air.

vii. The FDD System shall be certified by the Energy Commission as meeting requirements of Sections 160.3(a)2Hi through160.3(a)2Hvii in accordance with Section 110.0 and JA6.3.

EXCEPTION to Section 160.3(a)2Hviii: FDD algorithms based in Direct Digital Control systems are not required to be certified to the Energy Commission.

I. Direct Digital Controls (DDC). Direct Digital Controls to the zone shall be provided as specified by Table 160.3-C.

i. The provided DDC system shall meet the control logic requirements of Sections 160.3(a)2E and 160.3(a)2G, and be capable of the following:

ii. Monitoring zone and system demand for fan pressure, pump pressure, heating and cooling;

iii. Transferring zone and system demand information from zones to air distribution system controllers and from air distribution systems to heating and cooling plant controllers;

iv. Automatically detecting the zones and systems that may be excessively driving the reset logic and generate an alarm or other indication to the system operator;

v. Readily allow operator removal of zones(s) from the reset algorithm;

vi. For new buildings, trending and graphically displaying input and output points; and

vii. Resetting heating and cooling setpoints in all non-critical zones upon receipt of a signal from a centralized contact or software point as described in Section 160.3(a)2G.

J. Optimum Start/Stop Controls. Space conditioning systems with DDC to the zone level shall have optimum start/stop controls. The control algorithm shall, as a minimum, be a function of the difference between space temperature and occupied setpoint, the outdoor air temperature, and the amount of time prior to scheduled occupancy. Mass radiant floor slab systems shall incorporate floor temperature onto the optimum start algorithm.

EXCEPTION to Section 160.3(a)2J: Systems that must operate continuously.

(b) Dwelling Unit Space Conditioning and Air Distribution Systems.

1. Building Cooling and Heating Loads. Building heating and cooling loads shall be determined using a method based on any one of the following, using cooling and heating loads as two of the criteria for equipment sizing and selection:

A. The ASHRAE Handbook, Equipment Volume, Applications Volume, and Fundamentals Volume; or

B. The SMACNA Residential Comfort System Installation Standards Manual; or

C. The ACCA Manual J.

NOTE: Heating systems are required to have a minimum heating capacity adequate to meet the minimum requirements of the CBC.

2. Design conditions. Design conditions shall be determined in accordance with the following:

A. For the purpose of sizing the space-conditioning (HVAC) system, the indoor design temperatures shall be 68°F for heating and 75°F for cooling.

B. Outdoor design conditions shall be selected from Reference Joint Appendix JA2, which is based on data from the ASHRAE Climatic Data for Region X.

C. The outdoor design temperatures for heating shall be no lower than the Heating Winter Median of Extremes values.

D. The outdoor design temperatures for cooling shall be no greater than the 1.0 percent Cooling Dry Bulb and Mean Coincident Wet Bulb values.

3. Outdoor Condensing Units.

A. Clearances. Installed air conditioner and heat pump outdoor condensing units shall have a clearance of at least five (5) feet (1.5 meters) from the outlet of any dryer vent.

B. Liquid Line Drier. Installed air conditioner and heat pump systems shall be equipped with liquid line filter driers if required, as specified by manufacturer's instructions.

4. Central Forced-Air Heating Furnaces.

A. Temperature Rise. Central forced-air heating furnace installations shall be configured to operate in conformance with the furnace manufacturer's maximum inlet-to-outlet temperature rise specifications.

5. Air-Distribution and Ventilation System Ducts, Plenums, and Fans.

A. CMC Compliance.

i. All air-distribution system ducts and plenums, including, but not limited to, mechanical closets and air-handler boxes, shall meet the requirements of the CMC Sections 601.0, 602.0, 603.0, 604.0, 605.0 and ANSI/SMACNA-006-2006 HVAC Duct Construction Standards Metal and Flexible 3rd Edition, incorporated herein by reference.

ii. Portions of supply-air and return-air ducts and plenums of a space heating or cooling system shall either be insulated to:

a. a minimum installed level of R-6.0, or

b. a minimum installed level of R-4.2 when the duct system is located entirely in conditioned space. For buildings with three or fewer habitable stories, duct systems located entirely in conditioned space shall be confirmed through field verification and diagnostic testing in accordance with the requirements of Reference Residential Appendix RA3.1.4.3.8.

EXCEPTION 1 to Section 160.3(b)Aii: Portions of the duct system located in wall cavities are not required to be insulated if the following conditions are met:

a. The cavity, duct or plenum is located entirely inside the building's thermal envelope as confirmed by visual inspection.

b. At all locations where portions of non-insulated cavities, ducts, or plenums make a transition into unconditioned space, the transition shall be air-sealed to prevent air infiltration into the cavity and be insulated to a minimum of R-6 as confirmed by visual inspection.

EXCEPTION 2 to Section 160.3(b)Aii: Portions of the duct system completely exposed and surrounded by directly conditioned space are not required to be insulated.

iii. Connections of metal ducts and the inner core of flexible ducts shall be mechanically fastened.

iv. Openings shall be sealed with mastic, tape, or other duct-closure system that meets the applicable requirements of UL 181, UL 181A or UL 181B or aerosol sealant that meets the requirements of UL 723. If mastic or tape is used to seal openings greater than 1/4 inch, the combination of mastic and either mesh or tape shall be used.

v. Building cavities, support platforms for air handlers, and plenums designed or constructed with materials other than sealed sheet metal, duct board or flexible duct shall not be used for conveying conditioned air. Building cavities and support platforms may contain ducts. Ducts installed in cavities and support platforms shall not be compressed to cause reductions in the cross-sectional area of the ducts.

EXCEPTION to Section 160.3(b)A: Ducts and fans integral to a wood heater or fireplace.

B. Factory-Fabricated Duct Systems.

i. All factory-fabricated duct systems shall comply with UL 181 for ducts and closure systems, including collars, connections, and splices, and be labeled as complying with UL 181. UL 181 testing may be performed by UL laboratories or a laboratory approved by the Executive Director.

ii. All pressure-sensitive tapes, heat-activated tapes, and mastics used in the manufacture of rigid fiberglass ducts shall comply with UL 181 and UL 181A.

iii. All pressure-sensitive tapes and mastics used with flexible ducts shall comply with UL 181 and UL 181B.

iv. Joints and seams of duct systems and their components shall not be sealed with cloth back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.

C. Field-Fabricated Duct Systems.

i. Factory-made rigid fiberglass and flexible ducts for field-fabricated duct systems shall comply with UL 181. All pressure-sensitive tapes, mastics, aerosol sealants, or other closure systems used for installing field-fabricated duct systems shall meet the applicable requirements of UL 181, UL 181A, and UL 181B.

ii. Mastic sealants and mesh.

a. Sealants shall comply with the applicable requirements of UL 181, UL 181A, and UL 181B, and be nontoxic and water resistant.

b. Sealants for interior applications shall be tested in accordance with ASTM C731 and D2202, incorporated herein by reference.

c. Sealants for exterior applications shall be tested in accordance with ASTM C731, C732, and D2202, incorporated herein by reference.

d. Sealants and meshes shall be rated for exterior use.

iii. Pressure-sensitive tape. Pressure-sensitive tapes shall comply with the applicable requirements of UL 181, UL 181A, and UL 181B.

iv. Joints and seams of duct systems and their components shall not be sealed with cloth back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.

v. Drawbands used with flexible duct.

a. Drawbands shall be either stainless-steel worm-drive hose clamps or UV-resistant nylon duct ties.

b. Drawbands shall have a minimum tensile strength rating of 150 pounds.

c. Drawbands shall be tightened as recommended by the manufacturer with an adjustable tensioning tool.

vi. Aerosol-sealant closures.

a. Aerosol sealants shall meet the requirements of UL 723 and be applied according to manufacturer specifications.

b. Tapes or mastics used in combination with aerosol sealing shall meet the requirements of this section.

D. Duct Insulation R-value Ratings. All duct insulation product R-values shall be based on insulation only (excluding air films, vapor retarder, or other duct components) and tested C-values at 75°F mean temperature

at the installed thickness, in accordance with ASTM C518 or ASTM C177, incorporated herein by reference, and certified pursuant to Section 110.8.

E. Duct Insulation Thickness. The installed thickness of duct insulation used to determine its R-value shall be determined as follows:

i. For duct board, duct liner, and factory-made rigid ducts not normally subjected to compression, the nominal insulation thickness shall be used**.**

ii. For duct wrap, installed thickness shall be assumed to be 75 percent (25 percent compression) of nominal thickness.

iii. For factory-made flexible air ducts, the installed thickness shall be determined by dividing the difference between the actual outside diameter and nominal inside diameter by two.

F. Duct Labeling. Insulated flexible duct products installed to meet this requirement shall include labels, in maximum intervals of 3 feet, showing the thermal performance R-value for the duct insulation itself (excluding air films, vapor retarder, or other duct components), based on the tests in Section 160.3(b)5D and the installed thickness determined by Section 160.3(b)5Eiii**.**

G. Backdraft Dampers. All fan systems, regardless of volumetric capacity, that exchange air between the building conditioned space and the outside of the building shall be provided with backdraft or automatic dampers to prevent unintended air leakage through the fan system when the fan system is not operating.

H. Gravity Ventilation Dampers. All gravity ventilating systems that serve conditioned space shall be provided with either automatic or readily accessible, manually operated dampers in all openings to the outside except combustion inlet and outlet air openings and elevator shaft vents.

I. Protection of Insulation. Insulation shall be protected from damage, including that due to sunlight, moisture, equipment maintenance, and wind but not limited to the following: Insulation exposed to weather shall be suitable for outdoor service (e.g., protected by aluminum, sheet metal, painted canvas, or plastic cover). Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation that can cause degradation of the material.

J. Porous Inner Core Flex Duct. Flexible ducts having porous inner cores shall have a non-porous layer or air barrier between the inner core and the outer vapor barrier.

K. Duct System Sealing and Leakage Testing. When space conditioning systems utilize forced air duct systems to supply conditioned air to an individual dwelling unit, the ducts shall be sealed, as confirmed through field verification and diagnostic testing, in accordance with all applicable procedures specified in Reference Residential Appendix RA3.1. Air handler airflow for calculation of duct leakage rate compliance targets shall be determined according to methods specified in Reference Residential Appendix RA3.1.4.2.

For multifamily dwellings with the air-handling unit installed and the ducts connected directly to the air handler, regardless of duct system location:

i. The total leakage of the duct system shall not exceed 12 percent of the air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1; or

ii. The duct system leakage to outside shall not exceed 6 percent of the air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.4.

EXCEPTION 1 to Section 160.3(b)5K: The HERS Rater field verification and HERS Provider data registry requirements of Reference Residential Appendix RA2 and RA3 are not required for multifamily dwelling units in buildings four habitable stories and greater. The installer shall certify that diagnostic testing was performed in accordance with the applicable procedures.

EXCEPTION 2 to Section 160.3(b)5K: Multifamily dwelling units in buildings four habitable stories and greater in Climate Zone 1, 3, 5, and 7.

L. System Airflow Rate and Fan Efficacy. Space conditioning systems that utilize forced air ducts to supply cooling to an individual dwelling unit shall:

i. Static Pressure Probe. Have a hole for the placement of a static pressure probe (HSPP), or a permanently installed static pressure probe (PSPP) in the supply plenum downstream of the air conditioning evaporator coil. The size, location, and labeling of the HSPP or PSPP shall conform to the requirements specified in Reference Residential Appendix RA3.3.1.1 as confirmed by field verification and diagnostic testing; and

EXCEPTION to Section 160.3(b)5Li: Systems that cannot conform to the specifications for hole location in Reference Residential Appendix Figure RA3.3-1 shall not be required to provide holes as described in Figure RA3.3-1.

ii. Single Zone Central Forced Air Systems. Demonstrate, in every control mode, airflow greater than or equal to 350 cfm per ton of nominal cooling capacity through the return grilles, and an air-handling unit fan efficacy less than or equal to the maximum W/cfm specified in subsections a or b below. The airflow rate and fan efficacy requirements in this section shall be confirmed by field verification and diagnostic testing in accordance with the procedures given in Reference Residential Appendix RA3.3.

a. 0.45 W/cfm for gas furnace air-handling units.

b. 0.58 W/cfm for air-handling units that are not gas furnaces.

EXCEPTION 1 to Section 160.3(b)5Lii: Standard ducted systems without zoning dampers may comply by meeting the applicable requirements in TABLE 160.3-A or 160.3-B as confirmed by field verification and diagnostic testing in accordance with the procedures in Reference Residential Appendix Sections RA3.1.4.4 and RA3.1.4.5. The design clean-filter pressure drop requirements specified by Section 160.2(b)1Div for the system air filter(s) shall conform to the requirements given in TABLE 160.3-A or 160.3-B.

EXCEPTION 2 to Section 160.3(b)5Lii: Multispeed compressor systems or variable speed compressor systems shall verify airflow (cfm/ton) and fan efficacy (Watt/cfm) for system operation at the maximum compressor speed and the maximum air handler fan speed.

EXCEPTION 3 to Section 160.3(b)5Lii: Gas furnace air-handling units manufactured prior to July 3, 2019 shall comply with a fan efficacy value less than or equal to 0.58 w/cfm as confirmed by field verification and diagnostic testing in accordance with the procedures given in Reference Residential Appendix RA3.3.

iii. Zonally Controlled Central Forced Air Systems. Zonally controlled central forced air cooling systems shall be capable of simultaneously delivering, in every zonal control mode, an airflow from the dwelling, through the air handler fan and delivered to the dwelling, of greater than or equal to 350 CFM per ton of nominal cooling capacity, and operating at an air-handling unit fan efficacy of less than or equal to the maximum W/cfm specified in subsections a or b below. The airflow rate and fan efficacy requirements in this section shall be confirmed by field verification and diagnostic testing in accordance with the applicable procedures specified in Reference Residential Appendix RA3.3.

a. 0.45 W/cfm for gas furnace air-handling units.

b. 0.58 W/cfm for air-handling units that are not gas furnaces.

EXCEPTION 1 to Section 160.3(b)5Liii: Multispeed or variable speed compressor systems, or single speed compressor systems that utilize the performance compliance approach, shall demonstrate compliance with the airflow (cfm/ton) and fan efficacy (Watt/cfm) requirements of Section 160.3(b)5Liii by operating the system at maximum compressor capacity and system fan speed with all zones calling for conditioning, rather than in every zonal control mode.

EXCEPTION 2 to Section 160.3(b)5Liii: Gas furnace air-handling units manufactured prior to July 3, 2019 shall comply with a fan efficacy value less than or equal to 0.58 w/cfm as confirmed by field verification and diagnostic testing in accordance with the procedures given in Reference Residential Appendix RA3.3.

iv. Small Duct High Velocity Forced Air Systems. Demonstrate, in every control mode, airflow greater than or equal to 250 cfm per ton of nominal cooling capacity through the return grilles, and an air-handling unit fan efficacy less than or equal to 0.62 W/cfm as confirmed by field verification and diagnostic testing in accordance with the procedures given in Reference Residential Appendix RA3.3

EXCEPTION 1 to Section 160.3(b)5Liv: Standard ducted systems without zoning dampers may comply by meeting the applicable requirements in TABLE 160.3-A or 160.3-B as confirmed by field verification and diagnostic testing in accordance with the procedures in Reference Residential Appendix Sections RA3.1.4.4 and RA3.1.4.5. The design clean-filter pressure drop requirements specified by Section 160.2(b)1Div for the system air filter(s) shall conform to the requirements given in TABLE 160.3-A or 160.3-B.

EXCEPTION 2 Section to 160.3(b)5Liv: Multispeed compressor systems or variable speed compressor systems shall verify airflow (cfm/ton) and fan efficacy (Watt/cfm) for system operation at the maximum compressor speed and the maximum air handler fan speed.

EXCEPTION 1 to Section 160.3(b)5L: The HERS Rater field verification and HERS Provider data registry requirements of Reference Residential Appendix RA2 and RA3 are not required for multifamily dwelling units in buildings four habitable stories and greater. The installer shall certify that diagnostic testing was performed in accordance with the applicable procedures.

EXCEPTION 2 to Section 160.3(b)5L: Multifamily dwelling units in buildings four habitable stories and greater in Climate Zone 1.

6. Piping for space conditioning systems, solar water-heating system collector loop, and distribution piping for steam and hydronic heating system, shall meet the requirements of Section 160.3(c)1.

(c) Common Services Area Space-Conditioning Systems. Multifamily common services areas shall comply with the applicable requirements of Sections 160.3(a)2A through160.3(a)2J.

1. Pipe Insulation. Multifamily buildings shall comply with the applicable requirements of Sections 160.3(c)1A through 160.3(c)1D.

A. General Requirements. The piping conditions listed below for space-conditioning systems with fluid normal operating temperatures listed in 160.3-D, shall have at least the amount of insulation specified in Section 160.3(c)1C:

i. Space Cooling Systems. All refrigerant suction, chilled water, and brine fluid distribution systems.

ii. Space Heating Systems. All refrigerant, steam, steam condensate and hot water fluid distribution systems.

B. Insulation conductivity shall be determined in accordance with ASTM C335 at the mean temperature listed in 160.3-D, and shall be rounded to the nearest 1/100 Btu-inch per hour per square foot per °F. Fluid distribution systems include all elements that are in series with the fluid flow, such as pipes, pumps, valves, strainers, coil u-bends, and air separators, but not including elements that are not in series with the fluid flow, such as expansion tanks, fill lines, chemical feeders, and drains.

C. Insulation Protection. Pipe Insulation shall be protected from damage due to sunlight, moisture, equipment maintenance, and wind. Protection shall, at minimum, include the following:

i. Pipe insulation exposed to weather shall be protected by a cover suitable for outdoor service. The cover shall be water retardant and provide shielding from solar radiation that can cause degradation of the material. Adhesive tape shall not be used to provide this protection.

ii. Pipe insulation covering chilled water piping and refrigerant suction piping located outside the conditioned space shall include, or be protected by, a Class I or Class II vapor retarder. All penetrations and joints shall be sealed.

iii. Pipe insulation buried below grade must be installed in a water proof and non-crushable casing or sleeve.

D. Insulation Thickness

i. For insulation with a conductivity in the range shown in 160.3-D for the applicable fluid temperature range, the insulation shall have the applicable minimum thickness or R-value shown in 160.3-D.

ii. For insulation with a conductivity outside the range shown in 160.3-D for the applicable fluid temperature range, the insulation shall have a minimum R-value shown in 160.3-D or thickness as calculated with Equation 160.3-A:

$$T = PR\left[\left(1+\frac{t}{PR}\right)^{\frac{K}{k}}-1\right] \quad \text{(Equation 160.3-A)}$$

WHERE:

T = Minimum insulation thickness for material with conductivity K, inches.

PR = Pipe actual outside radius, inches.

t = Insulation thickness from 160.3-D, inches.

K = Conductivity of alternate material at the mean rating temperature indicated in 160.3-D for the applicable fluid temperature range, in Btu-inch per hour per square foot per °F.

k = The lower value of the conductivity range listed in 160.3-D for the applicable fluid temperature range, Btu-inch per hour per square foot per °F.

EXCEPTION 1 to Section 160.3(c)1: Factory-installed piping within space-conditioning equipment certified under Section 110.1 or 110.2.

EXCEPTION 2 to Section 160.3(c)1: Piping that conveys fluids with a design operating temperature range between 60°F and 105°F.

EXCEPTION 3 to Section 160.3(c)1: Where the heat gain or heat loss to or from piping without insulation will not increase building source energy use.

EXCEPTION 4 to Section 160.3(c)1: Piping that penetrates framing members shall not be required to have pipe insulation for the distance of the framing penetration. Metal piping that penetrates metal framing shall use grommets, plugs, wrapping or other insulating material to assure that no contact is made with the metal framing.

2. Requirements for Air Distribution System, Ducts, and Plenum. Multifamily common services areas shall comply with the applicable requirements of Sections 160.3(c)2A through 160.3(c)2F.

A. CMC Compliance. All air distribution system ducts and plenums, including, but not limited to, building cavities, mechanical closets, air-handler boxes and support platforms used as ducts or plenums, shall meet the requirements of the CMC Sections 601.0, 602.0, 603.0, 604.0, 605.0, and ANSI/SMACNA-006-2006 HVAC Duct Construction Standards Metal and Flexible 3rd Edition, incorporated herein by reference. Connections of metal ducts and the inner core of flexible ducts shall be mechanically fastened. Openings shall be sealed with mastic, tape, aerosol sealant, or other duct-closure system that meets the applicable requirements of UL 181, UL 181A, or UL 181B. If mastic or tape is used to seal openings greater than 1/4 inch, the combination of mastic and either mesh or tape shall be used.

B. Portions of supply-air and return-air ducts conveying heated or cooled air located in one or more of the following spaces shall be insulated to a minimum installed level of R-8:

i. Outdoors; or

ii. In a space between the roof and an insulated ceiling; or

iii. In a space directly under a roof with fixed vents or openings to the outside or unconditioned spaces; or

iv. In an unconditioned crawlspace; or

v. In other unconditioned spaces.

Portions of supply-air ducts that are not in one of these spaces, including ducts buried in concrete slab, shall be insulated to a minimum installed level of R-4.2 or be enclosed in directly conditioned space.

C. Duct and Plenum Materials.

i. Factory-fabricated duct systems.

a. All factory-fabricated duct systems shall comply with UL 181 for ducts and closure systems, including collars, connections, and splices, and be labeled as complying with UL 181. UL 181 testing may be performed by UL laboratories or a laboratory approved by the Executive Director.

b. All pressure-sensitive tapes, heat-activated tapes, and mastics used in the manufacture of rigid fiberglass ducts shall comply with UL 181 and UL 181A.

c. All pressure-sensitive tapes and mastics used with flexible ducts shall comply with UL 181 and UL 181B.

d. Ductwork and plenums with pressure class ratings shall be constructed to Seal Class A. Joints and seams of duct systems and their components shall not be sealed with cloth back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.

EXCEPTION to Section 160.3(c)2Cid: Ductwork located in occupied space and exposed to view.

ii. Field-fabricated duct systems.

a. Factory-made rigid fiberglass and flexible ducts for field-fabricated duct systems shall comply with UL 181. All pressure-sensitive tapes, mastics, aerosol sealants, or other closure systems used for installing field-fabricated duct systems shall meet the applicable requirements of UL 181, UL 181A, and UL 181B.

b. Mastic sealants and mesh.

I. Sealants shall comply with the applicable requirements of UL 181, UL 181A, and UL 181B, and be nontoxic and water resistant.

II. Sealants for interior applications shall pass ASTM C731 (extrudability after aging) and D2202 (slump test on vertical surfaces), incorporated herein by reference.

III. Sealants for exterior applications shall pass ASTM C731, C732 (artificial weathering test), and D2202, incorporated herein by reference.

IV. Sealants and meshes shall be rated for exterior use.

c. Pressure-sensitive tape. Pressure-sensitive tapes shall comply with the applicable requirements of UL 181, UL 181A, and UL 181B.

d. Ductwork and plenums with pressure class ratings shall be constructed to Seal Class A. Joints and seams of duct systems and their components shall not be sealed with cloth back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.

e. Drawbands used with flexible duct.

I. Drawbands shall be either stainless-steel worm-drive hose clamps or UV-resistant nylon duct ties.

II. Drawbands shall have a minimum tensile strength rating of 150 pounds.

III. Drawbands shall be tightened as recommended by the manufacturer with an adjustable tensioning tool.

f. Aerosol-sealant closures.

I. Aerosol sealants shall meet the requirements of UL 723 and be applied according to manufacturer specifications.

II. Tapes or mastics used in combination with aerosol sealing shall meet the requirements of this section.

D. All duct insulation product R-values shall be based on insulation only (excluding air films, vapor retarders, or other duct components) and tested C-values at 75°F mean temperature at the installed thickness, in accordance with ASTM C518 or ASTM C177, incorporated herein by reference, and certified pursuant to Section 110.8.

E. The installed thickness of duct insulation used to determine its R-value shall be determined as follows:

i. For duct board, duct liner, and factory-made rigid ducts not normally subjected to compression, the nominal insulation thickness shall be used.

ii. For duct wrap, installed thickness shall be assumed to be 75 percent (25 percent compression) of nominal thickness.

iii. For factory-made flexible air ducts, the installed thickness shall be determined by dividing the difference between the actual outside diameter and nominal inside diameter by two.

F. Insulated flexible duct products installed to meet this requirement must include labels, in maximum intervals of 3 feet, showing the thermal performance R-value for the duct insulation itself (excluding air films, vapor retarder, or other duct components), based on the tests in Section160.3(c)2D and the installed thickness determined by Section 160.3(c)2Eiii.

G. Insulation shall be protected from damage, including that due to sunlight, moisture, equipment maintenance, and wind but not limited to the following: Insulation exposed to weather shall be suitable for outdoor service e.g., protected by aluminum, sheet metal, painted canvas, or plastic cover. Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation that can cause degradation of the material.

H. Duct systems shall be tested in accordance with i or ii below

i. New duct systems that meet the criteria in Subsections a, b and c below or ductwork that is part of a system that meets the criteria of Section 180.2(b)2B shall be sealed to a leakage rate not to exceed 6 percent of the nominal air handler airflow rate as confirmed through field verification and diagnostic testing, in accordance with the applicable procedures in Reference Nonresidential Appendices NA1 and NA2;

a. The duct system provides conditioned air to an occupiable space for a constant volume, single zone, space-conditioning system; and

b. The space conditioning system serves less than 5,000 square feet of conditioned floor area; and

c. The combined surface area of the ducts located in the following spaces is more than 25 percent of the total surface area of the entire duct system:

I. Outdoors; or

II. In a space directly under a roof that has a U-factor greater than the U-factor of the ceiling, or if the roof does not meet the requirements of Section 170.2(a)1; or

III. In a space directly under a roof that has fixed vents or openings to the outside or unconditioned spaces; or

IV. In an unconditioned crawlspace; or

V. In other unconditioned spaces.

ii. All duct systems that do not meet the criteria in Section 160.3(c)2H shall meet the duct leakage testing requirements of CMC Section 603.10.1.

3. Mechanical Acceptance Testing. Multifamily common services areas shall comply with the applicable requirements of Sections 160.3(c)3A and 160.3(c)3B.

A. Before an occupancy permit is granted the following equipment and systems shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified by the Reference Nonresidential Appendix NA7. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements:

i. Outdoor air ventilation systems shall be tested in accordance with NA7.5.1

ii. Constant volume, single zone air conditioning and heat pump unit controls shall be tested in accordance with NA7.5.2.

iii. Duct systems shall be tested in accordance with NA7.5.3 where either:

a. They are new duct systems; or

b. They are part of an altered system.

iv. Air economizers shall be tested in accordance with NA7.5.4.

EXCEPTION to Section160.3(c)3Aiv: Air economizers installed by the HVAC system manufacturer and certified to the Commission as being factory calibrated and tested are exempt from the Functional Testing section of the Air Economizer Controls acceptance test as described in NA7.5.4.2.

v. Demand control ventilation systems required by Section 160.2(c)3 shall be tested in accordance with NA7.5.5

vi. Supply fan variable flow controls shall be tested in accordance with NA7.5.6

vii. Hydronic system variable flow controls shall be tested in accordance with NA7.5.7 and NA7.5.9

viii. Boiler or chillers that require isolation controls as specified by Section70.2(c)4Iii or 170.2(c)4Iiii shall be tested in accordance with NA7.5.7

ix. Hydronic systems with supply water temperature reset controls shall be tested in accordance with NA7.5.8

x. Automatic demand shed controls shall be tested in accordance with NA7.5.10.

xi. Fault Detection and Diagnostics (FDD) for Packaged Direct-Expansion Units shall be tested in accordance with NA7.5.11.

xii. Automatic Fault Detection and Diagnostics (FDD) for air handling units and zone terminal units shall be tested in accordance with NA7.5.12.

xiii. Distributed Energy Storage DX AC Systems shall be tested in accordance with NA7.5.13.

xiv. Thermal Energy Storage (TES) Systems shall be tested in accordance with NA7.5.14.

xv. Supply air temperature reset controls shall be tested in accordance with NA7.5.15.

xvi. Water-cooled chillers served by cooling towers with condenser water reset controls shall be tested in accordance with NA7.5.16.

xvii. When an Energy Management Control System is installed, it shall functionally meet all of the applicable requirements of Part 6.

xviii. Occupant Sensing Zone Controls shall be tested in accordance with NA7.5.17.

xviv Multifamily building dwelling unit ventilation systems shall be tested in accordance with NA7.18.1.

xx. Multifamily building dwelling unit enclosure leakage shall be tested in accordance with NA7.18.2 when exhaust or supply ventilation systems are used for compliance with whole-building ventilation requirements as specified in 160.2(b)2Aivb2.

xxi Multifamily building central ventilation ducts shall be leak tested in accordance with NA7.18.3.

xxii Multifamily building central ventilation system heat recovery or energy recovery systems shall be tested in accordance with NA7.18.4

B. When certification is required by Title 24, Part 1, Section 10-103.2, the acceptance testing specified by Section 160.3(c)3A shall be performed by a Certified Mechanical Acceptance Test Technician (CMATT). If the CMATT is operating as an employee, the CMATT shall be employed by a Certified Mechanical Acceptance Test Employer. The CMATT shall disclose on the Certificate of Acceptance a valid CMATT certification identification number issued by an approved Acceptance Test Technician Certification Provider. The CMATT shall complete all Certificate of Acceptance documentation in accordance with the applicable requirements in Section 10-103(a)4.

TABLE 160.3-A: Return Duct Sizing for Single Return Duct Systems

Return duct length shall not exceed 30 feet and shall contain no more than 180 degrees of bend. If the total bending exceeds 90 degrees, one bend shall be a metal elbow.

Return grille devices shall be labeled in accordance with the requirements in Section 160.2(b)1Biv to disclose the grille's design airflow rate and a maximum allowable clean-filter pressure drop of 25 Pa (0.1 inches water) for the air filter when tested using ASHRAE Standard 52.2, or as rated in accordance with AHRI Standard 680 for the design airflow rate for the return grille.

System Nominal Cooling Capacity (Ton)*	Return Duct Minimum Nominal Diameter (inch)	Minimum Total Return Filter Grille Nominal Area (inch^2)
1.5	16	500
2.0	18	600
2.5	20	800

*Not applicable to systems with nominal cooling capacity greater than 2.5 tons or less than 1.5 ton

TABLE 160.3-B: Return Duct Sizing for Multiple Return Duct Systems

Each return duct length shall not exceed 30 feet and shall contain no more than 180 degrees of bend. If the total bending exceeds 90 degrees, one bend shall be a metal elbow.

Return grille devices shall be labeled in accordance with the requirements in Section 160.2(b)1Biv to disclose the grille's design airflow rate and a maximum allowable clean-filter pressure drop of 25 Pa (0.1 inches water) for the air filter when tested using ASHRAE Standard 52.2, or as rated in accordance with AHRI Standard 680 for the design airflow rate for the return grille.

System Nominal Cooling Capacity (Ton)*	Return Duct 1 Minimum Nominal Diameter (inch)	Return Duct 2 Minimum Nominal Diameter (inch)	Minimum Total Return Filter Grille Nominal Area (inch^2)
1.5	12	10	500
2.0	14	12	600
2.5	14	14	800
3.0	16	14	900
3.5	16	16	1000
4.0	18	18	1200
5.0	20	20	1500

*Not applicable to systems with nominal cooling capacity greater than 5.0 tons or less than 1.5 tons.

TABLE 160.3-C DDC Applications and Qualifications

Building Status	**Applications**	**Qualifications**
Newly Constructed Buildings	Air handling system and all zones served by the system	Individual systems supplying more than three zones and with design heating or cooling capacity of 300 kBtu/h and larger
Newly Constructed Buildings	Chilled water plant and all coils and terminal units served by the system	Individual plants supplying more than three zones and with design cooling capacity of 300 kBtu/h (87.9 kW) and larger
Newly Constructed Buildings	Hot water plant and all coils and terminal units served by the system	Individual plants supplying more than three zones and with design heating capacity of 300 kBtu/h (87.9 kW) and larger
Additions or Alterations	Zone terminal unit such as VAV box	Where existing zones served by the same air handling, chilled water, or hot water systems that have DDC
Additions or Alterations	Air handling system or fan coil	Where existing air handling system(s) and fan coil(s) served by the same chilled or hot water plant have DDC
Additions or Alterations	New air handling system and all new zones served by the system	Individual systems with design heating or cooling capacity of 300 kBtu/h and larger and supplying more than three zones and more than 75 percent of zones are new
Additions or Alterations	New or upgraded chilled water plant	Where all chillers are new and plant design cooling capacity is 300 kBtu/h (87.9 kW) and larger
Additions or Alterations	New or upgraded hot water plant	Where all boilers are new and plant design heating capacity is 300 kBtu/h (87.9 kW) and larger

TABLE 160.3-D PIPE INSULATION THICKNESS

Fluid Operating Temperature Range (°F)	Insulation Conductivity			Nominal Pipe Diameter (in inches)				
	Conductivity (in Btu·in/h·ft²·°F)	Mean Rating Temperature (°F)		< 1	1 to <1.5	1.5 to < 4	4 to < 8	8 and larger
Space heating (Steam, Steam Condensate, Refrigerant, Space Heating)				**Minimum Pipe Insulation Required (Thickness in inches or R-value)**				
Above 350	0.32-0.34	250	Inches	4.5	5.0	5.0	5.0	5.0
			R-value	R 37	R 41	R 37	R 27	R 23
251-350	0.29-0.32	200	Inches	3.0	4.0	4.5	4.5	4.5
			R-value	R 24	R 34	R 35	R 26	R 22
201-250	0.27-0.30	150	Inches	2.5	2.5	2.5	3.0	3.0
			R-value	R 21	R 20	R 17.5	R 17	R 14.5
141-200	0.25-0.29	125	Inches	1.5	1.5	2.0	2.0	2.0
			R-value	R 11.5	R 11	R 14	R 11	R 10
105-140	0.22-0.28	100	Inches	1.0	1.5	1.5	1.5	1.5
			R-value	R 7.7	R 12.5	R 11	R 9	R 8
				Nominal Pipe Diameter (in inches)				
				< 1	**1 to <1.5**	**1.5 to < 4**	**4 to < 8**	**8 and larger**
Space cooling systems (chilled water, refrigerant and brine)				**Minimum Pipe Insulation Required (Thickness in inches or R-value)[1]**				
40-60	0.21-0.27	75	Inches	0.75	0.75	1.0	1.0	1.0
			R-value	R 6	R 5	R 7	R 6	R 5
Below 40	0.20-0.26	50	Inches	1.0	1.5	1.5	1.5	1.5
			R-value	R 8.5	R 14	R 12	R 10	R 9

Footnote to TABLE 160.3-D:

1. These thicknesses are based on energy efficiency considerations only. Issues such as water vapor permeability or surface condensation sometimes require vapor retarders or additional insulation.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 160.4 – MANDATORY REQUIREMENTS FOR WATER HEATING SYSTEMS

(a) Systems using gas or propane water heaters to serve individual dwelling units shall include the following components:

1. A dedicated 125 volt, 20 amp electrical receptacle that is connected to the electric panel with a 120/240 volt 3 conductor, 10 AWG copper branch circuit, within 3 feet from the water heater and accessible to the water heater with no obstructions. In addition, all of the following:

   A. Both ends of the unused conductor shall be labeled with the word "spare" and be electrically isolated; and

   B. A reserved single pole circuit breaker space in the electrical panel adjacent to the circuit breaker for the branch circuit in A above and labeled with the words "Future 240V Use"; and

2. A Category III or IV vent, or a Type B vent with straight pipe between the outside termination and the space where the water heater is installed; and

3. A condensate drain that is no more than 2 inches higher than the base of the installed water heater, and allows natural draining without pump assistance, and

4. A gas supply line with a capacity of at least 200,000 Btu/hr.

(b) Water heating recirculation loops serving multiple dwelling units shall meet the requirements of Section 110.3(c)4.

(c) Solar water-heating systems and collectors shall be certified and rated by the Solar Rating and Certification Corporation (SRCC), the International Association of Plumbing and Mechanical Officials, Research and Testing (IAPMO R&T), or by a listing agency that is approved by the Executive Director.

(d) Instantaneous water heaters with an input rating greater than 6.8 kBTU/hr (2kW) shall meet the requirements of Section 110.3(c)7

(e) Commercial Boilers

1. Combustion air positive shut-off shall be provided on all newly installed boilers as follows:

   A. All boilers with an input capacity of 2.5 MMBtu/h (2,500,000 Btu/h) and above, in which the boiler is designed to operate with a nonpositive vent static pressure.

   B. All boilers where one stack serves two or more boilers with a total combined input capacity per stack of 2.5 MMBtu/h (2,500,000 Btu/h).

2. Boiler combustion air fans with motors 10 horsepower or larger shall meet one of the following for newly installed boilers:

   A. The fan motor shall be driven by a variable speed drive, or

   B. The fan motor shall include controls that limit the fan motor demand to no more than 30 percent of the total design wattage at 50 percent of design air volume.

3. Newly installed boilers with an input capacity 5 MMBtu/h (5,000,000 Btu/h) and greater shall maintain excess (stack-gas) oxygen concentrations at less than or equal to 5.0 percent by volume on a dry basis over firing rates of 20 percent to 100 percent. Combustion air volume shall be controlled with respect to firing rate or flue gas oxygen concentration. Use of a common gas and combustion air control linkage or jack shaft is prohibited.

   EXCEPTION to Section 160.4(e)3: Boilers with steady state full-load thermal efficiency 90 percent or higher.

(f) Insulation for Piping and Tanks

1. **Storage tank insulation.** Unfired hot water tanks, such as storage tanks and backup storage tanks for solar water-heating systems, shall be externally wrapped with insulation having an installed thermal resistance of R-4 or greater.

   EXCEPTION to Section 160.4(f)1: Unfired storage tank with internal insulation of at least R-16 and a label on the exterior of the tank showing the insulation R-value.

2. Piping for multifamily domestic hot water systems, shall be insulated to meet the requirements of Table 160.4-A.

EXCEPTION 1 to Section 160.4(f)2: Factory-installed piping within space-conditioning equipment certified under Section 110.1 or 110.2.

EXCEPTION 2 to Section 160.4(f)2: Piping that penetrates framing members shall not be required to have pipe insulation for the distance of the framing penetration. Piping that penetrates metal framing shall use grommets, plugs, wrapping or other insulating material to assure that no contact is made with the metal framing. Insulation shall abut securely against all framing members.

EXCEPTION 3 to Section 160.4(f)2: Piping installed in interior or exterior walls shall not be required to have pipe insulation if all of the requirements are met for compliance with Quality Insulation Installation (QII) as specified in the Reference Residential Appendix RA3.5.

EXCEPTION 4 to Section 160.4(f)2: Piping surrounded with a minimum of 1 inch of wall insulation, 2 inches of crawlspace insulation, or 4 inches of attic insulation, shall not be required to have pipe insulation.

TABLE 160.4-A PIPE INSULATION THICKNESS – Multifamily Domestic Hot Water

Fluid Operating Temperature Range (°F)	Insulation Conductivity			Nominal Pipe Diameter (in inches)				
	Conductivity (in Btu·in/h·ft^2· °F)	Mean Rating Temperature (°F)		< 1	1 to <1.5	1.5 to < 4	4 to < 8	8 and larger
Multifamily Domestic Hot Water Systems				**Minimum Pipe Insulation Required (Thickness in inches or R-value)**				
105-140[2]	0.22-0.28	100	Inches	1.0	1.5	2.0	2.0	2.0
			R-value	R 7.7	R 12.5	R 16	R 12.5	R 11

Footnote to TABLE 160.4-A:

1. Multifamily and hotel/motel domestic hot water systems with water temperature above 140°F shall use the row in table 120.3-A for the applicable water temperature.

3. Insulation Protection. Pipe Insulation shall be protected from damage due to sunlight, moisture, equipment maintenance, and wind. Protection shall, at minimum, include the following:

A. Pipe insulation exposed to weather shall be protected by a cover suitable for outdoor service. The cover shall be water retardant and provide shielding from solar radiation that can cause degradation of the material. Adhesive tape shall not be used to provide this protection.

B. Pipe insulation covering chilled water piping and refrigerant suction piping located outside the conditioned space shall include, or be protected by, a Class I or Class II vapor retarder. All penetrations and joints shall be sealed.

C. Pipe insulation buried below grade must be installed in a water proof and non-crushable casing or sleeve.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 160.5 – MANDATORY LIGHTING REQUIREMENTS FOR INDOOR AND OUTDOOR SPACES

The design and installation of all lighting systems and equipment in multifamily buildings within the scope of Section 100.0(a) shall comply with the applicable provisions of Section 160.5. All functional areas except dwelling units and common living areas shall comply with the applicable requirements of Section 160.5(b) through 160.5(e).

(a) Dwelling Unit and Common Living Area Lighting.

The design and installation of all lighting systems and equipment in multifamily dwelling units and common living areas shall comply with Section 160.5(a). Multifamily dwelling units include dormitory and senior housing dwelling accommodations. Outdoor lighting attached to multifamily buildings and controlled from the inside of a dwelling unit shall comply with the lighting requirements of Section 160.5(a).

1. Luminaire Requirements.

A. Luminaire Efficacy. All installed luminaires shall meet the requirements in TABLE 160.5-A.

EXCEPTION 1 to Section 160.5(a)1A: **Integrated device lighting:** Lighting integral to exhaust fans, kitchen range hoods, bath vanity mirrors, and garage door openers, and non-removable lighting attached to ceiling fans.

EXCEPTION 2 to Section 160.5(a)1A: Navigation Lighting: Night lights, step lights, path lights less than 5 watts.

EXCEPTION 3 to Section 160.5(a)1A: Cabinet Lighting: Lighting internal to drawers, cabinetry, and linen closets with an efficacy of 45 lumens per watt or greater.

B. Screw based luminaires. Screw based luminaires shall contain lamps that comply with Reference Joint Appendix JA8 or may contain lamps as specified in Table 150.0-A including qualified colored lamps, dim-to-warm lamps, tunable-white lamps, color-tunable lamps, and Title 20-compliant LED lamps.

C. Recessed Downlight Luminaire**s** In addition to complying with Section 160.5(a)1A, luminaires recessed into ceilings shall meet all of the following requirements:

i. Shall not contain screw base lamp sockets; and

ii. Have a label that certifies the luminaire is airtight with air leakage less than 2.0 cfm at 75 Pascals when tested in accordance with ASTM E283. An exhaust fan housing with integral light shall not be required to be certified airtight; and

iii. Be sealed with a gasket or caulk between the luminaire housing and ceiling, and have all air leak paths between conditioned and unconditioned spaces sealed with a gasket or caulk, or be installed per manufacturer's instructions to maintain airtightness between the luminaire housing and ceiling; and

iv. Meet the clearance and installation requirements of California Electrical Code Section 410.116.

EXCEPTION to Section 160.5(a)1Cii and Iii: Recessed luminaires marked for use in fire-rated installations, and recessed luminaires installed in non-insulated ceilings.

D. Light Sources in Enclosed or Recessed Luminaires. Lamps and other separable light sources that are not compliant with the JA8 elevated temperature requirements, including marking requirements, shall not be installed in enclosed or recessed luminaires.

E. Blank Electrical Boxes. The number of electrical boxes that are more than 5 feet above the finished floor and do not contain a luminaire or other device shall be no greater than the number of bedrooms. These electrical boxes must be served by a dimmer, vacancy sensor control, low voltage wiring or fan speed control.

2. Indoor Lighting Controls.

A. Lighting shall have readily accessible wall-mounted controls that allow the lighting to be manually turned ON and OFF.

EXCEPTION to Section 160.5(a)2A: Ceiling fans may provide control of integrated lighting via a remote control.

B. No controls shall bypass a dimmer, occupant sensor or vacancy sensor function where that dimmer or sensor has been installed to comply with Section160.5(a)2.

C. Lighting controls shall comply with the applicable requirements of Section 110.9.

D. An Energy Management Control System (EMCS) or a multiscene programmable controller may be used to comply with dimming, occupancy, and lighting control requirements in Section 160.5(a)2 if it provides the functionality of the specified controls in accordance with Section 110.9, and the physical controls specified in in Section 160.5(a)2.

E. Automatic Off Contols.

i. In bathrooms, garages, laundry rooms, utility rooms, and walk-in closets, at least one installed luminaire shall be controlled by an occupant or vacancy sensor providing automatic-off functionality. If an occupant sensor is installed, it shall be initially configured to manual-on operation using the manual control required under Section 160.5(a)2A.

ii. For lighting internal to drawers and cabinetry with opaque fronts or doors, controls that turn light off when the drawer or door is closed shall be provided.

F. Dimming Controls. Lighting in habitable spaces, including but not limited to living rooms, dining rooms, kitchens, and bedrooms, shall have readily accessible wall-mounted dimming controls that allow the lighting to be manually adjusted up and down. Forward phase cut dimmers controlling LED light sources shall comply with NEMA SSL 7A.

EXCEPTION 1 to Section 160.5(a)2F: Ceiling fans may provide control of integrated lighting via a remote control.

EXCEPTION 2 to Section 160.5(a)2F: Luminaires controlled by an occupancy or vacancy sensor providing automatic-off functionality.

EXCEPTION 3 to Section 160.5(a)2F: Navigation lighting such as night lights, step lights, and path lights less than 5 watts. Lighting internal to drawers and cabinetry with opaque fronts or doors.

G. Independent controls. Integrated lighting of exhaust fans shall be controlled independently from the fans. The following shall be controlled separately from ceiling-installed lighting such that one can be turned on without turning on the other:

i. Undercabinet lighting

ii. Undershelf lighting

iii. Interior lighting of display cabinets

iv. Switched outlets

3. Outdoor Lighting Controls. In addition to meeting the requirements of Section 160.5(a)1, luminaires providing residential outdoor lighting shall meet the following requirements, as applicable:

A. Outdoor lighting attached to a building and separately controlled from the inside of a dwelling unit, shall meet the requirement in item i and the requirements in either item ii or item iii:

i. Controlled by a manual ON and OFF control switch that permits the automatic actions of items ii or iii below; and

ii. Controlled by a photocell; or

iii. Controlled by an astronomical time clock control or an automatic time switch control. Time switch or time clock controls with manual override to ON shall not be allowed unless the override automatically returns the automatic control to its normal operation within 6 hours.

An energy management control system that provides the specified lighting control functionality and complies with all requirements applicable to the specified controls may be used to meet these requirements.

TABLE 160.5-A CLASSIFICATION OF DWELLING UNIT HIGH LUMINOUS EFFICACY LIGHT SOURCES

Light sources in this column are classified as high luminous efficacy and are **not** required to comply with Reference Joint Appendix JA8	Light sources in this column are required to comply with Reference Joint Appendix JA8 and shall be certified and marked as required by JA8.
1. LED light sources installed outdoors. 2. Inseparable Solid State Lighting (SSL) luminaires and colored light sources that are installed to provide decorative, accent, display, utility, undercabinet or special effect lighting. 3. Dim-to-warm and tunable-white LED light sources with at least one light source controller setting of 4000K or less and color rendering index (CRI) rating of 90 or greater. 4. Color-tunable LED light sources with at least one light source controller setting of 4000K or less. 5. LED lamps compliant with Title 20 as general service lamps and with a correlated color temperature (CCT) of 4000K or less. 6. Pin-based linear fluorescent or compact fluorescent light sources using electronic ballasts. 7. High intensity discharge (HID) light sources including pulse start metal halide and high pressure sodium light sources. 8. Luminaires with hardwired high frequency generator and induction lamp. 9. Ceiling Fan Light Kits compliant with Title 20 requirements.	10. All light sources installed in ceiling recessed downlight luminaires other than those specified in items 3, 4, or 5. Note that ceiling recessed downlight luminaires shall not have screw base sockets regardless of lamp type as specified in Section 150.0(k)1C. 11. Any light source not otherwise listed in this table.

(b) Common Services Area Lighting. Lighting systems and equipment in multifamily common services areas shall comply with the applicable provisions of Sections 160.5(b)1 through 160.5(b)4.

NOTE: The requirements of Section160.5(b) applies to newly constructed buildings. Sections 180.1 and 180.2 specify which requirements of Sections 160.5(b)1 through 160.5(e) also apply to additions and alterations to existing buildings.

1. Luminaire classification and power. Luminaires shall be classified and their wattage determined as follows:

A. Luminaire wattage shall be labeled as follows:

i. The maximum rated wattage or relamping rated wattage of a luminaire shall be listed on a permanent, preprinted, factory-installed label, as specified by UL 1574, 1598, 2108, or 8750, as applicable; and

ii. The factory-installed maximum rated wattage or relamping rated wattage label shall not consist of peel-off or peel-down layers or other methods that allow the rated wattage to be changed after the luminaire has been shipped from the manufacturer

Exception to Section 160.3(b)1Aii: Luminaires with a single lamp and an integrated ballast or transformer may use a peel-down label provided that they are layered such that the rated wattage reduces as successive layers are removed.

a. Low-voltage luminaires (except low voltage track systems), ≤ 24 volts, with a maximum relamping rated wattage of 50 watts.

b. Compact fluorescent luminaires, having an integral electronic ballast, with a maximum relamping rated wattage of 42 watts.

c. High intensity discharge luminaires, having an integral electronic ballast, with a maximum relamping rated wattage of 150 watts.

B. For luminaires with line voltage lamps not served by drivers, ballasts, or transformers, the wattage of such luminaires shall be determined as the maximum rated wattage as labeled in accordance with Section 160.5(b)1A.

C. For luminaires with permanently installed or remotely installed ballasts, the wattage of such luminaires shall be the operating input wattage of the rated lamp/ballast combination published in the ballast manufacturer's catalogs based on independent testing lab reports as specified by UL 1598.

D. For inseparable SSL luminaires and SSL luminaires with remotely mounted drivers, the maximum rated wattage shall be the maximum rated input wattage of the SSL luminaire as specified in Section 160.5(b)1A when tested in accordance with UL 1598, 2108, 8750, or IES LM-79.

E. For LED tape lighting and LED linear lighting with LED tape lighting components, the maximum rated wattage shall be the sum of the installed length of the tape lighting times its rated linear power density in watts per linear feet, or the maximum rated input wattage of the driver or power supply providing power to the lighting system, with tape lighting tested in accordance with UL 2108, 8750, or IES LM-79,

F. For modular lighting systems that allow the addition or relocation of luminaires without altering the wiring of the system, shall be determined as follows:

i. The wattage shall be the greater of:

a. 30 watts per linear foot of track or plug-in busway; or

b. the rated wattage of all of the luminaires included in the system, where the luminaire wattage is determined as specified in Section 160.5(b)1A; or

ii. For line-voltage lighting track and plug-in busway served by a track lighting integral current limiter or a dedicated track lighting supplementary overcurrent protection panel, the wattage shall be determined as follows:

a. The volt-ampere rating of current limiter as specified by UL 1077; or

b. The sum of the ampere (A) rating of all of the current protection devices times the branch circuit voltages for track lighting supplementary overcurrent protection panel.

iii. For other modular lighting systems with power supplied by a driver, power supply or transformer, including but not limited to low-voltage lighting systems, the wattage of the system shall be the maximum rated input wattage of the driver, power supply or transformer published in the manufacturer's catalogs, as specified by UL 2108 or 8750.

EXCEPTION to Section 160.5(b)1F: For power-over-Ethernet lighting systems, power provided to installed non-lighting devices may be subtracted from the total power rating of the power-over-Ethernet system.

G. For all other lighting equipment not addressed by Sections 160.5(b)1B through F, the wattage of the lighting equipment shall be the maximum rated wattage of the lighting equipment, or operating input wattage of the system, labeled in accordance with Section 160.5(b)1A, or published in manufacturer's catalogs, based on independent testing lab reports as specified by UL 1574, 1598, 2108, 8750, or IES LM-79.

2. Lighting Controls. All lighting controls and equipment shall comply with the applicable requirements in Sections 110.9, 160.5(b) and 160.5(c), and shall be installed in accordance with any applicable manufacturer instructions.

3. Energy Management Control System (EMCS). An EMCS may be installed to comply with the requirements of one or more lighting controls if it meets the following minimum requirements:

A. Provides all applicable functionality for each specific lighting control or system for which it is installed in accordance with Sections 110.9, 160.5(b) and 160.5(c); and

B. Complies with all applicable Lighting Control Installation Requirements in accordance with Section 160.5(e) for each specific lighting control or system for which it is installed; and

C. Complies with all applicable application requirements for each specific lighting control or system for which it is installed, in accordance with Part 6.

4. Mandatory Indoor Lighting Controls. Multifamily common use areas shall comply with the applicable requirements of Sections 160.5(b)4A through 160.5(b)4F, in addition to the applicable requirements of Sections 110.9.

A. Manual Area Controls. Each area enclosed by ceiling-height partitions shall provide lighting controls that allow the lighting in that area to be manually turned on and off. The manual control shall:

i. Be readily accessible; and

EXCEPTION to Section 160.5(b)4Ai: Restrooms having two or more stalls, parking areas, stairwells, corridors, and areas of the building intended for access or use by the public may use a manual control not accessible to unauthorized personnel.

ii. Be located in the same enclosed area with the lighting it controls; and

EXCEPTION to Section 160.5(b)4Aii: For areas where placement of a manual area control poses a health and safety hazard, the manual area control may instead be located so that a person using the control can see the lights or area controlled by that control, or visually signal or display showing the current state of the controlled lighting.

iii. Provide separate control of general, floor display, wall display, window display, case display, ornamental, and special effects lighting, such that each type of lighting can be turned on or off without turning on or off other types of lighting. Scene controllers may comply with this requirement provided that at least one scene turns on general lighting only, and the control provides a means to manually turn off all lighting.

EXCEPTION to Section 160.5(b)4A: Up to 0.1 watts per square foot of indoor lighting may be continuously illuminated to allow for means of egress illumination consistent with California Building Code Section 1008. Egress lighting complying with this wattage limitation is not required to comply with manual area control requirements if:

i. The area is designated for means of egress on the plans and specifications submitted to the enforcement agency under Section 10-103(a)2 of Part 1; and

ii. The controls for the egress lighting are not accessible to unauthorized personnel.

B. **Multi-Level Lighting Controls.** The general lighting of any enclosed area 100 square feet or larger with a connected lighting load that exceeds 0.5 watts per square foot shall provide multi-level lighting controls that allow the level of lighting to be adjusted up and down. The multi-level controls shall:

1. Provide the number of control steps specified in TABLE 160.5-B;
2. Meet the uniformity requirements.

EXCEPTION 1 to Section 160.5(b)4B: An area enclosed by ceiling height partitions that has only one luminaire with no more than two lamps or has only one inseparable SSL luminaire.

EXCEPTION 2 to Section 160.5(b)4B: Restrooms.

C. Automatic Shut-OFF Controls. All installed indoor lighting shall be equipped with controls able to automatically reduce lighting power when the space is typically unoccupied.

EXCEPTION to Section 160.5(b)4C: Lighting providing means of egress illumination, as the term is used in the California Building Code, shall be configured to provide no less than the amount of light required by California Building Code Section 1008 while in the partial-off mode.

i. In addition to lighting controls installed to comply with Sections 160.5(b)4A and B, all installed indoor lighting shall be equipped with controls that meet the following requirements:

a. Shall be controlled with an occupant sensing control, automatic time-switch control, or other control capable of automatically shutting OFF all of the lighting when the space is typically unoccupied; and

b. Separate controls for the lighting on each floor, other than lighting in stairwells; and

c. Separate controls for a space enclosed by ceiling height partitions not exceeding 5,000 square feet; and

d. Separate controls for general, display, ornamental, and display case lighting; and

e. For automatic time-switch controls, may include a manual-on mode.

EXCEPTION 1 to Section 160.5(b)4Ci: Where the lighting is serving an area that is in continuous use, 24 hours per day/365 days per year.

EXCEPTION 2 to Section 160.5(b)4Ci: Lighting complying with Section 160.5(b)4Cv or vii.

EXCEPTION 3 to Section 160.5(b)4Ci: Up to 0.1 watts per square foot of lighting in any area within a building may be continuously illuminated, provided that the area is designated for means of egress on the plans and specifications submitted to the enforcement agency under Section 10-103(a)2 of Part 1.

EXCEPTION 4 to Section 160.5(b)4Ci: Electrical equipment rooms subject to Article 110.26(D) of the California Electrical Code.

EXCEPTION 5 to Section 160.5(b)4Ci: Illumination provided by lighting equipment that is designated for emergency lighting, connected to an emergency power source or battery supply, and is intended to function in emergency mode only when normal power is absent.

EXCEPTION 6 to Section 160.5(b)4Ci: Lighting in stairways provided that the stairway is designated for means of egress on the plans and specifications submitted to the enforcement agency under Section 10-103(a)2 of Part 1.

ii. Countdown timer switches may be used to comply with the automatic shut-OFF control requirements in **Section 160.5(b)4Ci** only in closets less than 70 square feet. The maximum timer setting shall be 10 minutes for closets.

iii. If an automatic time-switch control, other than an occupant sensing control, is installed to comply with **Section 160.5(b)4Ci**, it shall incorporate a manual override lighting control that:

a. Complies with 160.5(b)4A; and

b. Allows the lighting to remain ON for no more than 2 hours when an override is initiated.

iv. If an automatic time-switch control, other than an occupant sensing control, is installed to comply with Section 160.5(b)4Ci, it shall incorporate an automatic holiday "shut-OFF" feature that turns OFF all loads for at least 24 hours, and then resumes the normally scheduled operation.

v. Occupant Sensing Controls are required for specified offices, multipurpose rooms, conference rooms and restrooms. Lighting installed in offices 250 square feet or smaller, multipurpose rooms of less than 1,000 square feet, conference rooms of any size, and restrooms of any size shall be controlled with occupant sensing controls to automatically shut OFF all of the lighting within 20 minutes of the control zone being unoccupied.

In areas required by Section 160.5(b)4B to have multi-level lighting controls, the occupant sensing controls shall function either as:

a. a partial-ON occupant sensing control capable of automatically activating between 50-70 percent of controlled lighting power, or

b. a vacancy sensing control, where all lighting responds to a manual ON input only.

In areas not required by Section 160.5(b)4B to have multi-level lighting controls, the occupant sensing controls shall function either as:

a. an occupant sensing control; or

b. a partial-ON occupant sensing control, or

c. a vacancy sensing control, where all lighting responds to a manual ON input only.

In addition, controls shall be provided that allow the lights to be manually shut-OFF in accordance with Section 160.5(b)4A regardless of the sensor status.

vi. Partial OFF occupant sensing controls are required for corridors and stairwells, and offices greater than 300 square feet. Lighting installed in the following areas shall meet the following requirements in addition to complying with Section 160.5(b)4A.

a. Lighting installed in corridors and stairwells shall be controlled by occupant sensing controls that separately reduce the lighting power in each space by at least 50 percent when the space is unoccupied. The occupant sensing controls shall be capable of automatically turning the lighting fully ON only in the separately controlled space, and shall be automatically activated from all designed paths of egress.

EXCEPTION to Section 160.5(b)4Cvia: In corridors and stairwells in which the installed lighting power is 80 percent or less of the value allowed under the Area Category Method, occupant sensing controls shall reduce power by at least 40 percent.

b. In office spaces greater than 250 square feet, general lighting shall be controlled by occupancy sensing controls that meet all of the following:

I. The occupancy sensing controls shall be configured so that lighting shall be controlled separately in control zones not greater than 600 square feet. For luminaires with an embedded occupancy sensor that are capable of reducing power independently from other luminaires, each luminaire can be considered its own control zone; and

II. Within 20 minutes of the control zone being unoccupied, the occupancy sensing controls shall uniformly reduce lighting power in the control zone to by at least 80 percent of full power. Control functions that switch control zone lights completely off when the zone is vacant meet this requirement; and

III. Within 20 minutes of the entire office space being unoccupied, the occupancy sensing controls shall automatically turn off lighting in all control zones in the space; and

IV. In each control zone, lighting shall be allowed to automatically turn on to full power upon occupancy within the control zone. When occupancy is detected in any control zone in the space, the lighting in other control zones that are unoccupied shall operate at no more than 20 percent of full power.

EXCEPTION to Section 130.1(c)6D: Under-shelf or furniture-mounted task lighting controlled by a local switch and either a time switch or an occupancy sensor.

vii. Partial OFF occupant sensing controls are required for parking garages, parking areas, and loading and unloading areas. General lighting installed in the following areas shall meet the following requirements instead of complying with Section 160.5(b)4Ci.

a. (reserved)

b. In parking garages, parking areas and loading and unloading areas, general lighting shall be controlled by occupant sensing controls having at least one control step between 20 percent and 50 percent of design lighting power. No more than 500 watts of rated lighting power shall be controlled together as a single zone. A reasonably uniform level of illuminance shall be achieved in accordance with the applicable requirements in TABLE 160.5-B. The occupant sensing controls shall be capable of automatically turning the lighting fully ON only in the separately controlled space, and shall be automatically activated from all designed paths of egress.

Interior areas of parking garages are classified as indoor lighting for compliance with Section 160.5(b)4Cviib. Parking areas on the roof of a parking structure are classified as outdoor hardscape and shall comply with the (applicable provisions in Section 160.5(c).

EXCEPTION to Section 160.5(b)4Cviib: Metal halide luminaires with a lamp plus ballast mean system efficacy of greater than 75 lumens per watt, used for general lighting in parking garages, parking areas and loading and unloading areas, shall be controlled by occupant sensing controls having at least one control step between 20 percent and 60 percent of design lighting power.

D. Automatic Daylighting Controls. The general lighting in skylit daylit zones, primary sidelit daylit zones, and secondary sidelit daylit zones, as well as the general lighting in the combined primary and secondary sidelit daylit zones in parking garages, shall be provided with controls that automatically adjust the power of the installed general lighting up and down to keep the total light level stable as the amount of incoming daylight changes. For skylights located in an atrium, the skylit daylit zones shall apply to the floor area directly under the atrium and the top floor area directly adjacent to the atrium.

i. All skylit daylit zones, primary sidelit daylit zones, secondary sidelit daylit zones and the combined primary and secondary sidelit daylit zones in parking garages shall be shown on the plans.

NOTE: Parking areas on the roof of a parking structure are outdoor hardscape, not skylit daylit areas.

ii. The automatic daylighting controls shall provide separate control for general lighting in each type of daylit zone. General Lighting in overlapping skylit daylit zone and sidelit daylit zone shall be controlled as part of the Skylit Daylit Zone. General lighting in overlapping primary and secondary sidelit daylit zone shall be controlled as part of the primary sidelit daylit zone. Linear LED luminaires and other solid state lighting (SSL) light sources in linear form may be treated as linear lamps in increments of 4 feet segment or smaller, and each segment is separately controlled based on the type of the daylit zone the segment is primarily located.

iii. The automatic daylighting controls shall:

a. For spaces required to install multilevel controls under Section 160.5(b)4B, adjust lighting via continuous dimming or the number of control steps provided by the multilevel controls;

b. For each space, ensure the combined illuminance from the controlled lighting and daylight is not less than the illuminance from controlled lighting when no daylight is available;

c. For areas other than parking garages, ensure that when the daylight illuminance is greater than 150 percent of the illuminance provided by the controlled lighting system when no daylight is available, the controlled lighting power in that daylight zone shall be reduced by a minimum of 90 percent; and

d. For parking garages, ensure that when daylight illuminance levels measured at the farthest edge of the secondary sidelit zone away from the glazing or opening are greater than 150 percent of the illuminance provided by the controlled lighting when no daylight is available, the controlled lighting power in the combined primary and secondary sidelit daylight zones shall be reduced by 100 percent.

iv. Photosensor shall be located so that they are not readily accessible to unauthorized personnel.

v. The location where calibration adjustments are made to the automatic daylighting controls shall be readily accessible to authorized personnel but may be inside a locked case or under a cover which requires a tool for access.

EXCEPTION 1 to Section 160.5(b)4D: Areas under skylights where it is documented that existing adjacent structures or natural objects block direct sunlight for more than 1,500 daytime hours per year between 8a.m. and 4p.m.

EXCEPTION 2 to Section 160.5(b)4D Areas adjacent to vertical glazing below an overhang, where the overhang covers the entire width of the vertical glazing, no vertical glazing is above the overhang, and the ratio of the overhang projection to the overhang rise is greater than 1.5 for South, East and West orientations or greater than 1 for North orientations.

EXCEPTION 3 to Section 160.5(b)4D: Rooms in which the total installed general lighting power in the Skylit Daylit Zone and Primary Sidelit Daylit Zone is less than 120 watts do not require automatic daylighting controls in the daylit zones.

EXCEPTION 4 to Section 160.5(b)4D: Rooms in which the total installed general lighting power in the Secondary Sidelit Daylit Zone is less than 120 watts do not require automatic daylighting controls in the daylit zones.

EXCEPTION 5 to Section 160.5(b)4D: Rooms in which the total installed wattage of the general lighting in the primary and the secondary sidelit daylit zones is less than 240 watts do not require automatic daylighting controls in the sidelit daylit zones.

EXCEPTION 6 to Section 160.5(b)4D: Parking garage areas where the total installed wattage of the general lighting in the primary and the secondary sidelit daylit zones is less than 60 watts do not require automatic daylighting controls in the daylit zones.

EXCEPTION 7 to Section 160.5(b)4D: Rooms that have a total glazing area of less than 24 square feet, or parking garage areas with a combined total of less than 36 square feet of glazing or opening.

EXCEPTION 8 to Section 160.5(b)4D: For parking garages, luminaires located in the daylight adaptation zone and luminaires for only dedicated ramps. Daylight adaptation zone and dedicated ramps are defined in Section 100.1.

EXCEPTION 9 to Section 160.5(b)4D: Luminaires in sidelit daylit zones in retail merchandise sales and wholesale showroom areas.

E. Demand Responsive Controls. See Section 110.12 for requirements for demand responsive lighting controls.

F. Control Interactions. Each lighting control installed to comply with Section 160.5(b)4 shall permit or incorporate the functions of the other lighting controls required by this Section.

i. For general lighting, the manual area control shall permit the level or amount of light provided while the lighting is on to be set or adjusted by the controls specified in Sections 160.5(b)4B, C, D, and E.

ii. The manual area control shall permit the shutoff control to turn the lighting down or off.

iii. The multi-level lighting control shall permit the automatic daylighting control to adjust the electric lighting level in response to changes in the amount of daylight in the daylit zone.

iv. The multi-level lighting control shall permit the demand responsive control to adjust the lighting during a demand response event and to return it to the level set by the multilevel control after the event.

v. The shutoff control shall permit the manual area control to turn the lighting on. If the on request occurs while an automatic time switch control would turn the lighting off, then the on request shall be treated as an override request consistent with Section160.5(c)4Ciii.

vi. The automatic daylighting control shall permit the multi-level lighting control to adjust the level of lighting.

vii. For lighting controlled by multi-level lighting controls and by occupant sensing controls that provide an automatic-on function, the controls shall provide a partial-on function that is capable of automatically activating between 50-70 percent of controlled lighting power.

viii. (RESERVED)

ix. For space conditioning system zones serving only spaces that are required to have occupancy sensing controls as specified in Section 160.5(b)4C, and where Table 120.1-A allows the ventilation air to be reduced to zero when the space is in occupied-standby mode, the space conditioning system shall be controlled by occupancy sensing controls as specified in Section 120.2(e)3.

TABLE 160.5-B MULTI-LEVEL LIGHTING CONTROLS AND UNIFORMITY REQUIREMENTS

<table>
<tr><th>Luminaire Type</th><th colspan="4">Minimum Required Control Steps (percent of full rated power[1])</th><th>Uniform level of illuminance shall be achieved by:</th></tr>
<tr><td>LED luminaires and LED light source systems</td><td colspan="4" rowspan="3">Continuous dimming 10-100 percent</td><td rowspan="3"></td></tr>
<tr><td>Line-voltage sockets except GU-24</td></tr>
<tr><td>Low-voltage incandescent systems</td></tr>
<tr><td>Fluorescent luminaires</td><td colspan="4">Continuous dimming 20-100 percent</td><td></td></tr>
<tr><td>GU-24 sockets rated for fluorescent ≤ 20 watts;
Pin-based compact fluorescent ≤ 20 watts[2]
Linear fluorescent and U-bent fluorescent ≤ 13 watts</td><td colspan="4" rowspan="2">Minimum one step between 30-70 percent</td><td>Continuous dimming; or
Stepped dimming; or
Switching alternate lamps in a luminaire, or
Separately switching circuits in multi-circuit track with a minimum of two circuits.</td></tr>
<tr><td>Track Lighting</td><td></td></tr>
<tr><td rowspan="2">Linear fluorescent and U-bent fluorescent > 13 watts</td><td colspan="4">Minimum one step in each range:</td><td rowspan="2">Stepped dimming; or
Continuous dimming; or
Switching alternate lamps in each luminaire, having a minimum of 4 lamps per luminaire illuminating the same area and in the same manner</td></tr>
<tr><td>20-40 %</td><td>50-70 %</td><td>75-85 %</td><td>100 %</td></tr>
<tr><td></td><td colspan="4"></td><td></td></tr>
</table>

Other light sources, including HID and induction	Minimum one step between 50 - 70 percent	Stepped dimming; or Continuous dimming; or Switching alternate lamps in each luminaire, having a minimum of 2 lamps per luminaire, illuminating the same area and in the same manner.
1. Full rated input power of driver, ballast and lamp, corresponding to maximum ballast factor 2. Includes only pin based lamps: twin tube, multiple twin tube, and spiral lamps		

(c) Outdoor Lighting and Controls Equipment. Multifamily buildings shall comply with the applicable requirements of Sections 160.5(c)1 through 160.5(c)2.

1. Luminaire Shielding Requirements. All outdoor luminaires of 6,200 initial luminaire lumens or greater, shall comply with Backlight, Uplight, and Glare (BUG) (in accordance with ANSI/IES TM-15-20, Annex A) requirements in accordance with Title 24, Part 11, Section 5.106.8.

EXCEPTION 1 to Section 160.5(c)1: Signs.

EXCEPTION 2 to Section 160.5(c)1: Lighting for building facades, public monuments, public art, statues, and vertical surfaces of bridges.

EXCEPTION 3 to Section 160.5(c)1: Lighting not permitted by a health or life safety statute, ordinance, or regulation to be a cutoff luminaire.

EXCEPTION 4 to Section 160.5(c)1: Temporary outdoor lighting**.**

EXCEPTION 5 to Section 160.5(c)1: Replacement of existing pole mounted luminaires in hardscape areas meeting all of the following conditions:

A. Where the existing luminaire does not meet the luminaire BUG requirements in Section 160.5(c)1; and

B. Spacing between existing poles is greater than six times the mounting height of the existing luminaires; and

C. Where no additional poles are being added to the site; and

D. Where new wiring to the luminaires is not being installed; and

E. Provided that the connected lighting power wattage is not increased.

EXCEPTION 6 to Section 160.5(c)1: Luminaires that illuminate the public right of way including publicly-maintained or utility-maintained roadways, sidewalks, and bikeways.

EXCEPTION 7 to Section 160.5(c)1: Outdoor lighting attached to a multifamily building and separately controlled from the inside of a dwelling unit.

2. Controls for Outdoor Lighting. Outdoor lighting shall be independently controlled from other electrical loads, and the controls for outdoor lighting shall meet the following functional requirements:

EXCEPTION 1 to Section 160.5(c)2: Outdoor lighting not permitted by a health or life safety statute, ordinance, or regulation to be turned OFF or reduced.

EXCEPTION 2 to Section 160.5(c)2: Lighting in tunnels required to be illuminated 24 hours per day and 365 days per year.

A. Daylight Availability. All installed outdoor lighting shall be controlled by a photo control, astronomical time-switch control, or other control capable of automatically shutting OFF the outdoor lighting when daylight is available.

B. Automatic Scheduling Controls.

i. Automatic scheduling controls shall be installed for all outdoor lighting. Automatic scheduling controls may be installed in combination with motion sensing controls or other outdoor lighting controls.

ii. Automatic scheduling controls shall be capable of reducing the outdoor lighting power by at least 60 percent and no more than 90 percent, and separately capable of turning the lighting OFF, during scheduled unoccupied periods.

iii. Automatic scheduling controls shall allow scheduling of a minimum of two nighttime periods with independent lighting levels, and may include an override function that turns lighting ON during its scheduled dim or OFF state for no more than two hours when an override is initiated.

C. Motion Sensing Controls.

i. Motion sensing controls shall be installed for the following luminaires. Motion sensing controls may be installed for other outdoor lighting and in combination with other outdoor lighting controls:

a. Outdoor luminaires other than Building Façade, Ornamental Hardscape, or Outdoor Dining, where the bottom of luminaire is mounted 24 feet or less above grade; and,

b. Outdoor wall mounted luminaires installed for General Hardscape parking lot lighting, located within 1 mounting height of a parking space, mounted 24 feet or less above grade.

ii. Motion sensing controls shall be capable of reducing the outdoor lighting power of each controlled luminaire by at least 60 percent and no more than 90 percent, and separately capable of turning the luminaire OFF, during unoccupied periods.

iii. Motion sensing controls shall be capable of reducing the lighting to its dim or OFF state no longer than 15 minutes after the area has been vacated, and of returning the lighting to its ON state when the area becomes occupied.

iv. No more than 1,500 watts of lighting power shall be controlled by a single sensor or as a single zone.

EXCEPTION 1 to Section 160.5(c)2C: Luminaires with a maximum rated wattage of 40 watts each are not required to have motion sensing controls.

EXCEPTION 2 to Section 160.5(c)2C: Applications listed as Exceptions to Section 170.2(e)2A are not required to have motion sensing controls.

EXCEPTION 3 to Section 160.5(c)2C: Lighting subject to a health or life safety statute, ordinance, or regulation may have a minimum time-out period longer than 15 minutes or a minimum dimming level above 50 percent when necessary to comply with the applicable law.

EXCEPTION 4 to Section 160.5(c)2C: For parking lots, luminaires with a maximum rated wattage of 78 watts each are not required to have motion sensing controls.

(d) Sign Lighting Controls. All sign lighting shall meet the requirements below as applicable:

1. Indoor Signs. All indoor sign lighting other than exit sign lighting shall be controlled with an automatic time-switch control or astronomical time-switch control.

2. Outdoor Signs. Outdoor sign lighting shall meet the following requirements as applicable:

A. All outdoor sign lighting shall be controlled with a photocontrol in addition to an automatic time-switch control, or an astronomical time-switch control.

EXCEPTION to Section 160.5(d)2A: Outdoor signs in tunnels, and signs in large permanently covered outdoor areas that are intended to be continuously lit, 24 hours per day and 365 days per year.

B. All outdoor sign lighting that is ON both day and night shall be controlled with a dimmer that provides the ability to automatically reduce sign lighting power by a minimum of 65 percent during nighttime hours. Signs that are illuminated at night and for more than 1 hour during daylight hours shall be considered ON both day and night.

EXCEPTION to Section 160.5(d)2B: Outdoor signs in tunnels and large covered areas that are intended to be illuminated both day and night.

3. Demand Responsive Electronic Message Center (EMC) Control. See Section 110.12 for requirements for demand responsive EMC controls.

(e) Lighting Control Acceptance and Installation Certificate Requirement. Multifamily common services areas shall comply with the applicable requirements of Sections 160.5(e)1 through 160.5(e)3.

1. Lighting Control Acceptance Requirements. Before an occupancy permit is granted, indoor and outdoor lighting controls serving the building, area, or site and installed to comply with Section 160.5(b)4D, 160.5(b)4C, 160.5(b)4E, 160.5(c)2, or 170.2(e)1Aiij shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified by the Reference Nonresidential Appendix NA7.6 and NA7.8. A Certificate of Acceptance shall be submitted to the enforcement agency under Section 10-103(a) of Part 1, that the equipment and systems meet the acceptance requirements:

A. RESERVED;

B. RESERVED;

C. Automatic daylight controls shall be tested in accordance with Reference Nonresidential Appendix NA7.6.1;

D. Lighting shut-OFF controls shall be tested in accordance with Reference Nonresidential Appendix NA7.6.2;

E. Demand responsive lighting controls shall be tested in accordance with Reference Nonresidential Appendix NA7.6.3; and

F. Outdoor lighting controls shall be tested in accordance with Reference Nonresidential Appendix NA7.8; and

G. Lighting systems receiving the Institutional Tuning Power Adjustment Factor shall be tested in accordance with Reference Nonresidential Appendix NA 7.6.4.

2. Lighting Control Installation Certificate Requirements. To be recognized for compliance with Part 6 an Installation Certificate shall be submitted in accordance with Section 10-103(a) for any lighting control system, Energy Management Control System, track lighting integral current limiter, track lighting supplementary overcurrent protection panel, interlocked lighting system, lighting Power Adjustment Factor, or additional wattage available for a videoconference studio, in accordance with the following requirements, as applicable:

A. Certification that when a lighting control system is installed to comply with lighting control requirements in Part 6 it complies with the applicable requirements of Section 110.9; and complies with Reference Nonresidential Appendix NA7.7.1.

B. Certification that when an Energy Management Control System is installed to function as a lighting control required by Part 6 it functionally meets all applicable requirements for each application for which it is installed, in accordance with Sections 110.9, 160, 170, and 180; and complies with Reference Nonresidential Appendix NA7.7.2.

C. Certification that interlocked lighting systems used to serve an approved area comply with Section 170.2(e)1A; and comply with Reference Nonresidential Appendix NA7.7.4.

D. Certification that lighting controls installed to earn a lighting Power Adjustment Factor (PAF) comply with Section 170.2(e)1B; and comply with Reference Nonresidential Appendix NA7.7.5.

E. Certification that additional lighting wattage installed for a videoconference studio complies with Section 170.2(e)1CifVI; and complies with Reference Nonresidential Appendix NA7.7.6.

3. When certification is required by Title 24, Part 1, Section 10-103.1, the acceptance testing specified by Section 160.5(e) shall be performed by a Certified Lighting Controls Acceptance Test Technician (CLCATT). If the CLCATT is operating as an employee, the CLCATT shall be employed by a Certified Lighting Controls Acceptance Test Employer. The CLCATT shall disclose on the Certificate of Acceptance a valid CLCATT certification identification number issued by an approved Acceptance Test Technician Certification Provider. The CLCATT shall complete all Certificate of Acceptance documentation in accordance with the applicable requirements in Section 10-103(a)4.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 160.6 – MANDATORY REQUIREMENTS FOR ELECTRIC POWER DISTRIBUTION SYSTEM

Multifamily buildings shall comply with the applicable requirements of Sections 160.6(a) through 160.6(e).

(a) Service Electrical Metering. Each electrical service or feeder that provides power to the common use areas (interior and exterior) shall have a permanently installed metering system which measures electrical energy use in accordance with TABLE 160.6-A.

EXCEPTION to Section 160.6(a): Service or feeder for which the utility company provides a metering system for the multifamily building that indicates instantaneous kW demand and kWh for a utility-defined period.

TABLE 160.6-A MINIMUM REQUIREMENTS FOR METERING OR SUBMETERING OF ELECTRICAL LOAD

Metering Functionality	**Electrical Services[1] rated 50 kVA or less**	**Electrical Services[1] rated more than 50kVA and less than or equal to 250 kVA**	**Electrical Services[1] rated more than 250 kVA and less than or equal to 1000kVA**	**Electrical Services[1] rated more than 1000kVA**
Instantaneous (at the time) kW demand	Required	Required	Required	Required
Historical peak demand (kW)	Not required	Not required	Required	Required
Tracking kWh for a user-definable period.	Required	Required	Required	Required
kWh per rate period	Not required	Not required	Not required	Required

[1] *"Electrical Services" applies to the building service-entrance rating or to the submetering service. For a building with submetering, this applies to the submetering service size to the common use areas.*

(b) Separation of Electrical Circuits for Electrical Energy Monitoring. Electrical power distribution systems shall be designed so that measurement devices can monitor the electrical energy usage of load types according to TABLE 160.6-B.

EXCEPTION 1 to Section 160.6(b): For each separate load type, up to 10 percent of the connected load may be of any type.

EXCEPTION 2 to Section 160.6(b): Submetered electrical power distribution systems that provide power to dwelling units or common living areas.

TABLE 160.6-B MINIMUM REQUIREMENTS FOR SEPARATION OF ELECTRICAL LOAD

Electrical Load Type	**Electrical Services[1] rated 50 kVA or less**	**Electrical Services[1] rated more than 50kVA and less than or equal to 250 kVA**	**Electrical Services[1] rated more than 250 kVA and less than or equal to 1000kVA**	**Electrical Services[1] rated more than 1000kVA**
Lighting including exit and egress lighting and exterior lighting	Not required	All lighting in aggregate	All lighting disaggregated by floor, type or area	All lighting disaggregated by floor, type or area
HVAC systems and components including chillers, fans, heaters, furnaces, package units, cooling towers, and circulation pumps associated with HVAC	Not required	All HVAC in aggregate	All HVAC in aggregate and each HVAC load rated at least 50 kVA	All HVAC in aggregate and each HVAC load rated at least 50kVA
Domestic and service water system pumps and related systems and components	Not required	All loads in aggregate	All loads in aggregate	All loads in aggregate
Plug load including appliances rated less than 25 kVA	Not required	All plug load in aggregate Groups of plug loads exceeding 25 kVA connected load in an area less than 5000 sf	All plug load separated by floor, type or area Groups of plug loads exceeding 25 kVA connected load in an area less than 5000 sf	All plug load separated by floor, type or area All groups of plug loads exceeding 25 kVA connected load in an area less than 5000 sf
Elevators, escalators, moving walks, and transit systems	Not required	All loads in aggregate	All loads in aggregate	All loads in aggregate
Renewable power source (net or total)	Each group	Each group	Each group	Each group
Loads associated with renewable power source	Not required	All loads in aggregate	All loads in aggregate	All loads in aggregate
Charging stations for electric vehicles	All loads in aggregate	All loads in aggregate	All loads in aggregate	All loads in aggregate

[1] "Electrical Services" applies to the building service-entrance rating or to the submetering service. For a building with submetering, this applies to the submetering service size to the common use area.

(c) Voltage Drop. The maximum combined voltage drop on both installed feeder conductors and branch circuit conductors to the farthest connected load or outlet shall not exceed 5 percent.

EXCEPTION to Section 160.6(c): Voltage drop permitted by California Electrical Code Sections 647.4, 695.6 and 695.7.

(d) **Circuit Controls for 120-Volt Receptacles and Controlled Receptacles**. In all common services areas, both controlled and uncontrolled 120 volt receptacles shall be provided in office areas, lobbies, conference rooms, kitchen areas in office spaces, and copy rooms. Controlled receptacles shall meet the following requirements, as applicable:

1. Install a control capable of automatically shutting OFF the controlled receptacles when the space is typically unoccupied, either at the receptacle or circuit level. When an automatic time switch control is installed it shall incorporate an override control that allows the controlled receptacle to remain ON for no more than 2 hours when an override is initiated and an automatic holiday "shut-OFF" feature that turns OFF all loads for at least 24 hours and then resumes the normally scheduled operation. Countdown timer switches shall not be used to comply with the automatic time switch control requirements; and

2. Install at least one controlled receptacle within 6 feet from each uncontrolled receptacle, or install a splitwired receptacle with at least one controlled and one uncontrolled receptacle. Where receptacles are installed in

modular furniture in open office areas, at least one controlled receptacle shall be installed at each workstation; and

3. Provide a permanent and durable marking for controlled receptacles or circuits to differentiate them from uncontrolled receptacles or circuits; and

NOTE: A hardwired power strip controlled by an occupant sensing control may be used to comply with Section 160.6(d). Plug-in strips and other plug-in devices shall not be used to comply with the requirements of this Section.

EXCEPTION to Section 160.6(d): Receptacles that are only for the following purposes:

A. Receptacles specifically for refrigerators and water dispensers in kitchen areas.

B. Receptacles located a minimum of six feet above the floor that are specifically for clocks.

C. Receptacles for network copiers, fax machines, A/V and data equipment other than personal computers in copy rooms.

D. Receptacles on circuits rated more than 20 amperes.

E. Receptacles connected to an uninterruptible power supply (UPS) that are intended to be in continuous use, 24 hours per day/365 days per year, and are marked to differentiate them from other uncontrolled receptacles or circuits.

F. Demand responsive controls and equipment. See Section 110.12 for requirements for demand responsive controls and equipment.

NOTE: Definitions of terms and phrases in Section 160.6 are determined as specified in Section 100.1(b). Terms and phrases not found in Section 100.1(b) shall be defined as specified in Title 24, Part 3, Article 100 of the California Electrical Code.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 160.7 – MANDATORY REQUIREMENTS FOR COVERED PROCESSES

(a) **Elevators.** Elevators shall meet the requirements of section 120.6(f).

(b) **Pool and spa systems.** Pool and spa systems available to multiple tenants or to the public shall comply with the applicable requirements of Section 110.4. Pool and spa systems installed for exclusive use by a single tenant shall comply with the applicable requirements of 150.0(p).

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 160.8 – MANDATORY REQUIREMENTS FOR SOLAR READY BUILDINGS

(a) Solar Ready Buildings. Newly constructed multifamily buildings shall meet the requirements of Section 110.10 applicable to the building project.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 160.9 – MANDATORY REQUIREMENTS FOR ELECTRIC READY BUILDINGS

(a) **Heat Pump Space Heater Ready.** Systems using gas or propane furnaces to serve individual dwelling units shall include the following:

1. A dedicated 240 volt branch circuit shall be installed within 3 feet from the furnace and accessible to the furnace with no obstructions. The branch circuit shall be rated at 30 amps minimum. The blank cover shall be identified as "240V ready". All electrical components shall be installed in accordance with the *California Electrical Code*.

2. The main electrical service panel shall have a reserved space to allow for the installation of a double pole circuit breaker for a future heat pump space heater installation. The reserved space shall be permanently marked as "For Future 240V use".

(b) **Electric Cooktop Ready.** Systems using gas or propane cooktops to serve individual dwelling units shall include the following:

1. A dedicated 240 volt branch circuit shall be installed within 3 feet from the cooktop and accessible to the cooktop with no obstructions. The branch circuit shall be rated at 50 amps minimum. The blank cover shall be identified as "240V ready". All electrical components shall be installed in accordance with the *California Electrical Code*.

2. The main electrical service panel shall have a reserved space to allow for the installation of a double pole circuit breaker for a future electric cooktop installation. The reserved space shall be permanently marked as "For Future 240V use".

(c) **Electric Clothes Dryer Ready.** Systems using gas or propane clothes dryers shall include the following:

1. Systems serving individual dwelling units shall include:

   A. A dedicated 240 volt branch circuit shall be installed within 3 feet from the clothes dryer and accessible to the clothes dryer with no obstructions. The branch circuit shall be rated at 30 amps minimum. The blank cover shall be identified as "240V ready". All electrical components shall be installed in accordance with the *California Electrical Code*.

   B. The main electrical service panel shall have a reserved space to allow for the installation of a double pole circuit breaker for a future electric clothes dryer installation. The reserved space shall be permanently marked as "For Future 240V use".

2. Systems in common areas shall include:

   A. Conductors or raceway shall be installed with termination points at the main electrical panel, via subpanels panels if applicable, to a location no more than 3 feet from each gas outlet or a designated location of future electric replacement equipment. Both ends of the conductors or raceway shall be labelled "Future 240V Use." The conductors or raceway and any intervening subpanels, panelboards, switchboards, and busbars shall be sized to meet the future electric power requirements, at the service voltage to the point at which the conductors serving the building connect to the utility distribution system, as specified below. The capacity requirements may be adjusted for demand factors in accordance with the California Electric Code. Gas flow rates shall be determined in accordance with the California Plumbing Code. Capacity shall be one of the following:

      i. 24 amps at 208/240 volts per clothes dryer;

      ii. 2.6 kVA for each 10,000 Btu per hour of rated gas input or gas pipe capacity; or

      iii. The electrical power required to provide equivalent functionality of the gas-powered equipment as calculated and documented by the responsible person associated with the project.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SUBCHAPTER 11
MULTIFAMILY BUILDINGS - PERFORMANCE AND PRESCRIPTIVE COMPLIANCE APPROACHES

SECTION 170.0 – GENERAL

Multifamily buildings shall comply with the applicable requirements of Sections 170.0 through 170.2. Sections 170.0 through 170.2 apply to dwelling units and common use areas in multifamily buildings. Nonresidential occupancies in mixed occupancy buildings shall comply with nonresidential requirements in Sections 120, 130, 140 and 141.

(a) Multifamily buildings shall meet all of the following:

1. The applicable requirements of Sections 110.0 through 110.10.
2. The applicable requirements of Section 160.0 (mandatory features).
3. Either the performance Standards (170.1) or the prescriptive Standards (170.2) set forth in this Subchapter for the Climate Zone in which the building is located. Climate zones are shown in Reference Joint Appendix JA2 – Weather/Climate Data.

   EXCEPTION to Section 170.0 (a)3: If a single development falls in more than one Climate Zone, all buildings in the subdivision or tract may be designed to meet the performance or prescriptive standards for the Climate Zone that contains 50 percent or more of the dwelling units.

   NOTE: The Commission periodically updates, publishes, and makes available to interested persons and local enforcement agencies precise descriptions of the Climate Zones, as specified in Reference Joint Appendix JA2 – Weather/Climate Data.

NOTE: The requirements of Sections 170.1(a) through 170.2(e) apply to newly constructed buildings and Sections 180.1 and 180.2 specify changes to the requirements of Sections 170.1(a) through 170.2(e) that apply to additions or alterations.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 170.1 – PERFORMANCE APPROACH

A building complies with the performance approach if the energy budget calculated for the Proposed Design Building under Subsection (b) is no greater than the energy budget calculated for the Standard Design Building under Subsection (a).

(a) **Energy Budget for the Standard Design Building.** The energy budget for the Standard Design Building is determined by applying the mandatory and prescriptive requirements to the Proposed Design Building. The energy budget is the sum of the TDV energy for space-conditioning, indoor lighting, mechanical ventilation, photovoltaic (PV) and battery storage system, service water heating, and covered process loads.

(b) **Energy Budget for the Proposed Design Building**. The energy budget for a Proposed Design Building is determined by calculating the TDV energy for the Proposed Design Building. The energy budget is the sum of the TDV energy for space-conditioning, indoor lighting, mechanical ventilation, photovoltaic (PV) and battery storage system, and service water heating and covered process loads.

EXCEPTION to Section 170.1(b). A community shared solar electric generation system, or other renewable electric generation system, and/or community shared battery storage system, which provides dedicated power, utility energy reduction credits, or payments for energy bill reductions, to the permitted building and is approved by the Energy Commission as specified in Title 24, Part 1, Section 10-115, may offset part or all of the solar electric generation system TDV energy required to comply with the Standards, as calculated according to methods established by the Commission in the Nonresidential ACM Reference Manual.

(c) **Calculation of Energy Budget**. The TDV energy for both the Standard Design Building and the Proposed Design Building shall be computed by Compliance Software certified for this use by the Commission. The processes for Compliance Software approval by the Commission are documented in the ACM Approval Manual.

(d) **Compliance Demonstration Requirements for Performance Standards.**

1. Certificate of Compliance and Application for a Building Permit. The application for a building permit shall include documentation pursuant to Sections 10-103(a)1 and 10-103(a)2 which demonstrates, using an approved calculation method, that the building has been designed so that its EDRs do not exceed the Standard Design EDRs for the applicable Climate Zone.
2. Field Verification of Individual Dwelling Unit Systems. When performance of installed features, materials, components, manufactured devices or systems above the minimum specified in Section 170.2 is necessary for the building to comply with Section 170.1, or is necessary to achieve a more stringent local ordinance, field verification shall be performed in accordance with the applicable requirements in the following subsections, and the results of the verification(s) shall be documented on applicable Certificates of Installation pursuant to Section 10-103(a)3 and applicable Certificates of Verification pursuant to Section 10-103(a)5.
    A. SEER Rating. When performance compliance requires installation of a space conditioning system with a SEER rating that is greater than the minimum SEER rating required by TABLE 170.2-K, the installed system shall be field verified in accordance with the procedures specified in Reference Residential Appendix RA3.4.4.1.
    B. EER Rating. When performance compliance requires installation of a space conditioning system with an EER rating greater than the standard design value for EER, the installed system shall be field verified in accordance with the procedures specified in Reference Residential Appendix RA3.4.4.1.
    C. Low Leakage Air Handler. When performance compliance requires installation of a low leakage air-handling unit, the installed air handling unit shall be field verified in accordance with the procedures specified in Reference Residential Appendix RA3.1.4.3.9.
    D. HSPF Rating. When performance compliance requires installation of a heat pump system with an HSPF rating that is greater than the minimum HSPF rating required in Table170.2-H the installed system shall be field verified in accordance with the procedures specified in Reference Residential Appendix RA3.4.4.1.

E. Heat Pump - Rated Heating Capacity. When performance compliance requires installation of a heat pump system, the heating capacity values at 47 degrees F and 17 degrees F shall be field verified in accordance with the procedures specified in Reference Residential Appendix RA3.4.4.2.

F. Whole House Fan. When performance compliance requires installation of a whole-house fan, the whole house fan ventilation airflow rate and fan efficacy shall be field verified in accordance with the procedures in Reference Residential Appendix RA3.9.

G. Central Fan Ventilation Cooling System. When performance compliance requires installation of a central fan ventilation cooling system, the installed system shall be field verified in accordance with the procedures in Reference Residential Appendix RA3.3.4.

H. Dwelling Unit Enclosure Air Leakage. When performance compliance requires a building enclosure leakage rate that is lower than the standard design, the building enclosure shall be field verified in accordance with the procedures specified in Reference Residential Appendix RA3.8.

I. Quality Insulation Installation (QII). When performance compliance requires field verification of QII, the building insulation system shall be field verified in accordance with the procedures in Reference Residential Appendix RA3.5.

J. Pre-Cooling. When performance compliance requires field verification of the installation and programming of a Pre-Cooling Thermostat, it shall be field verified in accordance with the procedures in Reference Residential Appendix RA3.4.5.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 170.2 – PRESCRIPTIVE APPROACH

Multifamily buildings, including both dwelling units and common use areas, that comply with the prescriptive standards shall be designed, constructed, and equipped to meet all of the requirements for the appropriate Climate Zone shown in TABLE 170.2-A. In TABLE 170.2-A, a NA (not allowed) means that feature is not permitted in a particular Climate Zone and a NR (no requirement) means that there is no prescriptive requirement for that feature in a particular Climate Zone. Installed components shall meet the following requirements:

(a) **Envelope Component Requirements**.

1. **Exterior roofs and ceilings**. Exterior roofs and ceilings shall comply with each of the applicable requirements in this subsection:

   A. Roofing Products. All roofing products shall meet the requirements of Section 110.8 and the applicable minimum aged solar reflectance and thermal emittance requirements of Table 170.2-A.

   EXCEPTION 1 to Section 170.2(a)1A: Building integrated photovoltaic panels and building integrated solar thermal panels are exempt from the minimum requirements for solar reflectance and thermal emittance or SRI.

   EXCEPTION 2 to Section 170.2(a)1A: Roof constructions with a weight of at least 25 lb/ft² are exempt from the minimum requirements for solar reflectance and thermal emittance or SRI.

   B. Roof Insulation. Roofs shall have an overall assembly U-factor no greater than the applicable value in TABLE 170.2-A, meeting option i, ii, iii, or iv below. Where required by Section 110.8 and 160.1(a), insulation shall be placed in direct contact with a continuous roof or drywall ceiling.

      i. Option A: RESERVED

      ii. Option B: A minimum R-value of insulation installed between the roof rafters in contact with the roof deck and an additional layer of ceiling insulation located between the attic and the conditioned space when meeting Section 170.2(c)3Biia; or

      iii. Option C: A minimum R-value of ceiling insulation located between the attic and the conditioned space when meeting Section 170.2(c)3Biib.

      iv. Option D: A minimum U-factor for roof assemblies above conditioned space without attic space.

   C. Radiant Barrier. A radiant barrier required in TABLE 170.2-A shall meet the requirements specified in Section 110.8(j), and shall meet the installation criteria specified in the Reference Residential Appendix RA4**.**

2. Wall Insulation

   A. Exterior walls shall have an overall assembly U-factor no greater than the applicable value in TABLE 170.2-A.

   B. Demising walls shall meet the requirements of 160.1(b)7. Vertical windows in demising walls between conditioned and unconditioned spaces shall have an area-weighted average U-factor no greater than the applicable value in TABLE 170.2-A.

3. Fenestration.

   A. Vertical fenestration and glazed doors in exterior walls shall comply with subsections i, ii, and iii:

      i. Percent fenestration area shall be limited in accordance with the applicable requirements of a and b below:

         a. A total fenestration area no greater than 20 percent of the conditioned floor area; and

         b. A total fenestration area no greater than 40 percent of the gross exterior wall area.

         NOTE: Demising walls are not exterior walls, and therefore demising wall area is not part of the gross exterior wall area, and fenestration in demising walls are not part of the fenestration area limitation.

ii. Fenestration Properties. Installed fenestration products, including glazed doors, shall have an area-weighted average U-factor, Relative Solar Heat Gain Coefficient (RSHGC), and Visual Transmittance (VT) meeting the applicable fenestration values in TABLE 170.2-A and shall be determined in accordance with Sections 110.6(a)2 and 110.6(a)3.

Vertical fenestration in demising walls between conditioned and unconditioned spaces are only required to comply with the area-weighted average U-factor requirement in TABLE 170.2-A.

EXCEPTION 1 to Section 170.2(a)3Aii: For each dwelling unit, up to 3 square feet of new glazing area installed in doors shall not be required to meet the U-factor and RSHGC requirements of TABLE 170.2-A.

EXCEPTION 2 to Section 170.2(a)3Aii: For fenestration containing chromogenic type glazing:

a. The lower-rated labeled U-factor and SHGC shall be used with automatic controls to modulate the amount of solar gain and light transmitted into the space in multiple steps in response to daylight levels or solar intensity;

b. Chromogenic glazing shall be considered separately from other fenestration; and

c. Area-weighted averaging with other fenestration that is not chromatic shall not be permitted and shall be determined in accordance with Section 110.6(a).

EXCEPTION 3to Section 170.2(a)3Aii: For dwelling units containing unrated site-built fenestration that meets the maximum area restriction, the U-factor and SHGC can be determined in accordance with the Nonresidential Reference Appendix NA6 or use default values in TABLE 110.6-A and TABLE 110.6-B.

EXCEPTION 4 to Section 170.2(a)3ii: Fenestration in dwelling units of buildings that are three habitable stories or fewer in climate zones 1, 3, 5, and 16, are not required to comply with the RSHGC requirements.

EXCEPTION 5 to Section 170.2(a)3ii: Fenestration in dwelling units of buildings that are three habitable stories or fewer are not required to comply with the VT requirements.

iii. Shading. Where Table 170.2-A requires a maximum RSHGC, the requirements shall be met with an area-weighted average RSHGC excluding the effects of interior shading, no greater than the applicable value in Table 170.2-A.

For the purposes of this paragraph, the RSHGC of a vertical window is:

a. The Solar Heat Gain Coefficient of the window; or

b. Relative Solar Heat Gain Coefficient is calculated using EQUATION 170.2-A, if the window has an overhang that extends beyond each side of the window jamb by a distance equal to the overhang's horizontal projection.

EXCEPTION 1 to Section 170.2(a)3Aiiib: An area-weighted average Relative Solar Heat Gain Coefficient of 0.56 or less shall be used for windows:

I. That are in the first story of exterior walls that form a display perimeter; and

II. For which codes restrict the use of overhangs to shade the windows.

EXCEPTION 2 to Section 170.2(a)3Aiiib: For vertical glazing containing chromogenic type glazing:

I. the lower-rate labeled RSHGC shall be used with automatic controls to modulate the amount of heat flow into the space in multiple steps in response to daylight levels or solar intensity; and

II. chromogenic glazing shall be considered separately from other glazing; and

III. area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

NOTE: Demising walls are not exterior walls, and therefore fenestration in demising walls are not subject to SHGC requirements.

$RSHGC = SHGC \times [1 + a \times (2.72^{-PF} - 1) \times (\sin(b \times Az) - c)]$ (Equation 170.2-A)

WHERE:

	a	b	c
Overhang	0.150	0.130	5.67
Exterior Horizontal Slat	0.144	0.133	5.13

RSHGC = Relative Solar Heat Gain Coefficient.
SHGC = Solar Heat Gain Coefficient of the vertical fenestration.
Az = Azimuth of the vertical fenestration in degrees.
PF = Projection factor as calculated by Equation 140.3-D.

iv. Vertical fenestration shall have an area-weighted average Visible Transmittance (VT) no less than the applicable value in TABLE 170.2-A, or EQUATION 170.2-B, as applicable.

EXCEPTION 1 to Section 170.2(a)3Aiv: When the window's primary and secondary sidelit daylit zones are completely overlapped by one or more skylit daylit zones, then the window need not comply with Section 170.2(a)3Aivw.

EXCEPTION 2 to Section 170.2(a)3Aiv: If the window's VT is not within the scope of NFRC 200, or ASTM E972, then the VT shall be calculated according to Reference Nonresidential Appendix NA6.

EXCEPTION 3 to Section 170.2(a)3Aiv: For vertical windows containing chromogenic type glazing:

a. The higher rated labeled VT shall be used with automatic controls to modulate the amount of light transmitted into the space in multiple steps in response to daylight levels or solar intensity;

b. Chromogenic glazing shall be considered separately from other glazing; and

c. Area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

EXCEPTION 4 to Section 170.2(a)3iv: Fenestration in dwelling units of buildings that are three habitable stories or fewer are not required to comply with the VT requirements.

NOTE: Demising walls are not exterior walls, and therefore windows in demising walls are not subject to VT requirements.

$VT \geq 0.11/ WWR$ (Equation 170.2-B)

WHERE:

WWR = Window Wall Ratio, the ratio of (i) the total window area of the entire building to (ii) the total gross exterior wall area of the entire building. If the WWR is greater than 0.40, then 0.40 shall be used as the value for WWR in EQUATION 170.2-B.

VT = Visible Transmittance of framed window.

B. **Skylights shal**l:

i. Have an area no greater than 5 percent of the gross exterior roof area Skylight Roof Ratio (SRR); and

EXCEPTION 1 to Section 170.2(a)3Bi: Buildings with an atria over 55 feet high shall have a skylight area no greater than 10 percent of the gross exterior roof area.

ii. Have an Area-Weighted Performance Rating U-factor no greater than the applicable value in TABLE 170.2-A.

EXCEPTION 2 to Section 170.2(a)3Bii: For each dwelling unit up to 16 square feet of new skylight area with a maximum U-factor of 0.55 and a maximum SHGC of 0.30.

iii. Solar Heat Gain Coefficient. Have an area-weighted performance rating Solar Heat Gain Coefficient no greater than the applicable value in TABLE 170.2-A.

EXCEPTION to Section 170.2(a)3Bii and 170.2(a)3Biii: For skylights containing chromogenic type glazing:

a. the lower-rated labeled SHGC shall be used with automatic controls to modulate the amount of heat flow into the space in multiple steps in response to daylight levels or solar intensity; and

b. chromogenic glazing shall be considered separately from other glazing; and

c. area-weighted averaging with other glazing that is not chromogenic shall not be permitted.

iv. Haze Value. Have a glazing material or diffuser that has a measured haze value greater than 90 percent, determined according to ASTM D1003, or other test method approved by the Energy Commission.

EXCEPTION to Section 170.2(a)3Biv: Skylights designed and installed to exclude direct sunlight entering the occupied space by the use of fixed or automated baffles or the geometry of the skylight and light well.

4. All exterior doors, excluding glazed doors, that separate conditioned space from unconditioned space or from ambient air shall have a U-factor not greater than the applicable value in TABLE 170.2-A. Glazed doors must comply with the requirements of Section 170.2(a)3A.

EXCEPTION to Section 170.2(a)4: Swinging doors that are required to have fire protection are not required to meet the applicable door value in TABLE 170.2-A.

5. Floors shall meet the following requirements:

A. Raised-floors shall be insulated such that the floor assembly has an assembly U-factor equal to or less than shown in TABLE 170.2-A, or shall be insulated between wood framing with insulation having an R-value equal to or greater than shown in TABLE 170.2-A.

B. All buildings with three habitable stories or fewer shall have slab floor perimeter insulation installed with a U-factor equal to or less than or R-value equal to or greater than shown in Table 170.2-A. The minimum depth of concrete slab floor perimeter insulation shall be 16 inches or the depth of the footing of the building, whichever is less.

EXCEPTION to Section 170.2(a)5: Raised-floor insulation may be omitted if the foundation walls are insulated to meet the wall insulation minimums shown in TABLE 170.2-A.

6. All buildings up to three habitable stories shall comply with the Quality Insulation Installation (QII) requirements shown in TABLE 170.2-A. When QII is required, insulation installation shall meet the criteria specified in Reference Appendix RA3.5.

EXCEPTION to Section 170.2(a): The insulation requirements of TABLE 170.2-A and TABLE 170.2-B may be met by ceiling, roof deck, wall, or floor assemblies that meet the required maximum U-factors using a U-factor calculation method that considers the thermal effects of all elements of the assembly and is approved by the Executive Director.

TABLE 170.2-A ENVELOPE COMPONENT PACKAGE – Multifamily Standard Building Design

Multifamily				Climate Zone															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Roof/Ceiling	Option B (meets § 170.2(a)1Bii)	Below Roof Deck Insulation [1,2] (With Air Space)		NR	NR	NR	R19	NR	NR	NR	R19	R19	R13	R19	R19	R19	R19	R19	R13
		Ceiling Insulation		R 38	R 38	R 30	R 38	R 30	R 30	R 30	R 38	R 38	R 38	R 38	R 38	R 38	R 38	R 38	R 38
		Radiant Barrier		NR	REQ	REQ	NR	REQ	REQ	REQ	NR	NR	NR	NR	NR	NR	NR	NR	NR
		Low-sloped	Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.63	NR	0.63	NR
			Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.75	NR	0.75	NR
			Solar Reflectance Index (SRI)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	75	NR	75	NR
		Steep-sloped	Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.20	0.20	0.20	0.20	0.20	0.20	NR
			Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0. 75	0.75	0.75	0.75	0.75	0.75	NR
			Solar Reflectance Index (SRI)	NR	NR	NR	NR	NR	NR	NR	NR	NR	16	16	16	16	16	16	NR
	Option C (meets § 170.2(a)1Biii)	Ceiling Insulation		R 38	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 38	R 38	R 38	R 38	R 38	R 38
		Radiant Barrier		NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR
		Low-sloped	Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.63	NR	0.63	NR
			Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.75	NR	0.75	NR
			Solar Reflectance Index (SRI)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	75	NR	75	NR
		Steep-sloped	Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.20	0.20	0.20	0.20	0.20	0.20	NR
			Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0. 75	0.75	0.75	0.75	0.75	0.75	NR
			Solar Reflectance Index (SRI)	NR	NR	NR	NR	NR	NR	NR	NR	NR	16	16	16	16	16	16	NR
	Option D (Non Attic Roof)	Metal Building U-factor		0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041
		Wood Framed and Other U-factor		0.028	0.028	0.034	0.028	0.034	0.034	0.039	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028
		Low-sloped	Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	0.63	0.63	0.63	NR	0.63	0.63	0.63	NR
			Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	0.75	0.75	0.75	NR	0.75	0.75	0.75	NR
			Solar Reflectance Index (SRI)	NR	NR	NR	NR	NR	NR	NR	NR	75	75	75	NR	75	75	75	NR
		Steep-sloped	Aged Solar Reflectance	NR	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	NR
			Thermal Emittance	NR	0. 75	0. 75	0. 75	0. 75	0. 75	0. 75	0. 75	0. 75	0. 75	0.75	0.75	0.75	0.75	0.75	NR
			Solar Reflectance Index (SRI)	NR	16	16	16	16	16	16	16	16	16	16	16	16	16	16	NR

Walls		Metal-Building, any fire rating	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.057	0.057	0.057	0.057	0.057	0.057
		Framed, (wood, metal, and others) >1hr fire rating	0.059	0.059	0.059	0.059	0.059	0.065	0.065	0.059	0.059	0.059	0.051	0.059	0.059	0.051	0.051	0.051
		Framed (wood, metal and others), ≤1hr fire rating[3]	0.051	0.051	0.051	0.051	0.051	0.065	0.065	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
		Mass Light [4,5]	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.077 R 13	U 0.059 R 17
		Mass Heavy	0.253	0.650	0.650	0.650	0.650	0.690	0.690	0.690	0.690	0.650	0.184	0.253	0.211	0.184	0.184	0.160
Floors/Soffits		Slab Perimeter, Three Habitable Stories or less	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	U 0.58 R 7.0
		Wood Framed	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19	U 0.037 R 19

		Raised Mass	U 0.092 R 8.0	U 0.092 R 8.0	U 0.269 R 0	U 0.269 R 0	U- 0.269 R 0	U 0.269 R 0	U 0.269 R 0	U 0.269 R 0	U 0.269 R 0	U 0.269 R 0	U 0.092 R 8.0	U 0.138 R 4.0	U 0.092 R 8.0	U 0.092 R 8.0	U 0.138 R 4.0	U 0.092 R 8.0
		Other	0.048	0.039	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.039	0.071	0.071	0.039	0.039	0.039
Quality Insulation Installation (QII) for buildings up to three habitable stories			Yes	Yes	Yes	Yes	Yes	Yes	NR	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fenestration	Curtain Wall/ Storefront	Maximum U-factor	0.38	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.38
		Maximum RSHGC, three or fewer habitable stories	NR	0.26	NR	0.26	NR	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.25	0.26	NR
		Maximum RSHGC, four or more habitable stories	0.35	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.25	0.26	0.25
		Minimum VT, four or more habitable stories	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
	NAFS 2017 Performance Class AW[5]	Maximum U-factor	0.38	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.38
		Maximum RSHGC, three or less habitable stories	NR	0.24	NR	0.24	NR	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	NR
		Maximum RSHGC, four or more habitable stories	0.35	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
		Minimum VT, four or more habitable stories	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
	All Other Fenestration	Maximum U-factor	0.30	0.30	0.30	0.30	0.30	0.30	0.34	0.34	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
		Maximum RSHGC, three or less habitable stories	NR	0.23	NR	0.23	NR	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	NR
		Maximum RSHGC, four or more habitable stories	0.35	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
	Maximum Window to Floor Ratio		20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Maximum Window to Wall Ratio		40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%

	Maximum Skylight Roof Ratio		5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Exterior Doors[6]	Maximum U-factor	Dwelling Unit Entry	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
		Common Use Area Entry Non-Swinging	0.50	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	0.50
		Common Use Area Entry Swinging	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70

Footnote requirements to TABLE 170.2-A:

1. Install the specified R-value with an air space present between the roofing and the roof deck. Such as standard installation of concrete or clay tile.
2. R-values shown for below roof deck insulation are for wood-frame construction with insulation installed between the framing members. Alternatives including insulation above rafters or above roof deck shall comply with the performance standards.
3. Assembly U-factors for exterior framed walls can be met with cavity insulation alone or with continuous insulation alone, or with both cavity and continuous insulation that results in an assembly U-factor equal to or less than the U-factor shown. Use Reference Joint Appendices JA4 Table 4.3.1, 4.3.1(a), or Table 4.3.4 to determine alternative insulation products to be less than or equal to the required maximum U-factor.
4. Mass wall has a heat capacity greater than or equal to 7.0 Btu/h-ft^2.
5. Product must be certified to meet the North American Fenestration Standard/Specification for an Architectural Window (AW).
6. Glazed doors must meet the fenestration requirements.

(b) **Minimum Daylighting Requirement for Large Enclosed Spaces.** In Climate Zones 2 through 15, conditioned enclosed spaces, and unconditioned enclosed spaces, that are greater than 5,000 ft² and that are directly under a roof with ceiling heights greater than 15 feet, shall meet the following requirements:

1. A combined total of at least 75 percent of the floor area, as determined in building floor plan (drawings) view, shall be within one or more of the following:

   A. Primary Sidelight Daylight Zone in accordance with Section 160.5(b)4Dib, or

   B. The total floor area in the space within a horizontal distance of 0.7 times the average ceiling height from the edge of rough opening of skylights.

2. All Skylit Daylit Zones and Primary Sidelit Daylit Zones shall be shown on building plans.

3. General lighting in daylit zones shall be controlled in accordance with Section 160.5(b)4D.

4. The total skylight area is at least 3 percent of the total floor area in the space within a horizontal distance of 0.7 times the average ceiling height from the edge of rough opening of skylights; or the product of the total skylight area and the average skylight visible transmittance is no less than 1.5 percent of the total floor area in the space within a horizontal distance of 0.7 times the average ceiling height from the edge of rough opening of skylights.

5. All skylights shall have a glazing material or diffuser that has a measured haze value greater than 90 percent, tested according to ASTM D1003 (notwithstanding its scope) or another test method approved by the Commission.

EXCEPTION 1 to Section 170.2(b): In buildings with unfinished interiors, future enclosed spaces for which there are plans to have:

   A. A floor area of less than or equal to 5,000 square feet; or

   B. Ceiling heights of less than or equal to 15 feet. This exception shall not be used for S-1 or S-2 (storage), or for F-1 or F-2 (factory) occupancies.

EXCEPTION 2 to Section 170.2(b): Enclosed spaces having a designed general lighting system with a lighting power density less than 0.5 watts per square foot.

EXCEPTION 3 to Section 170.2(b): Enclosed spaces where it is documented that permanent architectural features of the building, existing structures or natural objects block direct beam sunlight on at least half of the roof over the enclosed space for more than 1500 daytime hours per year between 8 a.m. and 4 p.m.

(c) **Space Conditioning Systems**. All space heating, space cooling, and ventilation equipment shall comply with minimum Appliance Efficiency Regulations as specified in Sections 110.0 through 110.2 and the applicable requirements of Subsections 1 through 4.

1. Sizing and Equipment Selection – Common Use Areas. Mechanical heating and mechanical cooling equipment serving common use areas of multifamily buildings, shall be the smallest size, within the available options of the desired equipment line, necessary to meet the design heating and cooling loads of the building, as calculated according to Subsection 2 below.

   EXCEPTION 1 to Section 170.2(c)1: Where it can be demonstrated to the satisfaction of the enforcing agency that oversizing will not increase building TDV energy use.

   EXCEPTION 2 to Section 170.2(c)1: Standby equipment with controls that allow the standby equipment to operate only when the primary equipment is not operating.

   EXCEPTION 3 to Section 170.2(c)1: Multiple units of the same equipment type, such as multiple chillers and boilers, having combined capacities exceeding the design load, if they have controls that sequence or otherwise optimally control the operation of each unit based on load.

2. Calculations – Common Use Areas. In making equipment sizing calculations under Subsection (c)1, all of the following rules shall apply:

   A. Heating and cooling loads. Heating and cooling system design loads shall be determined in accordance with

the method in the 2017 ASHRAE Handbook, Fundamentals Volume, or as specified in a method approved by the Commission.

B. Indoor design conditions. Indoor design temperature and humidity conditions for comfort applications shall be determined using ASHRAE Standard 55 or the 2017 ASHRAE Handbook, Fundamentals Volume, except that winter humidification and summer dehumidification shall not be required.

C. Outdoor design conditions. Outdoor design conditions shall be in accordance with the design conditions from Reference Joint Appendix JA2, which is based on data from the ASHRAE Climatic Data for Region X. Heating design temperatures shall be no lower than the Heating Winter Median of Extremes values. Cooling design temperatures shall be no greater than the 0.5 percent Cooling Dry Bulb and Mean Coincident Wet Bulb values.

EXCEPTION to Section 170.2(c)1C: Cooling design temperatures for cooling towers shall be no greater than the 0.5 percent Cooling Design Wet bulb values.

D. Ventilation. Outdoor air ventilation loads shall be calculated using the ventilation rates required in Section 160.2(c)3.

E. Envelope. Envelope heating and cooling loads shall be calculated using envelope characteristics, including square footage, thermal conductance, Solar Heat Gain Coefficient or shading coefficient, and air leakage, consistent with the proposed design.

F. Lighting. Lighting heating and cooling loads shall be based on actual design lighting levels or power densities as specified in Section170.2(e)1.

G. People. Occupant density shall be based on the expected occupancy of the building and shall be the same as determined under Section 160.2(c)3A, if used. Sensible and latent heat gains shall be as listed in the 2017 ASHRAE Handbook- Fundamentals, Chapter 18.

H. Process loads. Loads caused by a process shall be based upon actual information on the intended use of the building.

I. Miscellaneous equipment. Equipment loads other than process loads shall be calculated using design data compiled from one or more of the following sources:

i. Actual information based on the intended use of the building; or

ii. Published data from manufacturer's technical publications or from technical societies, such as the ASHRAE Handbook, Applications Volume; or

iii. Other data based on the designer's experience of expected loads and occupancy patterns.

J. Internal heat gains. Internal heat gains may be ignored for heating load calculations.

K. Safety factor. Calculated design loads based on Sections 170.2(c)2A through K may be increased by up to 10 percent to account for unexpected loads or changes in space usage.

L. Other loads. Loads such as warm-up or cool-down shall be calculated from principles based on the thermal capacity of the building and its contents, the degree of setback, and desired recovery time; or may be assumed to be no more than 30 percent for heating and 10 percent for cooling of the steady-state design loads. In addition, the steady-state load may include a safety factor in accordance with Section 170.2(c)2K.

3. Dwelling Unit Space Conditioning Systems

A. Heating System Type. Space conditioning systems with direct expansion cooling serving individual dwelling units shall meet i, ii, or shall meet the performance compliance requirements of 170.1. All other system types, including multi-zone systems and systems using central boilers or chillers, shall comply with the applicable requirements of Section 170.2.

i. Multifamily Buildings three habitable stories or less. For climate zones 1 through 15, the space conditioning system shall be a heat pump. For climate zones 16, the space conditioning system shall be an air conditioner

with furnace. Additionally, for climate zones 4-10, balanced ventilation systems without heat or energy recovery required by Section 160.2(b)2Aivb1 shall have fan efficacy of 0.4 W/cfm or less.

ii. Multifamily Buildings four habitable stories or greater. For climate zones 2 through 15, the space conditioning system shall be a heat pump. For climate zones 1 and 16, the space conditioning system shall be a dual-fuel heat pump.

EXCEPTION to Section 170.2(c)3A: A supplemental heating unit may be installed in a space served directly or indirectly by a primary heating system, provided that the unit thermal capacity does not exceed 2 kW or 7,000 Btu/hr and is controlled by a time-limiting device not exceeding 30 minutes.

B. Space Heating and Space Cooling. All space heating and space cooling equipment serving dwelling units shall comply with minimum Appliance Efficiency Regulations as specified in Sections 110.0 through 110.2 and meet all applicable requirements of Sections 160.3(b) and 170.2(c)2.

i. Refrigerant Charge. When refrigerant charge verification or fault indicator display is shown as required by TABLE 170.2-K, the system shall comply with either 170.2(c), 170.2(c)3Bia or 170.2(c)170.2(c)3Bib:

a. Air-cooled air conditioners and air-source heat pumps, including but not limited to ducted split systems, ducted packaged systems, small duct high velocity systems, and mini-split systems, shall comply with subsections I, II and III, unless the system is of a type that cannot be verified using the specified procedures:

I. Have measurement access holes (MAH) installed according to the specifications in the Reference Residential Appendix Section RA3.2.2.3; and

II. System airflow rate in accordance with subsection A or B below, shall be confirmed through field verification and diagnostic testing in accordance with all applicable procedures specified in Reference Residential Appendix Section RA3. 3 or an approved alternative procedure as specified by RA1; and

A. For small duct high velocity systems, the system airflow rate shall be greater than or equal to 250 cfm per ton; or

B. For all other air-cooled air conditioner or air-source heat pump systems, the system airflow rate shall be greater than or equal to 350 cfm per ton.

III. The installer shall charge the system according to manufacturer's specifications. Refrigerant charge shall be verified according to one of the following options, as applicable:

A. The installer and rater shall perform the standard charge procedure as specified by Reference Residential Appendix Section RA3.2.2 or an approved alternative procedure as specified by RA1; or

B. The system shall be equipped with a fault indicator display (FID) device that meets the specifications of Reference Joint Appendix JA6. The installer shall verify the refrigerant charge and FID device in accordance with the procedures in Reference Residential Appendix Section RA3.4.2. The HERS Rater shall verify FID device in accordance with the procedures in Section RA3.4.2; or

C. The installer shall perform the weigh-in charging procedure as specified by Reference Residential Appendix Section RA3.2.3.1 provided the system is of a type that can be verified using the RA3.2.2 standard charge verification procedure and RA3.3 airflow rate verification procedure or approved alternatives in RA1. The HERS Rater shall verify the charge using RA3.2.2 and RA3.3 or approved alternatives in RA1.

EXCEPTION to Section 170.2(c)3Bial: Systems that cannot conform to the specifications for hole location in Reference Residential Appendix Figure RA3.2-1, shall not be required to provide holes as described in Figure RA3.2-1.

EXCEPTION to Section 170.2(c)3BiaII: Standard ducted systems without zoning dampers may comply with the minimum airflow rate by meeting the applicable requirements in TABLE 160.3-A and TABLE 160.3-B as confirmed by field verification and diagnostic testing in accordance with the procedures in Reference Residential Appendix Section RA3.1.4.4 and RA3.1.4.5. The design clean-filter pressure drop requirements of Section 160.2(b)1D for the system air filter device(s) shall conform to the requirements given in TABLE 160.3-A and TABLE 160.3-B.

EXCEPTION to Section 170.2(c)3BiaIII: When the outdoor temperature is less than 55 degrees F and the installer utilizes the weigh-in charging procedure in Reference Residential Appendix Section RA3.2.3.1 to verify the refrigerant charge, the installer may elect to utilize the HERS Rater verification procedure in Reference Residential Appendix Section RA3.2.3.2. If the HERS Rater verification procedure in Section RA3.2.3.2 is used for compliance, the system's thermostat shall conform to the specifications in Section 110.12. Ducted systems shall comply with the minimum system airflow rate requirement in Section 170.2(c)3BiaII**.**

b. For air-cooled air conditioners and air-source heat pumps, including but not limited to ducted split systems, ducted packaged systems, small duct high velocity systems and mini-split systems, which are of a type that cannot comply with the requirements of 170.2(c)3Bi:

   I. The installer shall confirm the refrigerant charge using the weigh-in charging procedure specified in Reference Residential Appendix Section RA3.2.3.1, as verified by a HERS Rater according to the procedures specified in Reference Residential Appendix Section RA3.2.3.2; and

   II. Systems that utilize forced air ducts shall comply with the minimum system airflow rate requirement in Section 170.2(c)3BiaII provided the system is of a type that can be verified using the procedures in RA3.3 or an approved alternative procedure in RA1.

EXCEPTION 1 to Section 170.2(c)3Bi: Packaged systems for which the manufacturer has verified correct system refrigerant charge prior to shipment from the factory are not required to have refrigerant charge confirmed through field verification and diagnostic testing. The installer of these packaged systems shall certify that the packaged system was pre-charged at the factory and has not been altered in a way that would affect the charge. Ducted systems shall comply with minimum system airflow rate requirement in 170.2(c)3Bib, provided that the system is of a type that can be verified using the procedure specified in RA3.3 or an approved alternative in RA1.

EXCEPTION 2 to Section 170.2(c)3Bi: The HERS Rater field verification and HERS Provider data registry requirements of Reference Residential Appendix RA2 and RA3 are not required for multifamily dwelling units in buildings four habitable stories and greater. The installer shall certify that diagnostic testing was performed in accordance with the applicable procedures.

ii. Space Conditioning Distribution Systems. All space conditioning systems shall meet all applicable requirements of a or b below:

   a. High performance attics. Air handlers or ducts are allowed to be in ventilated attic spaces when the roof and ceiling insulation level meet Option B in TABLE 170.2-K.

   b. Duct and air handlers located in conditioned space. Duct systems and air handlers of HVAC systems shall be located in conditioned space, and confirmed by field verification and diagnostic testing to meet the criterion of Reference Residential Appendix RA3.1.4.3.8.

   NOTE: Gas heating appliances installed in conditioned spaces must meet the combustion air requirements of the California Mechanical Code Chapter 7, as applicable.

iii. Central Fan Integrated Ventilation Systems. Central forced air system fans used to provide outside air, shall have an air-handling unit fan efficacy less than or equal to the maximum W/cfm specified in a or b below. The airflow rate and fan efficacy requirements in this section shall be confirmed through field verification and diagnostic testing in accordance with all applicable procedures specified in Reference Residential Appendix RA3.3. Central Fan Integrated Ventilation Systems shall be certified to the Energy Commission as Intermittent Ventilation Systems as specified in Reference Residential Appendix RA3.7.4.2.

a. 0.45 W/cfm for gas furnace air-handling units; or

b. 0.58 W/cfm for air-handling units that are not gas furnaces.

iv. ERV or HRV. When balanced ventilation is used to meet Section 160.2(b)2Aivb in Climate Zones 1, 2, and 11-16, the ventilation system shall be a heat recovery ventilator (HRV) or energy recovery ventilator (ERV) system type that meets one of the following subsections a or b as applicable.

a. An ERV or HRV serving one individual dwelling unit shall have a minimum sensible recovery efficiency of 67 percent, rated at 32 degrees F (0 degrees C), and a minimum fan efficacy of 0.6 W per cfm as confirmed through HERS field verification in accordance with the procedures in RA3.7.4.4 for buildings with three habitable stories or less, or the procedures in NA2.2.4.1.5 for buildings with four or more habitable stories.

b. Buildings with four or more habitable stories with an ERV or HRV serving multiple dwelling units shall be field verified in accordance with NA7.18.4 and confirm a minimum sensible recovery efficiency or effectiveness of 67 percent, rated at 32 degrees F (0 degrees C), fan power meeting the requirements in Section 170.2(c), and recovery bypass or free cooling control capabilities to directly economize with ventilation air based on outdoor air limits that meet the requirements in Table 170.2-G.

EXCEPTION to Section 170.2(c)3B: The HERS Rater field verification and HERS Provider data registry requirements of Reference Residential Appendix RA2 and RA3 are not required for multifamily dwelling units in buildings four habitable stories and greater. The installer shall certify that diagnostic testing was performed in accordance with the applicable procedures.

C. HVAC System Bypass Ducts. Bypass ducts that deliver conditioned supply air directly to the space conditioning system return duct airflow shall not be used.

4. Common Use Area Space Conditioning Systems. A building complies with this section by being designed with and having constructed and installed a space-conditioning system that meets the applicable requirements of Subsections A through M.

A. Fan Systems. Each fan system moving air into, out of, or between spaces or circulating air for the purpose of conditioning air within a space shall meet the requirements of Items i, ii, and iii below.

i. Fan Power Budget. For each fan system that includes at least one fan or fan array with fan electrical input power ≥ 1 kW, fan system electrical input power (Fan $kW_{design,system}$) at the airflow determined per section 170.2(c)4Aib shall not exceed Fan kW_{budget} as calculated per section 170.2(c)4Aia.

a. Calculation of Fan Power Budget (Fan kW_{budget}). For each fan system:

I. Determine the fan system airflow and choose the appropriate table(s) for fan power allowance.

A. For single-cabinet fan systems, use the fan system airflow and the power allowances in both Tables 170.2-B and Table 170.2-C.

B. For supply-only fan systems, use the fan system airflow and power allowances in Table 170.2-B.

C. For relief fan systems, use the design relief airflow and the power allowances in Table 170.2-C.

D. For exhaust, return, and transfer fan systems, use the fan system airflow and the power allowances in Table 170.2-C.

E. For complex fan systems, separately calculate the fan power allowance for the supply and return/exhaust systems and sum them. For the supply airflow, use supply airflow at the fan system design conditions, and the power allowances in Table 170.2-B. For the return/exhaust airflow, use return/exhaust airflow at the fan system design conditions, and the power allowances in Table 170.2-C.

II. For each fan system determine the components included in the fan system and sum the Fan Power Allowances of those components. All fan systems shall include the System Base Allowance. If, for a

given component, only a portion of the fan system airflow passes through the component, calculate the Fan Power Allowance for that component per this equation:

$$FPA_{adj} = \frac{Q_{comp}}{Q_{sys}} X\ FPA_{comp}$$

Where:

FPA_{adj} = The correct/ed fan power allowance for the component in w/cfm

Q_{comp} = The airflow through component in cfm

Q_{sys} = The fan system airflow in cfm

FPA_{comp} = The fan power allowance of the component from Table 170.2-B or Table 170.2-C

III. Multiply the fan system airflow by the sum of the fan power allowances for the fan system.

IV. Divide by 1000 to convert to Fan kW_{budget}.

V. For building sites at elevations greater than 3,000 feet, multiply Fan kW_{budget} by Correction Factor in Table 170.2-D.

b. Determining Fan System Electrical Input Power (Fan $kW_{design,system}$). Fan $kW_{design,system}$ is the sum of Fan kW_{design} for each fan or fan array included in the fan system with Fan $kW_{design} \geq 1$ kW. If variable speed drives are used their efficiency losses shall be included. Fan input power shall be calculated with mid-life filter pressure drop, which is the mean of the clean filter pressure drop and design final filter pressure drop. The Fan kW_{design} for each fan or fan array shall be determined using one of the following methods. There is no requirement to use the same method for all fans in a fan system:

I. Use the default Fan kW_{design} in Table 170.2-E for one or more of the fans. This method cannot be used for complex fan systems.

II. Use the Fan kW_{design} at fan system design conditions provided by the manufacturer of the fan, fan array, or equipment that includes the fan or fan array calculated per a test procedure included in USDOE 10 CFR Part 430, USDOE 10 CFR Part 431, ANSI/AMCA Standard 208-2018, ANSI/AMCA Standard 210-2016, AHRI Standard 430-2020, AHRI Standard 440-2019, or ISO 5801-2017.

III. Use the Fan kW_{design} provided by the manufacturer, calculated at fan system design conditions per one of the methods listed in section 5.3 of ANSI/AMCA 208-2018.

IV. Determine the Fan kW_{design} by using the maximum electrical input power provided on the motor nameplate.

ii. Variable air volume (VAV) systems.

a. Static Pressure Sensor Location. Static pressure sensors used to control variable air volume fans shall be placed in a position such that the controller set point is no greater than one-third the total design fan static pressure, except for systems with zone reset control complying with Section 170.2(c)4Aiib. If this results in the sensor being located downstream of any major duct split, multiple sensors shall be installed in each major branch with fan capacity controlled to satisfy the sensor furthest below its setpoint; and

b. Setpoint Reset. For systems with direct digital control of individual zone boxes reporting to the central control panel, static pressure setpoints shall be reset based on the zone requiring the most pressure; i.e., the set point is reset lower until one zone damper is nearly wide open.

iii. Fractional HVAC Motors for Fans. HVAC motors for fans that are less than1 hp and 1/12 hp or greater shall be electronically-commutated motors or shall have a minimum motor efficiency of 70 percent when rated in accordance with NEMA Standard MG 1-2006 at full load rating conditions. These motors shall also have the

means to adjust motor speed for either balancing or remote control. Belt-driven fans may use sheave adjustments for airflow balancing in lieu of a varying motor speed.

EXCEPTION 1 to Section 170.2(c)4Aiii: Motors in fan-coils and terminal units that operate only when providing heating to the space served.

EXCEPTION 2 to Section 170.2(c)4Aiii: Motors in space conditioning equipment certified under Section 110.1 or 110.2

EXCEPTION 1 to 170.2(c)4A: fan system power caused solely by process loads.

TABLE 170.2-B: Supply Fan Power Allowances (watts/cfm)

	Multi-Zone VAV Systems >10,000 cfm	Multi-Zone VAV Systems >5,000 and ≤10,000 cfm	Multi-Zone VAV Systems ≤5,000 cfm	All Other Fan Systems >10,000 cfm	All Other Fan Systems >5,000 and ≤10,000 cfm	All Other Fan Systems ≤5,000 cfm
Supply System Base Allowance for AHU Serving Spaces < 6 Floors Away.	0.413	0.453	0.395	0.236	0.256	0.232
Supply System Base Allowance for AHU Serving Spaces > 6 Floors Away	0.501	0.548	0.508	0.325	0.356	0.349
MERV 13 to MERV 16 Filter Upstream of Thermal Conditioning Equipment (mid-life)[2]	0.105	0.114	0.136	0.107	0.120	0.139
MERV 13 to MERV 16 Final Filter Downstream of Thermal Conditioning Equipment. (mid-life) [2]	0.176	0.188	0.225	0.177	0.197	0.231
Filtration Allowance for > Merv 16 or HEPA Filter (mid-life) [2]	0.265	0.280	0.335	0.264	0.292	0.342
Central Hydronic Heating Coil Allowance	0.052	0.048	0.046	0.054	0.050	0.046
Electric Heat Allowance	0.035	0.038	0.046	0.036	0.040	0.046
Gas Heat Allowance	0.070	0.057	0.069	0.072	0.060	0.058
Hydronic/DX Cooling Coil, or Heat Pump Coil (wet) Allowance	0.105	0.114	0.135	0.107	0.120	0.139
Solid or Liquid Desiccant System Allowance	0.123	0.132	0.157	0.124	0.139	0.163
Reheat Coil for Dehumidification Allowance	0.035	0.038	0.045	0.036	0.040	0.046
Allowance for evaporative humidifier/cooler in series with a cooling coil. Value shown is allowed watts/cfm per 1.0 in. wg. Determine pressure loss (in. wg) at 400 fpm or maximum velocity allowed by the manufacturer, whichever is less. *[Calculation required, see note 4]*	0.176	0.188	0.224	0.177	0.197	0.231
Allowance for 100% outdoor air system meeting the requirements of Note 5.	0.000	0.000	0.000	0.107	0.100	0.070

TABLE 170.2-B (continued)

Energy Recovery Allowance for 0.50 ≤ ERR <0.55[6]	0.105	0.114	0.135	0.107	0.120	0.139
Energy Recovery Allowance for 0.55 ≤ ERR <0.60[6]	0.124	0.134	0.160	0.126	0.141	0.165
Energy Recovery Allowance for 0.60 ≤ ERR <0.65[6]	0.144	0.155	0.184	0.146	0.163	0.190
Energy Recovery Allowance for 0.65 ≤ ERR <0.70[6]	0.163	0.175	0.208	0.165	0.184	0.215
Energy Recovery Allowance for 0.70 ≤ ERR <0.75[6]	0.183	0.196	0.232	0.184	0.205	0.240
Energy Recovery Allowance for 0.75 ≤ ERR <0.80[6]	0.202	0.216	0.257	0.203	0.226	0.264
Energy Recovery Allowance for ERR ≥ 0.80[6]	0.222	0.236	0.281	0.222	0.247	0.289
Allowance for Sensible-Only Recovery	0.105	0.114	0.135	0.107	0.120	0.139
Allowance for gas phase filtration required by code or accredited standard. Value shown is allowed w/cfm per 1.0 in. wg air pressure drop. *[Calculation required, see note 4]*	0.176	0.188	0.224	0.177	0.197	0.231
Air Blender Allowance	0.035	0.038	0.045	0.036	0.040	0.046
Allowance for sound attenuation section [fans serving spaces with design background noise goals below NC35].	0.026	0.029	0.034	0.027	0.030	0.035
Deduction for systems that feed a terminal unit with a fan with electrical input power < 1kW.	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100

1. See FAN SYSTEM, MULTI-ZONE VARIABLE AIR VOLUME (VAV) in definition a Multi-Zone VAV System.

2. Filter fan power allowance can only be counted once per fan system.

3. RESERVED.

4. Power allowance requires further calculation by multiplying the actual in. wg. of the device/ component by the watts/ cfm in Table 170.2-B.

5. The 100% outdoor air system must serve 3 or more HVAC zones and airflow during non-economizer operating periods must not exceed 135% of minimum requirements in Section 120.1(c)(3).

6. Energy Recovery Ratio (ERR) calculated per ANSI/ASHRAE 84-2020.

TABLE 170.2-C: EXHAUST, RETURN, RELIEF, TRANSFER FAN POWER ALLOWANCES (CFM/ WATT)

	Multi-Zone VAV Systems >10,000 cfm[1]	Multi-Zone VAV Systems >5,000 and ≤10,000 cfm[1]	Multi-Zone VAV Systems ≤5,000 cfm[1]	All Other Fan Systems >10,000 cfm	All Other Fan Systems >5,000 and ≤10,000 cfm	All Other Fan Systems ≤5,000 cfm
Exhaust System Base Allowance	0.236	0.246	0.221	0.190	0.184	0.186
Filter (any MERV value)[2]	0.036	0.041	0.046	0.035	0.041	0.046
Energy Recovery Allowance for 0.50 ≤ ERR <0.55 [3]	0.107	0.120	0.139	0.109	0.123	0.139
Energy Recovery Allowance for 0.55 ≤ ERR <0.60 [3]	0.126	0.142	0.165	0.128	0.144	0.165
Energy Recovery Allowance for 0.60 ≤ ERR <0.65 [3]	0.146	0.163	0.190	0.148	0.166	0.191
Energy Recovery Allowance for 0.65 ≤ ERR <0.70 [3]	0.165	0.184	0.215	0.167	0.188	0.216
Energy Recovery Allowance for 0.70 ≤ ERR <0.75 [3]	0.184	0.206	0.240	0.186	0.209	0.241
Energy Recovery Allowance for 0.75 ≤ ERR <0.80 [3]	0.203	0.227	0.265	0.205	0.231	0.266
Energy Recovery Allowance for ERR ≥ 0.80 [3]	0.222	0.248	0.289	0.225	0.252	0.291
Allowance for Sensible-Only Recovery	0.107	0.120	0.139	0.109	0.123	0.139

TABLE 170.2-C (CONTINUED)

Economizer return damper	0.036	0.041	0.046	0.037	0.041	0.046
Return or exhaust systems required by code or accreditation standards to be fully ducted, or systems required to maintain air pressure differentials between adjacent rooms	0.089	0.100	0.116	0.091	0.102	0.116
Return and/or exhaust airflow control devices	0.089	0.100	0.116	0.091	0.102	0.116
Laboratory and vivarium exhaust systems in high-rise buildings for vertical duct exceeding 75 ft. Value shown is allowed w/cfm per 0.25 in. wg for each 100 feet exceeding 75 feet. [Calculation required, see note 4]	0.045	0.051	0.058	0.046	0.052	0.058
Biosafety cabinet. Value shown is allowed w/cfm per 1.0 in. wg air pressure drop. [Calculation required, see note 4]	0.177	0.198	0.231	0.179	0.202	0.232
Exhaust filters, scrubbers, or other exhaust treatment required by code or standard. Value shown is allowed w/cfm per 1.0 in. wg air pressure drop. [Calculation required, see note 4]	0.177	0.198	0.231	0.179	0.202	0.232
Sound attenuation section [Fans serving spaces with design background noise goals below NC35.]	0.027	0.030	0.035	0.028	0.031	0.035
1. For requirements to be classified as a Multi-Zone VAV System see definition for Multi-Zone Variable Air Volume Fan System.						
2. Filter pressure loss can only be counted once per fan system.						
3. Energy Recovery Ratio (ERR) calculated per ANSI/ASHRAE 84-2020.						
4. Power allowance requires further calculation, multiplying the actual pressure drop (in. wg.) of the device/ component by the watts/cfm in the Table 170.2-C.						

TABLE 170.2-D AIR DENSITY CORRECTION FACTORS

Altitude (ft)	*Correction factor*
<3,000	*1.000*
2:3,000 and <4,000	*0.896*
2:4,000 and <5,000	*0.864*
2:5,000 and <6,000	*0.832*
2:6,000	*0.801*

*TABLE **170.2-E: Default values for Fan kW_{design} Based on Motor Nameplate HP***

Motor Nameplate HP	Default Fan kW_{design} with variable speed drive (Fan kW_{design})	Default Fan kW_{design} without variable speed drive (Fan kW_{design})
≤1	0.96	0.89
≥1 and <1.5	1.38	1.29
≥1.5 and <2	1.84	1.72
≥2 and <3	2.73	2.57
≥3 and <5	4.38	4.17
≥5 and <7.5	6.43	6.15
≥7.5 and <10	8.46	8.13
≥10 and <15	12.47	12.03
≥15 and <20	16.55	16.04
≥20 and <25	20.58	19.92
≥25 and <30	24.59	23.77
≥30 and <40	32.74	31.70
≥40 and <50	40.71	39.46
≥50 and <60	48.50	47.10
≥60 and <75	60.45	58.87
≥75 and ≤100	80.40	78.17
1. This table cannot be used for Motor Nameplate Horsepower values greater than 100.		
2. This table is to be used only with motors with a service factor ≤1.15. If the service factor is not provided, this table may not be used.		

B. Space-conditioning Zone Controls. Each space-conditioning zone shall have controls designed in accordance with i or ii:

i. Each space-conditioning zone shall have controls that prevent:

a. Reheating; and

b. Recooling; and

c. Simultaneous provisions of heating and cooling to the same zone, such as mixing or simultaneous supply of air that has been previously mechanically heated and air that has been previously cooled either by cooling equipment or by economizer systems; or

ii. Zones served by variable air-volume systems that are designed and controlled to reduce, to a minimum, the volume of reheated, recooled, or mixed air are allowed only if the controls meet all of the following requirements:

a. For each zone with direct digital controls (DDC), the volume of primary air that is reheated, recooled or mixed air supply shall not exceed the larger of:

I. 50 percent of the peak primary airflow; or

II. The design zone outdoor airflow rate as specified by Section 160.2(c)3.

b. The volume of primary air in the deadband shall not exceed the design zone outdoor airflow rate as specified by Section 160.2(c)3.

c. The first stage of heating consists of modulating the zone supply air temperature setpoint up to a maximum setpoint no higher than 95ºF while the airflow is maintained at the dead band flow rate.

d. The second stage of heating consists of modulating the airflow rate from the dead band flow rate up to the heating maximum flow rate.

e. For each zone without DDC, the volume of primary air that is reheated, re-cooled, or mixed air supply shall not exceed the larger of the following:

I. 30 percent of the peak primary airflow; or

II. The design zone outdoor airflow rate as specified by Section 160.2(c)3.

EXCEPTION 1 to Section 170.2(c)4B: Zones with special pressurization relationships or cross-contamination control needs.

EXCEPTION 2 to Section 170.2(c)4B: Zones served by space-conditioning systems in which at least 75 percent of the energy for reheating, or providing warm air in mixing systems, is provided from a site-recovered or site-solar energy source.

EXCEPTION 3 to Section 170.2(c)4B: Zones in which specific humidity levels are required to satisfy exempt process loads. Computer rooms or other spaces where the only process load is from IT equipment may not use this exception.

EXCEPTION 4 to Section 170.2(c)4B: Zones with a peak supply-air quantity of 300 cfm or less.

C. Economizers.

i. Each cooling air handler that has a design total mechanical cooling capacity over 33,000 Btu/hr, or chilled-water cooling systems without a fan or that use induced airflow that has a cooling capacity greater than the systems listed in TABLE 170.2-E, shall include either:

a. An air economizer capable of modulating outside-air and return-air dampers to supply 100 percent of the design supply air quantity as outside-air; or

b. A water economizer capable of providing 100 percent of the expected system cooling load, at outside air temperatures of 50°F dry-bulb and 45°F wet-bulb and below.

EXCEPTION 1 to Section 170.2(c)4Ci: Where special outside air filtration and treatment, for the reduction and treatment of unusual outdoor contaminants, makes compliance infeasible.

EXCEPTION 2 to Section 170.2(c)4Ci: Where the use of outdoor air for cooling will affect other systems, such as humidification or dehumidification, so as to increase overall building TDV energy use.

EXCEPTION 3 to Section 170.2(c)4Ci: Systems serving dwelling units.

EXCEPTION 4 to Section 170.2(c)4Ci: Where comfort cooling systems have the cooling efficiency that meets or exceeds the cooling efficiency improvement requirements in TABLE 170.2-F.

EXCEPTION 5 to Section 170.2(c)4Ci: Fan systems primarily serving computer rooms. See Section 140.9(a) for computer room economizer requirements.

TABLE 170.2-E CHILLED WATER SYSTEM COOLING CAPACITY

Climate Zones	Total Building Chilled Water System Capacity, Minus Capacity of the Cooling units with Air Economizers	
	Building Water-Cooled Chilled Water System	Air-Cooled Chilled Water Systems or District Chilled Water Systems
15	≥ 960,000 Btu/h (280 kW)	≥ 1,250,000 Btu/h (365 kW)
1-14	≥720,000 Btu/h (210 kW)	≥940,000 Btu/h (275 kW)
16	≥1,320,000 Btu/h (385 kW)	≥1,720,000 Bu/h (505 kW)

TABLE 170.2-F ECONOMIZER TRADE-OFF TABLE FOR COOLING SYSTEMS

Climate Zone	Efficiency Improvement [a]	
1	70%	[a] If a unit is rated with an annualized or part-load metric, then to eliminate the required economizer, only the annualized or part-load minimum cooling efficiency of the unit must be increased by the percentage shown. If the unit is only rated with a full load metric, like EER or COP cooling, then that metric must be increased by the percentage shown. To determine the efficiency required to eliminate economizer, when the unit *equipment efficiency* is rated with an energy-input divided by work-output metric, the metric shall first be converted to COP prior to multiplying by the *efficiency* improvement percentage and then converted back to the rated metric.
2	65%	
3	65%	
4	65%	
5	70%	
6	30%	
7	30%	
8	30%	
9	30%	
10	30%	
11	30%	
12	30%	
13	30%	
14	30%	
15	30%	
16	70%	

ii. If an economizer is required by Section 170.2(c)4Ci, and an air economizer is used to meet the requirement, then it shall be:

a. Designed and equipped with controls so that economizer operation does not increase the building heating energy use during normal operation; and

EXCEPTION to Section 170.2(c)4Ciia: Systems that provide 75 percent of the annual energy used for mechanical heating from site-recovered energy or a site-solar energy source.

b. Capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load.

c. Designed and equipped with a device type and high limit shut off complying with TABLE 170.2-G.

TABLE 170.2-G AIR ECONOMIZER HIGH LIMIT SHUT OFF CONTROL REQUIREMENTS

Device Type[a]	Climate Zones	Required High Limit (Economizer Off When):	
		Equation[b]	Description
Fixed Dry Bulb	1, 3, 5, 11-16	T_{OA} > 75°F	Outdoor air temperature exceeds 75°F
	2, 4, 10	T_{OA} > 73°F	Outdoor air temperature exceeds 73°F
	6, 8, 9	T_{OA} > 71°F	Outdoor air temperature exceeds 71°F
	7	T_{OA} > 69°F	Outdoor air temperature exceeds 69°F
Differential Dry Bulb	1, 3, 5, 11-16	T_{OA} > T_{RA}°F	Outdoor air temperature exceeds return air temperature
	2, 4, 10	T_{OA} > T_{RA}-2°F	Outdoor air temperature exceeds return air temperature minus 2°F
	6, 8, 9	T_{OA} > T_{RA}-4°F	Outdoor air temperature exceeds return air temperature minus 4°F
	7	T_{OA} > T_{RA}-6°F	Outdoor air temperature exceeds return air temperature minus 6°F
Fixed Enthalpy[c] + Fixed Drybulb	All	h_{OA} > 28 Btu/lb[c] or T_{OA} > 75°F	Outdoor air enthalpy exceeds 28 Btu/lb of dry air[c] or Outdoor air temperature exceeds 75°F

[a] Only the high limit control devices listed are allowed to be used and at the setpoints listed. Others such as Dew Point, Fixed Enthalpy, Electronic Enthalpy, and Differential Enthalpy Controls, may not be used in any Climate Zone for compliance with Section 170.2(c)4Ci unless approval for use is provided by the Energy Commission Executive Director.

[b] Devices with selectable (rather than adjustable) setpoints shall be capable of being set to within 2°F and 2 Btu/lb of the setpoint listed.

[c] At altitudes substantially different than sea level, the Fixed Enthalpy limit value shall be set to the enthalpy value at 75°F and 50% relative humidity. As an example, at approximately 6,000 foot elevation, the fixed enthalpy limit is approximately 30.7 Btu/lb.

iii. The air economizer and all air dampers shall have the following features:

a. Warranty. 5-year Manufacturer warranty of economizer assembly.

b. Damper reliability testing. Suppliers of economizers shall certify that the economizer assembly, including but not limited to outdoor air damper, return air damper, drive linkage, and actuator, have been tested and are able to open and close against the rated airflow and pressure of the system for 60,000 damper opening and closing cycles.

c. Damper leakage. Economizer outdoor air and return air dampers shall have a maximum leakage rate of 10 cfm/sf at 250 Pascals (1.0 in. of water) when tested in accordance with AMCA Standard 500-D. The economizer outside air and return air damper leakage rates shall be certified to the Energy Commission in accordance with Section 110.0.

d. Adjustable setpoint. If the high-limit control is fixed dry-bulb or fixed enthalpy + fixed dry-bulb then the control shall have an adjustable setpoint.

e. Sensor accuracy. Outdoor air, return air, mixed air, and supply air sensors shall be calibrated within the following accuracies.

I. Drybulb and wetbulb temperatures accurate to ±2°F over the range of 40°F to 80°F;

II. Enthalpy accurate to ±3 Btu/lb over the range of 20 Btu/lb to 36 Btu/lb;

III. Relative humidity (RH) accurate to ±5 percent over the range of 20 percent to 80 percent RH;

f. Sensor calibration data. Data used for control of the economizer shall be plotted on a sensor performance curve.

g. Sensor high limit control. Sensors used for the high limit control shall be located to prevent false readings, including but not limited to being properly shielded from direct sunlight.

h. Relief air system. Relief air systems shall be capable of providing 100 percent outside air without over-pressurizing the building.

iv. The space conditioning system shall include the following:

a. Unit controls shall have mechanical capacity controls interlocked with economizer controls such that the economizer is at 100 percent open position when mechanical cooling is on and does not begin to close until the leaving air temperature is less than 45°F.

b. Direct Expansion (DX) units greater than 65,000 Btu/hr that control the capacity of the mechanical cooling directly based on occupied space temperature shall have a minimum of 2 stages of mechanical cooling capacity.

c. DX units not within the scope of Section 170.2(c)4Ciib shall (i) comply with the requirements in TABLE 170.2-H, and (ii) shall have controls that do not false load the mechanical cooling system by limiting or disabling the economizer or by any other means except at the lowest stage of mechanical cooling capacity.

TABLE 170.2-H DIRECT EXPANSION (DX) UNIT REQUIREMENTS FOR COOLING STAGES AND COMPRESSOR DISPLACEMENT

Cooling Capacity	Minimum Number of Mechanical Cooling Stages	Minimum Compressor Displacement
≥ 65,000 Btu/h and < 240,000 Btu/h	3 stages	≤ 35% full load
≥ 240,000 Btu/h	4 stages	≤ 25% full load

v. Systems that include a water economizer to meet Section 170.2(c)4Ci shall include the following:

a. Maximum pressure drop. Precooling coils and water-to-water heat exchangers used as part of a water economizer shall either have a waterside pressure drop of less than 15 feet of water, or a secondary loop shall be installed so that the coil or heat exchanger pressure drop is not contributing to pressure drop when the system is in the normal cooling (non-economizer) mode.

b. Economizer systems shall be integrated with the mechanical cooling system so that they are capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load. Controls shall not false load the mechanical cooling system by limiting or disabling the economizer or by any other means, such as hot gas bypass, except at the lowest stage of mechanical cooling.

D. Supply Air Temperature Reset Controls. Space-conditioning systems supplying heated or cooled air to multiple zones shall include controls that automatically reset supply-air temperatures. Air distribution systems serving zones that are likely to have constant loads shall be designed for the air flows resulting from the fully reset supply air temperature. Supply air temperature reset controls shall be:

i. In response to representative building loads or to outdoor air temperature; and

ii. At least 25 percent of the difference between the design supply-air temperature and the design room air temperature.

EXCEPTION 1 to Section 170.2(c)4D: Systems that meet the requirements of Section 170.2(c)3Bi, without using Exception 1 to that section.

EXCEPTION 2 to Section 170.2(c)4D: Where supply-air temperature reset would increase overall building energy use.

EXCEPTION 3 to Section 170.2(c)4D: Systems supplying zones in which specific humidity levels are required to satisfy process loads. Computer Rooms or other spaces with only IT equipment may not use this exception.

E. Electric Resistance Heating. Electric resistance heating systems shall not be used for space heating.

EXCEPTION 1 to Section 170.2(c)4E: Where an electric-resistance heating system supplements a heating system in which at least 60 percent of the annual energy requirement is supplied by site-solar or recovered energy.

EXCEPTION 2 to Section 170.2(c)4E: Where an electric-resistance heating system supplements a heat pump heating system, and the heating capacity of the heat pump is more than 75 percent of the design heating load calculated in accordance with Section 170.2(c)1 at the design outdoor temperature specified in Section 170.2(c)2.

EXCEPTION 3 to Section 170.2(c)4E: Where the total capacity of all electric-resistance heating systems serving the entire building is less than 10 percent of the total design output capacity of all heating equipment serving the entire building.

EXCEPTION 4 to Section 170.2(c)4E: Where the total capacity of all electric-resistance heating systems serving the entire building, excluding those allowed under Exception 2, is no more than 3 kW.

EXCEPTION 5 to Section 170.2(c)4E: heating systems serving as emergency backup to gas heating equipment.

F. Heat Rejection Systems. Heat rejection equipment used in comfort cooling systems such as air-cooled condensers, open cooling towers, closed-circuit cooling towers, and evaporative condensers shall include the following:

i. Fan Speed Control. Each fan powered by a motor of 7.5 hp (5.6 kW) or larger shall have the capability to operate that fan at 2/3 of full speed or less, and shall have controls that automatically change the fan speed to control the leaving fluid temperature or condensing temperature or pressure of the heat rejection device.

EXCEPTION 1 to Section 170.2(c)4Fi: Heat rejection devices included as an integral part of the equipment listed in TABLE 110.2-A through TABLE 110.2-I.

EXCEPTION 2 to Section 170.2(c)4Fi: Condenser fans serving multiple refrigerant circuits.

EXCEPTION 3 to Section 170.2(c)4Fi: Condenser fans serving flooded condensers.

EXCEPTION 4 to Section 170.2(c)4Fi: Up to one third of the fans on a condenser or tower with multiple fans where the lead fans comply with the speed control requirement.

ii. Tower Flow Turndown. Open cooling towers configured with multiple condenser water pumps shall be designed so that all cells can be run in parallel with the larger of:

a. The flow that is produced by the smallest pump; or

b. 50 percent of the design flow for the cell.

iii. Limitation on Centrifugal Fan Cooling Towers. Open cooling towers with a combined rated capacity of 900 gpm and greater at 95°F condenser water return, 85°F condenser water supply, and 75°F outdoor wet-bulb temperature, shall use propeller fans and shall not use centrifugal fans.

EXCEPTION 1 to Section 170.2(c)4Fiii: Cooling towers that are ducted (inlet or discharge) or have an external sound trap that requires external static pressure capability.

EXCEPTION 2 to Section 170.2(c)4Fiii: Cooling towers that meet the energy efficiency requirement for propeller fan towers in Section 110.2, TABLE 110.2-G.

iv. Multiple Cell Heat Rejection Equipment. Multiple cell heat rejection equipment with variable speed fan drives shall:

a. Operate the maximum number of fans allowed that comply with the manufacturer's requirements for all system components, and

b. Control all operating fans to the same speed. Minimum fan speed shall comply with the minimum allowable speed of the fan drive as specified by the manufacture's recommendation. Staging of fans is allowed once the fans are at their minimum operating speed.

v. Cooling tower efficiency. Axial fan, open-circuit cooling towers serving condenser water loops for chilled water plants with a total of 900 gpm or greater, shall have a rated efficiency of no less than 60 gpm/hp when rated in accordance with the conditions as listed in Table 110.2-G.

EXCEPTION 1 to Section 170.2(c)4Fv: Replacement of existing cooling towers that are inside an existing building or on an existing roof.

EXCEPTION 2 to Section 170.2(c)4Fv: Cooling towers serving buildings in Climate Zone 1 or 16.

G. Minimum Chiller Efficiency. Chillers shall meet or exceed Path B from TABLE 110.2-D

EXCEPTION 1 to Section 170.2(c)4G**:** Chillers with electrical service > 600V.

EXCEPTION 2 to Section 170.2(c)4G: Chillers attached to a heat recovery system with a design heat recovery capacity > 40 percent of the design chiller cooling capacity.

EXCEPTION 3 to Section 170.2(c)4G: Chillers used to charge thermal energy storage systems where the charging temperature is < 40 °F.

EXCEPTION 4 to Section 170.2(c)4G: In buildings with more than 3 chillers, only 3 chillers are required to meet the Path B efficiencies

H. Limitation of Air-Cooled Chillers. Chilled water plants shall not have more than 300 tons provided by air-cooled chillers.

EXCEPTION 1 to Section 170.2(c)4H: Where the water quality at the building site fails to meet manufacturer's specifications for the use of water-cooled chillers.

EXCEPTION 2 to Section 170.2(c)4H: Chillers that are used to charge a thermal energy storage system with a design temperature of less than 40 degrees F (4 degrees C).

I. Hydronic System Measures.

i. Hydronic Variable Flow Systems. HVAC chilled and hot water pumping shall be designed for variable fluid flow and shall be capable of reducing pump flow rates to no more than the larger of: a) 50 percent or less of the design flow rate; or b) the minimum flow required by the equipment manufacturer for the proper operation of equipment served by the system.

EXCEPTION 1 to Section 170.2(c)4I: Systems that include no more than three control valves.

EXCEPTION 2 to Section 170.2(c)4I: Systems having a total pump system power less than or equal to 1.5 hp.

ii. Chiller Isolation. When a chilled water system includes more than one chiller, provisions shall be made so that flow through any chiller is automatically shut off when that chiller is shut off while still maintaining flow through other operating chiller(s). Chillers that are piped in series for the purpose of increased temperature differential shall be considered as one chiller.

iii. Boiler Isolation. When a hot water plant includes more than one boiler, provisions shall be made so that flow through any boiler is automatically shut off when that boiler is shut off while still maintaining flow through other operating boiler(s).

iv. Chilled and Hot Water Temperature Reset Controls. Systems with a design capacity exceeding 500,000 Btu/hr supplying chilled or heated water shall include controls that automatically reset supply water temperatures as a function of representative building loads or outside air temperature.

EXCEPTION to Section 170.2(c)4Iiv: Hydronic systems that use variable flow to reduce pumping energy in accordance with Section 170.2(c)4Ii.

v. Water-Cooled Air Conditioner and Hydronic Heat Pump Systems. Water circulation systems serving water-cooled air conditioners, hydronic heat pumps, or both, that have total pump system power exceeding 5 hp shall have flow controls that meet the requirements of Section 170.2(c)4Ivi. Each such air conditioner or heat pump shall have a two-position automatic valve interlocked to shut off water flow when the compressor is off.

vi. Variable Flow Controls.

a. Variable Speed Drives. Individual pumps serving variable flow systems and having a motor horsepower exceeding 5 hp shall have controls or devices (such as variable speed control) that will result in pump motor demand of no more than 30 percent of design wattage at 50 percent of design water flow. The pumps shall be controlled as a function of required differential pressure.

b. Pressure Sensor Location and Setpoint.

c. For systems without direct digital control of individual coils reporting to the central control panel, differential pressure shall be measured at the most remote heat exchanger or the heat exchanger requiring the greatest differential pressure.

d. For systems with direct digital control of individual coils with a central control panel, the static pressure set point shall be reset based on the valve requiring the most pressure, and the setpoint shall be no less than 80 percent open. Pressure sensors may be mounted anywhere.

EXCEPTION 1 to Section 170.2(c)4Ivi: Heating hot water systems.

EXCEPTION 2 to Section 170.2(c)4Ivi: Condenser water systems serving only water-cooled chillers.

vii. Hydronic Heat Pump (WLHP) Controls. Hydronic heat pumps connected to a common heat pump water loop with central devices for heat rejection and heat addition shall have controls that are capable of providing a heat pump water supply temperature deadband of at least 20°F between initiation of heat rejection and heat addition by the central devices.

EXCEPTION to Section 170.2(c)4Ivii: Where a system loop temperature optimization controller is used to determine the most efficient operating temperature based on real-time conditions of demand and capacity, dead bands of less than 20°F shall be allowed**.**

J. RESERVED

K. Fan Control. Each cooling system listed in TABLE 170.2-H shall be designed to vary the indoor fan airflow as a function of load and shall comply with the following requirements:

i. DX and chilled water cooling systems that control the capacity of the mechanical cooling directly based on occupied space temperature shall (i) have a minimum of 2 stages of fan control with no more than 66 percent speed when operating on stage 1; and (ii) draw no more than 40 percent of the fan power at full fan speed, when operating at 66 percent speed.

ii. All other systems, including but not limited to DX cooling systems and chilled water systems that control the space temperature by modulating the airflow to the space, shall have proportional fan control such that at 50 percent air flow the power draw is no more than 30 percent of the fan power at full fan speed.

iii. Systems that include an air side economizer to meet 170.2(c)4Ci shall have a minimum of two speeds of fan control during economizer operation.

EXCEPTION to Section 170.2(c)4K: Modulating fan control is not required for chilled water systems with all fan motors <1 HP, or for evaporative systems with all fan motors < 1 HP, if the systems are not used to provide ventilation air and all indoor fans cycle with the load.

L. Mechanical System Shut-off. Any directly conditioned common use area space with operable wall or roof openings to the outdoors shall be provided with interlock controls that disable or reset the temperature setpoint to 55°F for mechanical heating and disable or reset the temperature setpoint to 90°F for mechanical cooling to that space when any such opening is open for more than 5 minutes.

EXCEPTION 1 to Section 170.2(c)4L: Interlocks are not required on doors with automatic closing devices**.**

EXCEPTION 2 to Section 170.2(c)4L: Any space without a thermostatic control (thermostat or a space temperature sensor used to control heating or cooling to the space).

M. Exhaust System Transfer Air. Conditioned supply air delivered to any space with mechanical exhaust shall not exceed the greater of:

i. The supply flow required to meet the space heating or cooling load; or

ii. The ventilation rate required by the authority having jurisdiction, the facility Environmental Health and Safety Department, or by Section 160.2(c)3; or

iii. The mechanical exhaust flow minus the available transfer air. Available transfer air shall be from another conditioned space or return air plenums on the same floor and same smoke or fire compartment, and that at their closest point are within 15 feet of each other.

EXCEPTION 1 to Section 170.2(c)4M: Spaces that are required by applicable codes and standards to be maintained at a positive pressure differential relative to adjacent spaces.

EXCEPTION 2 to Section 170.2(c)4M: Spaces where the highest amount of transfer air that could be used for exhaust makeup may exceed the available transfer airflow rate and where the spaces have a required negative pressure relationship.

N. Dedicated Outdoor Air Systems (DOAS). HVAC Systems utilizing a dedicated outdoor air system (DOAS) to condition, temper, or filter 100 percent outdoor air separate from local or central space-conditioning systems serving the same space shall meet the following criteria:

i. Provide each space with one of the following configurations:

a. A DOAS unit and a separate independent space-conditioning system in which the independent space-conditioning system complies with the economizer requirements specified by Section 170.2(c)4Ci and the DOAS unit complies with the exhaust air heat recovery requirements specified in Section 170.2(c)4N.

b. A DOAS unit which meets or exceeds the following criteria and a separate space cooling system:

I. Provides at least the minimum ventilation air flow rate as specified in Section 120.1(c)3 and provides no less than 0.3cfm/ft^2 during economizer operation.

II. Ventilation sensible energy recovery ratio of at least 60 percent or enthalpy recovery ratio of at least 50 percent at full flow cooling design conditions and heating design condition.

III. Energy recovery bypass or control to directly economize with ventilation air based on outdoor air temperature limits specified in TABLE 170.2-G.

c. DOAS units with airflow rate > 1,000 cfm must meet demand ventilation control requirements in accordance with Sections 160.2(c)5C, D, and E**.**

EXCEPTION to Section 170.2(c)4Ni: Systems installed for the sole purpose of providing makeup air for exhausting toxic fumes, flammable materials, paint, corrosive fumes, dust, dryer exhaust, or commercial kitchen hoods used for collecting and removing grease vapors and smoke.

ii. Ventilation fan systems shall be capable of modulating fan speed control.

iii. Heating and cooling equipment fans, heating and cooling circulation pumps, and terminal unit fans shall cycle off, and terminal unit primary cooling air shall be shut off when there is no call for heating or cooling in the zone.

EXCEPTION to Section 170.2(c)4Niii: Fans used for heating and cooling using less than 0.12 watts per cfm may operate when space temperatures are within the thermostat deadband to provide destratification and air mixing in the space.

iv. The DOAS supply air shall be delivered directly to the occupied space or downstream of the terminal heating/or cooling coils.

EXCEPTION 1 to Section 170.2(c)4Niv: Active chilled beam systems.

EXCEPTION 2 to Section 170.2(c)4Niv: Sensible only cooling terminal units with pressure-independent variable-airflow regulating devices limiting the DOAS supply air to the greater of latent load or minimum ventilation requirements.

EXCEPTION 3 to Section 170.2(c)4Niv: Terminal heating or cooling units that comply with the low fan power allowance requirements in Exception to Section 170.2(c)4Oiii.

v. DOAS with mechanical cooling providing ventilation to multiple zones and operating in conjunction with zone heating and cooling systems shall not use heating or heat recovery to warm supply air above 60°F when representative building loads or outdoor air temperature indicate that the majority of zones require cooling.

vi. DOAS with a total fan system power less than 1 kW shall not exceed a total combined fan power of 1.0 W/cfm. DOAS with fan power greater than or equal to 1 kW shall meet the requirements of Section 170.2(c)4A.

O. Exhaust Air Heat Recovery. Fan systems designed to operate to the criteria listed in either Table 170.2-I or Table 170.2-J shall include an exhaust air heat recovery system which meets the following:

i. A sensible energy recovery ratio of at least 60 percent or an enthalpy recovery ratio of at least 50 percent for both heating and cooling design conditions.

ii. Energy recovery bypass or control to disable energy recovery and to directly economize with ventilation air based on outdoor air temperature limits specified in TABLE 170.2-G. For energy recovery systems where the transfer of energy cannot be stopped, bypass shall prevent the total airflow rate of either outdoor air or exhaust air through the energy recovery exchanger from exceeding 10% of the full design airflow rate.

iii. For a DOAS unit and a separate independent space-conditioning system meeting the requirements of 170.2(c)4Nia, the design supply fan airflow rate shall be the total airflow of only the DOAS unit.

EXCEPTION 1 to Section 170.2(c)4Oii: DOAS units with the capability to shut off when a separate independent space-conditioning system meets the economizer requirements specified by section 170.2(c)4Ci is economizing.

EXCEPTION 2 to Section 170.2(c)4O: Systems meeting Section 140.9(c) Prescriptive Requirements for Laboratory and Factory Exhaust Systems.

EXCEPTION 3 to Section 170.2(c)4O: Systems serving spaces that are not cooled and that are heated to less than 60°F.

EXCEPTION 4 to Section 170.2(c)4O: Where more than 60 percent of the outdoor air heating energy is provided from site-recovered energy in Climate Zone 16.

EXCEPTION 5 to Section 170.2(c)4O: Sensible recovery ratio requirements at heating design conditions are exempted for Climate Zone 15.

EXCEPTION 6 to 170.2(c)4O: Sensible recovery ratio requirements at cooling design conditions are exempted for Climate Zone 01.

EXCEPTION 7 to Section 170.2(c)4O: Where the sum of the airflow rates exhausted and relieved within 20 feet of each other is less than 75 percent of the design outdoor airflow rate, excluding exhaust air that is either:

i. used for another energy recovery system;

ii. not allowed by California Mechanical Code (Title 24, Part 4) for use in energy recovery systems with leakage potential; or

iii. of Class 4 as specified in Section 160.2(c)8.

EXCEPTION 8 to Section 170.2(c)4O: Systems expected to operate less than 20 hours per week.

TABLE 170.2-I: ENERGY RECOVERY REQUIREMENTS BY CLIMATE ZONE AND PERCENT OUTDOOR AIR AT FULL DESIGN AIRFLOW (<8,000 HOURS / YEAR)

% Outdoor Air at Full Design Airflow	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
≥10% and <20%	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
≥20% and <30%	≥15,000	≥20,000	NR	NR	NR	NR	NR	NR	NR	NR	≥18,500	≥18,500	≥18,500	≥18,500	≥18,500	≥18,500
≥30% and <40%	≥13,000	≥15,000	NR	NR	NR	NR	NR	NR	NR	NR	≥15,000	≥15,000	≥15,000	≥15,000	≥15,000	≥15,000
≥40% and <50%	≥10,000	≥12,000	NR	NR	NR	NR	NR	NR	NR	≥22,000	≥10,000	≥10,000	≥10,000	≥10,000	≥10,000	≥10,000
≥50% and <60%	≥9,000	≥10,000	NR	≥18,500	NR	NR	NR	NR	NR	≥17,000	≥8,000	≥8,000	≥8,000	≥8,000	≥8,000	≥8,000
≥60% and <70%	≥7,000	≥7,500	NR	≥16,500	NR	NR	NR	NR	≥20,000	≥15,000	≥7,000	≥7,000	≥7,000	≥7,000	≥7,000	≥7,000
≥70% and <80%	≥6,500	≥7,000	NR	≥15,000	NR	NR	NR	NR	≥17,000	≥14,000	≥5,000	≥5,000	≥5,000	≥5,000	≥5,000	≥5,000
≥80%	≥4,500	≥6,500	NR	≥14,000	NR	NR	NR	NR	≥15,000	≥13,000	≥2,000	≥2,000	≥2,000	≥2,000	≥2,000	≥2,000

TABLE 170.2-J: ENERGY RECOVERY REQUIREMENTS BY CLIMATE ZONE AND PERCENT OUTDOOR AIR AT FULL DESIGN AIRFLOW (≥8,000 HOURS / YEAR)

% Outdoor Air at Full Design Airflow	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
≥10% and <20%	≥10,000	≥10,000	NR	NR	NR	NR	NR	NR	NR	≥40,000	≥40,000	≥20,000	≥10,000	≥10,000	≥10,000	≥10,000
≥20% and <30%	≥2,000	≥5,000	≥13,000	≥9,000	≥9,000	NR	NR	NR	NR	≥15,000	≥15,000	≥5,000	≥5,000	≥5,000	≥5,000	≥5,000
≥30% and <40%	≥2,000	≥3,000	≥10,000	≥6,500	≥6,500	NR	NR	NR	≥15,000	≥7,500	≥7,500	≥3,000	≥3,000	≥3,000	≥3,000	≥3,000
≥40% and <50%	≥2,000	≥2,000	≥8,000	≥6,000	≥6,000	NR	NR	NR	≥12,000	≥6,000	≥6,000	≥2,000	≥2,000	≥2,000	≥2,000	≥2,000
≥50% and <60%	≥2,000	≥2,000	≥7,000	≥6,000	≥6,000	NR	NR	≥20,000	≥10,000	≥5,000	≥5,000	≥2,000	≥2,000	≥2,000	≥2,000	≥2,000
≥60% and <70%	≥2,000	≥2,000	≥6,000	≥6,000	≥6,000	NR	NR	≥18,000	≥9,000	≥4,000	≥4,000	≥2,000	≥2,000	≥2,000	≥2,000	≥2,000
≥70% and <80%	≥2,000	≥2,000	≥6,000	≥5,000	≥5,000	NR	NR	≥15,000	≥8,000	≥3,000	≥3,000	≥2,000	≥2,000	≥2,000	≥2,000	≥2,000
≥80%	≥2,000	≥2,000	≥6,000	≥5,000	≥5,000	NR	NR	≥12,000	≥7,000	≥3,000	≥3,000	≥2,000	≥2,000	≥2,000	≥2,000	≥2,000

(d) **Water Heating Systems.** Water-heating systems shall meet the requirements of either 1, 2, 3 or 4.

For recirculation distribution systems serving individual dwelling units, only Demand Recirculation Systems with manual on/off control as specified in the Reference Appendix RA4.4.9 shall be used. Recirculation system serving multiple dwelling units shall meet the requirements of Sections 110.3(c)2 and 110.3(c)5, and shall be capable of automatically controlling the recirculation pump operation based on measurement of hot water demand and hot water return temperature:

1. For systems serving individual dwelling units, the water heating system shall meet the requirement of either A, B, C, or shall meet the performance compliance requirements of Section 170.1:

   A. A single 240 volt heat pump water heater. In addition, meet the following:

      i. A compact hot water distribution system as specified in the Reference Appendix RA4.4.6. in climate 1 and 16; and

      ii. A drain water heat recovery system that is field verified as specified in the Reference Appendix RA3.6.9 in climate zone 16.

   B. A single heat pump water heater that meets the requirements of NEEA Advanced Water Heater Specification Tier 3 or higher. In addition, for Climate Zones 16, a drain water heat recovery system that is field verified as specified in the Reference Appendix RA3.6.9.

   C. A gas or propane instantaneous water heater with an input of 200,000 Btu per hour or less and no storage tank.

2. For heat pump water-heating systems serving multiple dwelling units, the water heating system shall be installed according to the manufacturer design and installation guidelines and meet the following requirements:

   A. The hot water return from the recirculation loop shall connect to a recirculation loop tank and shall not directly connect to the primary heat pump water heater inlet or the primary thermal storage tanks.

   B. The fuel source for the recirculation loop tank shall be electricity if auxiliary heating is needed. The recirculation loop heater shall be capable of multi-pass water heating operation.

   C. For systems with single pass primary heat pump water heater, the primary thermal storage tanks shall be piped in series if multiple tanks are used. For systems with multi-pass primary heat pump water heater, the primary thermal storage tanks shall be piped in parallel if multiple tanks are used.

   D. The primary storage tank temperature setpoint shall be at least 135°F.

   E. The recirculation loop tank temperature setpoint shall be at least 10°F lower than the primary thermal storage tank temperature setpoint such that hot water from the recirculation loop tank is used for the temperature maintenance load before engaging the recirculation loop tank heater.

   F. The minimum heat pump water heater compressor cut-off temperature shall be equal to or lower than 40°F ambient air temperature.

   G. A recirculation system.

   H. Design documentation shall be provided in accordance with JA14.4.

   EXCEPTION to Section 170.2(d)2G: Buildings with eight or fewer dwelling units.

3. For gas or propane systems serving multiple dwelling units, a central water-heating system that includes the following components shall be installed:

   A. For Climate Zones 1 through 9, gas service water-heating systems with a total installed gas water-heating input capacity of 1 MMBtu/h or greater shall have gas service water-heating equipment with a minimum thermal efficiency of 90 percent. Multiple units are allowed to meet this requirement with an input capacity-weighted average of at least 90 percent.

EXCEPTION 1 to Section 170.2(d)3A: Individual gas water heaters with input capacity at or below 100,000 Btu/h shall not be included in the calculations of the total system input or total system efficiency.

EXCPTION 2 TO Section 170.2(d)3A: If 25 percent of the annual water-heating requirement is provided by site-solar energy or site-recovered energy.

B. A recirculation system.

EXCEPTION to Section 170.2(d)3B: Buildings with eight or fewer dwelling units.

C. A solar water-heating system meeting the installation criteria specified in Reference Residential Appendix RA4 and with a minimum solar savings fraction of either i or ii below:

i. A minimum solar savings fraction of 0.20 in Climate Zones 1 through 9 or a minimum solar savings fraction of 0.35 in Climate Zones 10 through 16; or

ii. A minimum solar savings fraction of 0.15 in Climate Zones 1 through 9 or a minimum solar savings fraction of 0.30 in Climate Zones 10 through 16. In addition, a drain water heat recovery system that is field verified as specified in the Reference Appendix RA3.6.9.

4. A water-heating system serving multiple dwelling units determined by the Executive Director to use no more energy than the one specified in subsection 1, 2, or 3 above.

TABLE 170.2-K MECHANICAL COMPONENT PACKAGE – Multifamily Standard Building Design

Multifamily			Climate Zone															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Balanced Ventilation[6]	Unitary (serving one dwelling unit)	Sensible Recovery Efficiency	0.67	0.67	NR	NR	NR	NR	NR	NR	NR	NR	0.67	0.67	0.67	0.67	0.67	0.67
		Fan Efficacy (W/cfm)	0.6	0.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.6	0.6	0.6	0.6	0.6	0.6
		If Heat Pump, HSPF[7]	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
		If dual-fuel heat pump, AFUE	MIN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	MIN
		Refrigerant Charge Verification or Fault Indicator Display	NR	REQ	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR
		SEER	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
	Central (serving multiple dwelling units)	Sensible Recovery Efficiency or Effective-ness	067	0.67	NR	NR	NR	NR	NR	NR	NR	NR	0.67	0.67	0.67	0.67	0.67	0.67
		Bypass Function	Req	Req	NR	NR	NR	NR	NR	NR	NR	NR	Req.	Req.	Req.	Req.	Req.	Req.
	Central System Air Handlers	Central Fan Integrated Ventilation System Fan Efficacy	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
	Duct Insulation	Ducts in Unconditioned Space	R-8	R-8	R- 6	R-8	R- 6	R- 6	R- 6	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8
Water Heating	All Buildings		System Shall meet Section 170.2(c)															

Footnote requirements to TABLE 170.2-K:

6. Requirements only apply when using Balanced Ventilation to meet 160.2(b)2Av

7. HSPF means "heating seasonal performance factor."

8. A supplemental heating unit may be installed in a space served directly or indirectly by a primary heating system, provided that the unit thermal capacity does not exceed 2 kilowatts or 7,000 Btu/hr and is controlled by a time-limiting device not exceeding 30 minutes.

(e) **Lighting.** Dwelling unit and common living area lighting shall meet the applicable mandatory requirements of Section 160.5(a). Common service area lighting shall meet the following requirements:

1. Interior Common Service Area Lighting. A building complies with Section 170.2(e)1 if:

A. The Calculation of Adjusted Indoor Lighting Power of all proposed building areas combined, calculated under Subsection A is no greater than the Calculation of Allowed Indoor Lighting Power, Specific Methodologies calculated under Subsection (c); and

B. The Calculation of Allowed Indoor Lighting Power, General Rules comply with Subsection B;

The prescriptive limits on indoor lighting power are the smaller of the Actual and Allowed Indoor Lighting Power values determined in accordance with item i.

2. Calculation of Adjusted Indoor Lighting Power. The adjusted indoor Lighting Power of all proposed building areas is the total watts of all planned permanent and portable lighting systems in all areas of the proposed building; subject to the applicable adjustments under Subdivisions A through D of this subsection.

A. Two interlocked lighting systems: No more than two lighting systems may be used for an area, and if there are two they must be interlocked. Where there are two interlocked lighting systems, the watts of the lower wattage system may be excluded from the Adjusted Indoor Lighting Power if:

i. An Installation Certificate detailing compliance with Section 170.2(e)1A is submitted in accordance with Section 10-103 and Section 160.5(e); and

ii. The area or areas served by the interlocking systems is an auditorium, a conference room, a multipurpose room, or a theater; and

iii. The two lighting systems are interlocked with a Nonprogrammable Double-Throw Switch to prevent simultaneous operation of both systems.

For compliance with Part 6 a Nonprogrammable Double-Throw Switch is an electrical switch commonly called a "single pole double throw" or "three-way" switch that is wired as a selector switch allowing one of two loads to be enabled. It can be a line voltage switch or a low voltage switch selecting between two relays. It cannot be overridden or changed in any manner that would permit both loads to operate simultaneously.

B. Reduction of wattage through controls. In calculating Adjusted Indoor Lighting Power, the installed watts of a luminaire providing general lighting in an area listed in TABLE 170.2-L may be reduced by the product of (i) the number of watts controlled as described in TABLE 170.2-L, times (ii) the applicable Power Adjustment Factor (PAF), if all of the following conditions are met:

i. An Installation Certificate is submitted in accordance with Section 160.5(e)2; and

ii. Luminaires and controls meet the applicable requirements of Section 110.9, and Sections 160.5(b) through 160.6; and

iii. The controlled lighting is permanently installed general lighting systems and the controls are permanently installed nonresidential-rated lighting controls.

When used for determining PAFs for general lighting in offices, furniture mounted luminaires that comply with all of the following conditions shall qualify as permanently installed general lighting systems:

a. The furniture mounted luminaires shall be permanently installed no later than the time of building permit inspection; and

b. The furniture mounted luminaires shall be permanently hardwired; and

c. The furniture mounted lighting system shall be designed to provide indirect general lighting; and

d. Before multiplying the installed watts of the furniture mounted luminaire by the applicable PAF, 0.3 watts per square foot of the area illuminated by the furniture mounted luminaires shall be subtracted from installed watts of the furniture mounted luminaires; and

e. The lighting control for the furniture mounted luminaire complies with all other applicable requirements in Section 170.2(e)1Aii.

iv. At least 50 percent of the light output of the controlled luminaire is within the applicable area listed in Table 170.2-L. Luminaires on lighting tracks shall be within the applicable area in order to qualify for a PAF.

v. Only one PAF from Table 170.2-L may be used for each qualifying luminaire. PAFs shall not be added together unless allowed in Table 170.2-L.

vi. Only lighting wattage directly controlled in accordance with Section 170.2(e)1Aii shall be used to reduce the installed watts as allowed by Section 170.2(e)1Aii for calculating the Adjusted Indoor Lighting Power. If only a portion of the wattage in a luminaire is controlled in accordance to Section 170.2(e)1Aii, then only that portion of controlled wattage may be reduced in calculating Adjusted Indoor Lighting Power.

vii. Lighting controls used to qualify for a PAF shall be designed and installed in addition to manual, multilevel, and automatic lighting controls required in Section 160.5(b)4, and in addition to any other lighting controls required by any provision of Part 6. PAFs shall not be available for lighting controls required by Part 6.

viii. To qualify for the PAF for daylight continuous dimming plus OFF control, the daylight control and controlled luminaires shall comply with Section 160.5(b)4D, 160.5(e)1C and 160.5(e)1G, and the controls shall be continuous dimming and shall additionally turn lights completely OFF when the daylight available in the daylit zone is greater than 150 percent of the illuminance received from the general lighting system at full power. The PAF shall apply to the luminaires in the primary sidelit daylit zone, secondary sidelit daylit zone, and the skylit daylit zone.

ix. To qualify for the PAF for an occupant sensing control controlling the general lighting in open plan office areas above workstations, in accordance with Table 170.2-L, the following requirements shall be met:u

a. The open plan office area shall be greater than 250 square feet; and

b. This PAF shall be available only in office areas which contain workstations; and

c. Controlled luminaires shall only be those that provide general lighting directly above the controlled area, or furniture mounted luminaires that comply with Section 170.2(e)1Aii and provide general lighting directly above the controlled area; and

d. Qualifying luminaires shall be controlled by occupant sensing controls that meet all of the following requirements, as applicable:

I. Infrared sensors shall be equipped by the manufacturer, of fitted in the field by the installer, with lenses or shrouds to prevent them from being triggered by movement outside of the controlled area.

II. Ultrasonic sensors shall be tuned to reduce their sensitivity to prevent them from being triggered by movements outside of the controlled area.

III. All other sensors shall be installed and adjusted as necessary to prevent them from being triggered by movements outside of the controlled area.

x. To qualify for the PAF for an Institutional Tuning in Table 170.2-L, the tuned lighting system shall comply with all of the following requirements:

a. The lighting controls shall limit the maximum output or maximum power draw of the controlled lighting to 85 percent or less of full light output or full power draw; and

b. The means of setting the limit is accessible only to authorized personnel; and

c. The setting of the limit is verified by the acceptance test required by Section 160.5(e)1G; and

d. The construction documents specify which lighting systems shall have their maximum light output or maximum power draw set to no greater than 85% of full light output or full power draw.

xi. To qualify for the PAF for a Demand Responsive Control in Table 170.2-L, the general lighting wattage receiving the PAF shall not be within the scope of Section 110.12(c) and a Demand Responsive Control shall meet all of the following requirements:

a. The controlled lighting shall be capable of being automatically reduced in response to a demand response signal; and

b. General lighting shall be reduced in a manner consistent with uniform level of illumination requirements in TABLE 160.5-B.

xii. To qualify for the PAFs for clerestory fenestration, horizontal slats, or light shelves in Table 170.2-L, the daylighting design shall meet the requirements in Section 140.3(d). The PAFs shall only apply to lighting in a primary or secondary sidelit daylit zone where continuous dimming daylighting controls meeting the requirements of Section 160.5(b)4D) are installed.

C. Lighting wattage excluded. The watts of the following indoor lighting applications may be excluded from Adjusted Indoor Lighting Power:

i. Lighting installed by the manufacturer in walk-in coolers or freezers, vending machines, and food preparation equipment.

ii. Lighting that is required for exit signs subject to the CBC. Exit signs shall meet the requirements of the Appliance Efficiency Regulations.

iii. Exit way or egress illumination that is normally off and that is subject to the CBC.

iv. Temporary lighting systems.

v. Lighting systems in qualified historic buildings, as defined in the California Historical Building Code (Title 24, Part 8), are exempt from the Lighting Power Density allowances, if they consist solely of historic lighting components or replicas of historic lighting components. If lighting systems in qualified buildings contain some historic lighting components or replicas of historic components, combined with other lighting components, only those historic or historic replica components are exempt. All other lighting systems in qualified historic buildings shall comply with the Lighting Power Density allowances.

vi. Lighting for signs: Lighting for signs shall comply with Section 170.2(e)7.

vii. Lighting in elevators where the lighting meets the requirements in Section 120.6(f).

viii. Lighting connected to a Life Safety Branch or Critical Branch, as specified in Section 517 of the California Electrical Code.

D. Luminaire Classification and Power Adjustment

i. Luminaire Classification and Power shall be determined in accordance with Section 160.5(b)1.

ii. Small Aperture Tunable-White and Dim-to-Warm Luminaires Lighting Power Adjustment. For qualifying small aperture tunable-white and dim-to-warm LED luminaires, the adjusted indoor lighting power of these luminaires shall be calculated by multiplying their maximum rated wattage by 0.75. Qualifying luminaires shall meet all of the following:

a. Small Aperture. Qualifying luminaires with a luminaire aperture length longer than 18 inches shall have a luminaire aperture no wider than four inches. Qualifying luminaires with a luminaire aperture length of 18 inches or less shall have a luminaire aperture no wider than eight inches.

b. Color Changing. Qualifying tunable-white luminaires shall be capable of a color change greater than or equal to 2000 Kelvin correlated color temperature (CCT). Qualifying dim-to-warm luminaires shall be capable of color change greater than or equal to 500 Kelvin CCT.

c. Controls. Qualifying luminaires shall be connected to controls that allows color changing of the luminaires.

iii. Tailored Method Display Lighting Mounting Height Lighting Power Adjustment. For wall display luminaires or floor display luminaires meeting Tailored Method Section 170.2(e)1Ciig and h and where the bottom of luminaires are 10 feet 7 inches and greater above the finished floor, the adjusted indoor lighting power of these luminaires shall be calculated by multiplying their maximum rated wattage and the appropriated mounting height adjustment factor from Table 170.2-O. Luminaire mounting height is the distance from the finished floor to the bottom of the luminaire. General lighting shall not qualify for a mounting height multiplier.

3. Calculation of Allowed Indoor Lighting Power: General Rules.

A. The allowed Indoor Lighting Power allotment for conditioned areas shall be calculated separately from the allowed Lighting Power allotment for unconditioned areas. Each allotment is applicable solely to the area to which it applies, and there shall be no trade-offs between conditioned and unconditioned area allotments.

B. Allowed Indoor Lighting Power allotment shall be calculated separately from the allowed Outdoor Lighting Power allotment. Each allotment is applicable solely to the area to which it applies, and there shall be no trade-offs between the separate Indoor and Outdoor allotments.

C. The Allowed Indoor Lighting Power allotment for general lighting shall be calculated as follows:

i. The Area Category Method, as described in Section 170.2(e)1Ci, shall be used either by itself for all common use areas in the building, or when some areas in the building use the Tailored Method described in Section 170.2(e)1Cii. Under the Area Category Method (either by itself or in conjunction with the Tailored Method), as described more fully in Section 170.2(e)1Ci, and subject to the adjustments listed there, the allowed Indoor Lighting Power allotment for general lighting shall be calculated for each area in the building as follows:

a. For conditioned areas, by multiplying the conditioned square feet of the area times the applicable allotment of watts per square foot for the area shown in Table 170.2-M (or TABLE 170.2-N if the Tailored Method is used for that area).

b. For unconditioned areas, by multiplying the unconditioned square feet of the area times the applicable allotment of watts per square foot for the area shown in TABLE 170.2-M (or Table 170.2-N if the Tailored Method is used for that area).

The Allowed Indoor Lighting Power allotment for general lighting for one area for which the Area Category Method was used may be increased up to the amount that the Allowed Indoor Lighting Power allotment for general lighting for another area using the Area Category Method or Tailored Method is decreased, except that such increases and decreases shall not be made between conditioned and unconditioned space.

D. The Tailored Method, as described in Section 170.2(e)1Cii, shall be used either by itself for all areas in the building, or when some areas in the building use the Area Category Method described in Section 170.2(e)1Ci. Under the Tailored Method (either by itself or in conjunction with the Area Category Method) as described more fully in Section 170.2(e)1Cii, and subject to the adjustments listed there,

allowed Indoor Lighting Power allotment for general lighting shall be calculated for each area in the building as follows:

i. For conditioned areas, by multiplying the conditioned square feet of the area times the applicable allotment of watts per square foot for the area shown in Table 170.2-N (or Table 170.2-M if the Area Category Method is used for that area);

ii. For unconditioned areas, by multiplying the unconditioned square feet of the area times the applicable allotment of watts per square foot for the area shown in TABLE 170.2-L (or TABLE 170.2-M if the Area Category Method is used for that area);

E. The Allowed Indoor Lighting Power allotment for general lighting for one area for which the Tailored Method was used may be increased up to the amount that the Allowed Indoor Power Lighting for general lighting for another area is decreased, but only if the Tailored Method or Area Category Method was used for the other area, except that such increases and decreases shall not be made between conditioned and unconditioned space.

F. If the Area Category Method is used for an area, the Tailored Method may not be used for that area. If the Tailored Method is used for an area, the Area Category Method may not be used for that area.

4. Calculation of Allowed Indoor Lighting Power: Specific Methodologies. The allowed indoor Lighting Power for each common use primary function area shall be calculated using only one of the methods in Subsection i, ii, or iii below as applicable.

A. Area Category Method. Requirements for using the Area Category Method include all of the following:

i. The Area Category Method shall be used only for primary function areas, as defined in Section 100.1, that are listed in Table 170.2-M. For primary function areas not listed, selection of a reasonably equivalent type shall be permitted.

ii. For purposes of compliance with Section 170.2(e)1Ci, an "area" shall be defined as all contiguous areas that accommodate or are associated with a single primary function area listed in Table 170.2-M.

iii. Where areas are bounded or separated by interior partitions, the floor area occupied by those interior partitions may be included in a Primary Function Area.

iv. The allowed indoor Lighting Power for each primary function area is the Lighting Power Density value in TABLE 170.2-M times the square feet of the primary function area. The total allowed indoor Lighting Power for the building is the sum of all allowed indoor Lighting Power for all areas in the building.

v. In addition to the allowed indoor Lighting Power calculated according to Sections 170.2(e)1Cia through f, the building may add additional lighting power allowances for qualifying lighting systems as specified in the Qualifying Lighting Systems column in TABLE 170.2-M under the following conditions:

a. Only primary function areas having a lighting system as specified in the Qualifying Lighting Systems column in TABLE 170.2-M and in accordance with the corresponding footnote of the TABLE shall qualify for the additional lighting power allowances; and

b. The additional lighting power allowances shall be used only if the plans clearly identify all applicable task areas and the lighting equipment designed to illuminate these tasks; and

c. Tasks that are performed less than two hours per day or poor quality tasks that can be improved are not eligible for the additional lighting power allowances; and

d. The additional lighting power allowances shall not utilize any type of luminaires that are used for general lighting in the building; and

e. The additional lighting power allowances shall not be used when using the Complete Building Method, or when the Tailored Method is used for any area in the building; and

f. The additional lighting power allowed is the smaller of:

I. the lighting power density listed in the “Allowed Additional Lighting LPD” column in TABLE 170.2-M, times the square feet of the primary function, or

II. the Adjusted Indoor Lighting Power of the applicable lighting; and

g. In addition to all other additional lighting power allowed under Sections 170.2(e)1CifI through VI, up to 1.0 watts per square foot of additional lighting power shall be allowed in a videoconferencing studio, as defined in Section 100.1, provided the following conditions are met:

I. A completed and signed Installation Certificate is prepared and submitted in accordance with Section 160.5(e)1B, specifically detailing compliance with the applicable requirements of Section 170.2(e)1CifVII; and

II. The Videoconferencing Studio is a room with permanently installed videoconferencing cameras, audio equipment, and playback equipment for both audio-based and video-based two-way communication between local and remote sites; and

III. General lighting is switched in accordance with TABLE 160.5-B; and

IV. Wall wash lighting is separately switched from the general lighting system; and

V. All of the lighting in the studio, including general lighting and additional lighting power allowed by Section 170.2(e)1CifVII is controlled by a multiscene programmable control system (also known as a scene preset control system).

B. Tailored Method. Requirements for using the Tailored Method include all of the following:

i. The Tailored Method shall be used only for primary function areas listed in TABLE 170.2-N as defined in Section 100.1.

ii. Allowed Indoor Lighting Power allotments for general lighting shall be determined according to Section 170.2(e)1Ciif, as applicable.

iii. For compliance with Section 170.2(e)1Cii, an "area" shall be defined as all contiguous areas that accommodate or are associated with a single primary function area listed in TABLE 170.2-N.

iv. Where areas are bounded or separated by interior partitions, the floor area occupied by those interior partitions may be included in a Primary Function Area.

v. In addition to the allowed indoor Lighting Power allotments for general lighting calculated according to Section 170.2(e)1Ciif, as applicable, the building may add additional lighting power allowances for wall display lighting, task lighting, and decorative/special effects lighting, according to Section 170.20(e)1Ciig through j.

vi. Determine allowed indoor Lighting Power allotments for general lighting for primary function areas listed in TABLE 170.2-N as follows:

a. Use the General Illumination Level (Lux) listed in Column 2 of TABLE 170.2-N to determine the Allowed General Lighting Power Density allotments for the area.

b. Determine the room cavity ratio (RCR) for the area. The RCR shall be calculated according to the applicable equation in TABLE 170.2-P.

c. Find the allowed General Lighting Power Density allotments in TABLE 170.2-Q that is applicable to the General Illuminance Level (Lux) from Column 2 of TABLE 170.2-N (as described in Item i.) and the RCR determined in accordance with TABLE 170.2-P (as described in Item ii).

d. Determine the square feet of the area in accordance with Section 170.2(e)1Ciic and d.

e. Multiply the allowed Lighting Power Density allotment, as determined in accordance with Item iii by the square feet of each primary function area, as determined in accordance with Item iv. The product is the Allowed Indoor Lighting Power allotment for general lighting for the area.

vii. Determine additional allowed power for wall display lighting according to column 3 of TABLE 170.2-N for each primary function area as follows:

a. Qualifying wall lighting shall:

I. Be mounted within 10 feet of the wall having the wall display. When track lighting is used for wall display, and where portions of that lighting track are more than 10 feet from the wall and other portions are within 10 feet of the wall, portions of track more than 10 feet from the wall shall not be used for the wall display allowance.

II. Be a lighting system type appropriate for wall lighting. Lighting systems appropriate for wall lighting are lighting track adjacent to the wall, wall-washer luminaires, luminaires behind a wall valance or wall cove, or accent light. (Accent luminaires are adjustable or fixed luminaires with PAR, R, MR, AR, or luminaires providing directional display light.)

b. Additional allowed power for wall display lighting is available only for lighting that illuminates walls having wall displays. The length of display walls shall include the length of the perimeter walls, including but not limited to closable openings and permanent full height interior partitions. Permanent full height interior partitions are those that (I) extend from the floor to within two feet of the ceiling or are taller than ten feet and (II) are permanently anchored to the floor.

c. For wall display lighting where the bottom of the luminaire is greater than 10 feet 6 inches above the finished floor, the mounting height adjustment factor from TABLE 170.2-O can be used to adjust the installed luminaire wattage as specified in Section 170.2(e)1Aivc.

d. The allowed power for wall display lighting shall be the smaller of:

I. the “wall display lighting power density” determined in accordance with TABLE 170.2-N, multiplied by the wall display lengths determined in accordance with Item iii; and

II. The Adjusted Indoor Lighting Power used for the wall display lighting systems.

e. Lighting internal to display cases that are attached to a wall or directly adjacent to a wall are counted as wall display lighting as specified in Section 170.2(e)1Ciig. All other lighting internal to display cases are counted as floor display lighting as specified in Section.

viii. Determine additional allowed power allotment for task lighting according to Column 4 of Table 170.2-N for each primary function area as follows:

a. Additional allowed power for task lighting, may be used by qualifying task lighting systems. For floor areas qualifying for task lighting power allowances, the additional allowed power shall be used only once for the same floor area, so that the allowance shall not be additive.

b. Qualifying task lighting shall:

I. Be located immediately adjacent to and capable of illuminating the task for which it is installed.

II. Be of a type different from the general lighting system.

III. Be separately switched from the general lighting system.

c. The square footage of task areas shall be determined in accordance with Section 170.2(e)1ciic and d, except that any floor area designed to not have tasks, such as floor areas designated as a path of egress, shall not be included for the task lighting allowance.

d. The allowed power for task lighting for each applicable area shall be the smaller of:

I. The allowed task lighting power determined in accordance with Section 170.2(e)1ciih multiplied by the floor square footage determined in accordance with Section 170.2(e)1ciihIII; and

II. The Adjusted Indoor Lighting Power used for the task lighting systems.

ix. Determine additional allowed power for decorative/special effects lighting for each primary function area as follows:

a. Qualifying decorative/special effects lighting includes luminaires such as chandeliers, sconces, lanterns, neon and cold cathode, light emitting diodes, theatrical projectors, moving lights and light color panels when any of those lights are used in a decorative manner that does not serve as display lighting or general lighting.

b. Additional lighting power for decorative/special effects lighting shall be used only if allowed by Column 5 of TABLE 170.2-N.

c. Additional lighting power for decorative/special effects lighting shall be used only in areas having decorative/special effects lighting. The square footage of the floor area shall be determined in accordance with Section 170.2(e)1Ciic and d, and it shall not include floor areas not having decorative/special effects lighting.

d. The additional allowed power for decorative/special effects lighting for each applicable area shall be the smaller of:

I. The product of the “allowed decorative/special effects lighting power” determined in accordance with Section 170.2(e)1CiikII, multiplied by the floor square footage determined in accordance with Section 170.2(e)1CiikIII; and

II. The Adjusted Indoor Lighting Power of allowed ornamental/special effects lighting.

TABLE 170.2-L LIGHTING POWER ADJUSTMENT FACTORS (PAF)

TYPE OF CONTROL	TYPE OF AREA		FACTOR
a. To qualify for any of the Power Adjustment Factors in this table, the installation shall comply with the applicable requirements in Section 170.2(e)1Aii b. Only one PAF may be used for each qualifying luminaire unless combined below. c. Lighting controls that are required for compliance with Part 6 shall not be eligible for a PAF			
1. Daylight Continuous Dimming plus OFF Control	Luminaires in skylit daylit zone or primary sidelit daylit zone		0.10
2. Occupant Sensing Controls in Office Spaces larger than 250 square feet	In open plan offices > 250 square feet: One sensor controlling an area that is:	No larger than 125 square feet	0.30
		From 126 to 250 square feet	0.20
3.Institutional Tuning	Luminaires in non-daylit areas. Luminaires that qualify for other PAFs in this table may also qualify for this tuning PAF.		0.10
	Luminaires in daylit areas. Luminaires that qualify for other PAFs in this table may also qualify for this tuning PAF.		0.05
4. Demand Responsive Control	General lighting luminaires not in the scope of Section 110.12(c). Luminaires that qualify for other PAFs in this table may also qualify for this demand responsive control PAF		0.05
5. Clerestory Fenestration	Luminaires in daylit areas adjacent to the clerestory. Luminaires that qualify for daylight dimming plus OFF control may also qualify for this PAF.		0.05
6. Horizontal Slats	Luminaires in daylit areas adjacent to vertical fenestration with interior or exterior horizontal slats. Luminaires that qualify for daylight dimming plus OFF control may also qualify for this PAF.		0.05
7.Light Shelves	Luminaires in daylit areas adjacent to clerestory fenestration with interior or exterior light shelves. This PAF may be combined with the PAF for clerestory fenestration. Luminaires that qualify for daylight dimming plus OFF control may also qualify for this PAF		0.10

TABLE 170.2-M AREA CATEGORY METHOD - LIGHTING POWER DENSITY VALUES (WATTS/FT²)

Primary Function Area		Allowed Lighting Power Density for General Lighting (W/ft²)	Additional Lighting Power	
			Qualified Lighting Systems	Additional Allowance (W/ft², unless noted otherwise)
Storage		0.45	-	-
Conference, Multipurpose and Meeting Area		0.75	Display/Decorative	0.30
Copy Room		0.50	-	-
Corridor Area		0.40	Decorative/Display	0.25
Dining Area	Bar/Lounge and Fine Dining	0.45	Display/Decorative	0.35
	Cafeteria/Fast Food	0.45		0.35
	Family and Leisure	0.40		0.25
Health Care / Assisted Living	Nurse's Station	0.75	Tunable white or dim-to-warm[8]	0.10
	Physical Therapy Room	0.85	Tunable white or dim-to-warm[8]	0.10
Kitchen/Food Preparation Area		0.95	-	-
Electrical, Mechanical, Telephone Rooms		0.40	Detailed Task Work[1]	0.20
Exercise/Fitness Center and Gymnasium Area		0.50	-	-
Lobby, Main Entry		0.70	Display/Decorative	0.25
Locker Room		0.45	-	-
Lounge, Breakroom, or Waiting Area		0.55	Display/Decorative	0.25
Concourse and Atria Area		0.60	Display/Decorative	0.25

Office Area	> 250 square feet	0.60	Decorative/Display and Portable lighting for office areas[5]	0.20
	≤ 250 square feet	0.65		
Parking Garage Area	Parking Zone and Ramps	0.10	First ATM or Ticket Machine	100 W
			Additional ATM or Ticket machine	50 W each
	Daylight Adaptation Zones[3]	1.00	-	-
Laundry Area		0.45	-	-
Restrooms		0.65	Decorative/ Display	0.35
Stairwell		0.60	Decorative/ Display	0.35
All other		0.40	-	-
Aging Eye/Low-vision[6]	Lobby, Main Entry	0.85	Display/Decorative	0.30
			Transition Lighting OFF at night[7]	0.95
	Stairwell	0.80	Display/Decorative	0.30
	Corridor Area	0.70	Display/Decorative	0.30
	Lounge/Waiting Area	0.80	Display/Decorative	0.30
	Multipurpose Room	0.85	Display/Decorative	0.30
	Dining	0.80	Display/Decorative	0.30
	Restroom	1.00	Display/Decorative	0.20

Footnotes for this table are listed below.

1. Detailed task work – Lighting provides high level of visual acuity required for activities with close attention to small elements and/or extreme close up work.

2. RESERVED

3. Daylight Adaptation Zones shall be no longer than 66 feet from the entrance to the parking garage.

4. RESERVED

5. Portable lighting in office areas includes under shelf or furniture-mounted supplemental task lighting qualifies when controlled by a time clock or an occupancy sensor.

6. Aging Eye/Low-vision areas can be documented as being designed to comply with the light levels in ANSI/IES RP-28 and are or will be licensed by local or state authorities for either senior long-term care, adult day care, senior support, and/or people with special visual needs.

7. Transition lighting OFF at night. Lighting power controlled by astronomical time clock or other control to shut off lighting at night. Additional LPD only applies to area within 30 feet of an exit. Not applicable to lighting in daylit zones.

8. Tunable white luminaires capable of color change greater than or equal to 2000K CCT, or dim-to-warm luminaires capable of color change greater than or equal to 500K CCT, connected to controls that allows color changing of the luminaires.

TABLE 170.2-N TAILORED METHOD LIGHTING POWER ALLOWANCES

1	2	3		5
Primary Function Area	**General Illumination Level (Lux)**	**Wall Lighting Power Density (W/ft)**	**Task Lighting Power Density (W/ft)**	**Allowed Decorative/ Special Effect Lighting Power Density (W/ft²)**
Conference, Multipurpose, and Meeting Center Areas	300	2.00	0.25	0.35
Dining Areas	200	1.25	0.25	0.35
Lobby, Main Entry	200	3.50	0.25	0.35

TABLE 170.2-O TAILORED WALL AND FLOOR DISPLAY MOUNTING HEIGHT ADJUSTMENT FACTORSFACTORS

Height in feet above finished floor and bottom of luminaire(s)	**Wall Display Mounting Height Adjustment Factor**
< 10’-7”	1.00
10’-7” to 14’-0”	0.85
>14’-0” to 18’-0”	0.75
> 18’-0”	0.70

Table 170.2-P ROOM CAVITY RATIO (RCR) EQUATIONS

Determine the Room Cavity Ratio for Table 170.2-Q using one of the following equations.
Room cavity ratio for rectangular rooms $\frac{5 \times H \times (L + W)}{A}$
Room cavity ratio for irregular-shaped rooms $\frac{2.5 \times H \times P}{A}$
Where: L =Length of room; W = Width of room; H =Vertical distance from the work plane to the centerline of the lighting fixture; P = Perimeter of room, and A = Area of room

TABLE 170.2-Q TAILORED METHOD GENERAL LIGHTING POWER ALLOWED – BY ILLUMINANCE *AND ROOM CAVITY RATIO*

	General Lighting Power Density (W/ft²) for the following RCR values[b]			
General Illuminance Level (lux)[a]	**RCR ≤ 2.0**	**RCR > 2.0 and ≤ 3.5**	**RCR > 3.5 and ≤ 7.0**	**RCR > 7.0**
150	0.35	0.40	0.50	0.65
200	0.40	0.50	0.65	0.85
300	0.55	0.70	0.85	1.20
400	0.65	0.80	1.05	1.25
500	0.80	0.90	1.25	1.55
600	0.90	1.05	1.40	2.00

[a] Illuminance values from Column 2 of TABLE 170.2-N.

[b] RCR values are calculated using applicable equations in TABLE 170.2-P.

6. Outdoor Lighting.

A. A multifamily or mixed occupancy outdoor lighting installation complies with this section if it meets the requirements in Subsections B and C, and the actual outdoor lighting power installed is no greater than the allowed outdoor lighting power calculated under Subsection D. The allowed outdoor lighting shall be calculated according to Outdoor Lighting Zone in Title 24, Part 1, Section 10-114.

EXCEPTIONS to Section 170.2(e)6A: When more than 50 percent of the light from a luminaire falls within one or more of the following applications, the lighting power for that luminaire shall be exempt from Section 170.2(e)6:

i. Temporary outdoor lighting.

ii. Lighting required and regulated by the Federal Aviation Administration, and the Coast Guard.

iii. Lighting for public streets, roadways, highways, and traffic signage lighting, including lighting for driveway entrances occurring in the public right-of-way owned or maintained by local municipality or utility.

iv. Lighting for sports and athletic fields, and children's playgrounds.

v. RESERVED.

vi. Lighting of public monuments.

vii. Lighting of signs complying with the requirements of Sections 160.5(d) and 170.2(e)7.

viii. Lighting of stairs, wheelchair elevator lifts for American with Disabilities Act (ADA) compliance, and ramps that are other than parking garage ramps.

ix. Landscape lighting.

x. RESERVED.

xi. Lighting for outdoor theatrical and other outdoor live performances, provided that these lighting systems are additions to area lighting systems and are controlled by a multiscene or theatrical cross-fade control station accessible only to authorized operators.

xii. Outdoor lighting systems for qualified historic buildings, as defined in the California Historic Building Code (Title 24, Part 8), if they consist solely of historic lighting components or replicas of historic lighting components. If lighting systems for qualified historic buildings contain some historic lighting components or replicas of historic components, combined with other lighting components, only those historic or historic replica components are exempt. All other outdoor lighting systems for qualified historic buildings shall comply with Section 170.2(e)6.

B. Outdoor Lighting Power Trade-offs. Outdoor lighting power trade-offs shall be determined as follows:

i. Allowed lighting power determined according to Section 170.2(e)6Di for general hardscape lighting allowance may be traded to specific applications in Section 170.2(e)6Dii, provided the hardscape area from which the lighting power is traded continues to be illuminated in accordance with Section 170.2(e)6Dia.

ii. Allowed lighting power determined according to Section 170.2(e)2Dii for additional lighting power allowances for specific applications shall not be traded between specific applications, or to hardscape lighting in Section 170.2(e)6Di.

iii. Trading off lighting power allowances between outdoor and indoor areas shall not be permitted.

C. Calculation of Actual Lighting Power. The wattage of outdoor luminaires shall be determined in accordance with Section 160.5(b)1.

D. Calculation of Allowed Lighting Power. The allowed lighting power shall be the combined total of the sum of the general hardscape lighting allowance determined in accordance with Section 170.2(e)2Di, and the sum of the additional lighting power allowance for specific applications determined in accordance with Section 170.2(e)6Dii.

i. General Hardscape Lighting Allowance. Determine the general hardscape lighting power allowances as follows:

a. The general hardscape area of a site shall include parking lot(s), roadway(s), driveway(s), sidewalk(s), walkway(s), bikeway(s), plaza(s), bridge(s), tunnel(s), and other improved area(s) that are illuminated. Public roadway(s) that are illuminated by a lighting system owned or maintained by the local municipality or utility shall not be included in the area calculations. In plan view of the site, determine the illuminated hardscape area, which is defined as any hardscape area that is within a square pattern around each luminaire or pole that is ten times the luminaire mounting height with the luminaire in the middle of the pattern, less any areas that are within a building, beyond the hardscape area, beyond property lines, or obstructed by a structure. The illuminated hardscape area shall include portions of planters and landscaped areas that are within the lighting application and are less than or equal to 10 feet wide in the short dimensions and are enclosed by hardscape or other improvement on at least three sides. Multiply the illuminated hardscape area by the Area Wattage Allowance (AWA) from Table 170.2R for the appropriate Lighting Zone.

b. Determine the Initial Wattage Allowance (IWA) for general hardscape lighting from TABLE 170.2-R for the appropriate lighting zone. The hardscape area shall be permitted one IWA per site.

c. The general hardscape lighting allowance shall be the sum of the allowed watts determined from a and b above.

ii. Additional Lighting Power Allowance for Specific Applications. Additional lighting power for specific applications shall be the smaller of the additional lighting allowances for specific applications determined in accordance with TABLE170.2-S for the appropriate lighting zone, or the actual installed lighting power meeting the requirements for the allowance.

TABLE 170.2-R GENERAL HARDSCAPE MULTIFAMILY LIGHTING POWER ALLOWANCE

Type of Power Allowance	Lighting Zone 0[2]	Lighting Zone 1[2]	Lighting Zone 2[2]	Lighting Zone 3[2]	Lighting Zone 4[2]
Area Wattage Allowance (AWA)	No allowance[1]	0.026 W/ft²	0.030 W/ft²	0.038 W/ft²	0.055 W/ft²
Initial Wattage Allowance (IWA)		300 W	350 W	400 W	450 W

1 Continuous lighting is explicitly prohibited in Lighting Zone 0. A single luminaire of 15 Watts or less may be installed at an entrance to a parking area, trail head, fee payment kiosk, outhouse, or toilet facility, as required to provide safe navigation of the site infrastructure. Luminaires installed shall meet the maximum zonal lumen limits as specified in Section 160.5(c)1.

2 Narrow band spectrum light sources with a dominant peak wavelength greater than 580 nm – as mandated by local, state, or federal agencies to minimize the impact on local, active professional astronomy or nocturnal habitat of specific local fauna – shall be allowed a 2.0 lighting power allowance multiplier.

TABLE 170.2-S ADDITIONAL MULTIFAMILY LIGHTING POWER ALLOWANCE FOR SPECIFIC APPLICATIONS
All area and distance measurements in plan view unless otherwise noted.

Lighting Application	**Lighting Zone 0**	**Lighting Zone 1**	**Lighting Zone 2**	**Lighting Zone 3**	**Lighting Zone 4**
WATTAGE ALLOWANCE PER APPLICATION. Use all that apply as appropriate.					
Building Entrances or Exits. Allowance per door. Luminaires qualifying for this allowance shall be within 20 feet of the door.	Not applicable	9 watts	15 watts	19 watts	21 watts
Primary Entrances to Senior Care Facilities Allowance per primary entrance(s) only. Primary entrances shall provide access for the general public and shall not be used exclusively for staff or service personnel. This allowance shall be in addition to the building entrance or exit allowance above. Luminaires qualifying for this allowance shall be within 100 feet of the primary entrance.	Not applicable	20 watts	40 watts	57 watts	60 watts
ATM Machine Lighting. Allowance per ATM machine. Luminaires qualifying for this allowance shall be within 50 feet of the dispenser.	Not applicable	100 watts for first ATM machine, 35 watts for each additional ATM machine.			
WATTAGE ALLOWANCE PER HARDSCAPE AREA (W/ft²). May be used for any illuminated hardscape area on the site.					
Hardscape Ornamental Lighting. Allowance for the total site illuminated hardscape area. Luminaires qualifying for this allowance shall be rated for 50 watts or less as determined in accordance with Section 160.5(b)1 and shall be post-top luminaires, lanterns, pendant luminaires, or chandeliers.	Not applicable	No Allowance	0.007 W/ft²	0.013 W/ft²	0.019 W/ft²
WATTAGE ALLOWANCE PER SPECIFIC AREA (W/ft²). Use as appropriate provided that none of the following specific applications shall be used for the same area.					
Building Facades. Only areas of building façade that are illuminated shall qualify for this allowance. Luminaires qualifying for this allowance shall be aimed at the façade and shall be capable of illuminating it without obstruction or interference by permanent building features or other objects. This allowance calculation shall not include portions of the building facades within 20 feet of residence bedroom windows.	Not applicable	No Allowance	0.100 W/ft²	0.170 W/ft²	0.225 W/ft²

Canopies and Tunnels. Allowance for the total area within the drip line of the canopy or inside the tunnel. Luminaires qualifying for this allowance shall be located under the canopy or tunnel.		Not applicable	0.057 W/ft²	0.137 W/ft²	0.270 W/ft²	0.370 W/ft²
	Student Pick-up/Drop-off zone. Allowance for the area of the student pick-up/drop-off zone, with or without canopy, for preschool through 12th grade school campuses. A student pick-up/drop off zone is a curbside, controlled traffic area on a school campus where students are picked-up and dropped off from vehicles. The allowed area shall be the smaller of the actual width or 25 feet, times the smaller of the actual length or 250 feet. Qualifying luminaires shall be within 2 mounting heights of the student pick-up/drop-off zone.	Not applicable	No Allowance	0.056 W/ft²	0.200 W/ft²	No Allowance
	Outdoor Dining. Allowance for the total illuminated hardscape of outdoor dining. Outdoor dining areas are hardscape areas used to serve and consume food and beverages. Qualifying luminaires shall be within 2 mounting heights of the hardscape area of outdoor dining.	Not applicable	0.004 W/ft²	0.030 W/ft²	0.050 W/ft²	0.075 W/ft²
	Special Security Lighting for Retail Parking and Pedestrian Hardscape. This additional allowance is for illuminated retail parking and pedestrian hardscape identified as having special security needs. This allowance shall be in addition to the building entrance or exit allowance.	Not applicable	0.004 W/ft²	0.005 W/ft²	0.010 W/ft²	No Allowance
	Security Camera. This additional allowance is for the illuminated general hardscape area. This allowance shall apply when a security camera is installed within 2 mounting heights of the general hardscape area and mounted more than 10 feet away from a building.	Not applicable	No Allowance	0.018 W/ft²	0.018 W/ft²	0.018 W/ft²

7. Requirements for Signs. Section 170.2(e)7 applies to all internally illuminated and externally illuminated signs, unfiltered light emitting diodes (LEDs), and unfiltered neon, both indoor and outdoor. Each sign shall comply with either Subsection A or B, as applicable.

A. Maximum Allowed Lighting Power.

i. For internally illuminated signs, the maximum allowed lighting power shall not exceed the product of the illuminated sign area and 12 watts per square foot. For double-faced signs, only the area of a single face shall be used to determine the allowed lighting power.

ii. For externally illuminated signs, the maximum allowed lighting power shall not exceed the product of the illuminated sign area and 2.3 watts per square foot. Only areas of an externally lighted sign that are illuminated without obstruction or interference, by one or more luminaires, shall be used.

iii. Lighting for unfiltered light emitting diodes (LEDs) and unfiltered neon shall comply with Section 170.2(e)7B.

B. Alternate Lighting Sources. The sign shall be equipped with one or more of the following light sources:

i. High pressure sodium lamps; or

ii. Metal halide lamps that are:

a. Pulse start or ceramic served by a ballast that has a minimum efficiency of 88 percent or greater; or

b. Pulse start that are 320 watts or smaller, are not 250 watt or 175 watt lamps, and are served by a ballast that has a minimum efficiency of 80 percent.

Ballast efficiency is the reference lamp power divided by the ballast input power when tested according to ANSI C82.6-2015.

iii. Neon or cold cathode lamps with transformer or power supply efficiency greater than or equal to following:

a. A minimum efficiency of 75 percent when the transformer or power supply rated output current is less than 50 mA; or

b. A minimum efficiency of 68 percent when the transformer or power supply rated output current is 50 mA or greater.

The ratio of the output wattage to the input wattage is at 100 percent tubing load.

iv. Fluorescent lighting systems meeting one of the following requirements:

a. Use only lamps with a minimum color rendering index (CRI) of 80; or

b. Use only electronic ballasts with a fundamental output frequency not less than 20 kHz.

v. Light emitting diodes (LEDs) with a power supply having an efficiency of 80 percent or greater; or

EXCEPTION to Section 170.2(e)7Bv: Single voltage external power supplies that are designed to convert 120 volt AC input into lower voltage DC or AC output, and have a nameplate output power less than or equal to 250 watts, shall comply with the applicable requirements of the Appliance Efficiency Regulations (Title 20).

vi. Compact fluorescent lamps that do not contain a medium screw base sockets (E24/E26).

EXCEPTION 1 to Section 170.2(e)7: Unfiltered incandescent lamps that are not part of an electronic message center (EMC), an internally illuminated sign, or an externally illuminated sign.

EXCEPTION 2 to Section 170.2(e)7: Exit signs. Exit signs shall meet the requirements of the Appliance Efficiency Regulations.

(f) Photovoltaic Requirements – Three Habitable Stories or Less. All multifamily buildings up to three habitable stories shall comply with the photovoltaic requirements of Section 150.1(c)14.

(g) Photovoltaic Requirements - More Than Three Habitable Stories. All multifamily buildings with more than three habitable stories shall comply with the photovoltaic requirements of Section 140.10(a).

(h) Battery Storage System Requirements – More Than Three Habitable Stories. All multifamily buildings with more than three habitable stories shall comply with the battery storage system requirements of Section 140.10(b).

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SUBCHAPTER 12
MULTIFAMILY BUILDINGS - ADDITIONS, ALTERATIONS, AND REPAIRS TO EXISTING MULTIFAMILY BUILDINGS

SECTION 180.0 – GENERAL

Additions, alterations, and repairs to existing attached dwelling units and common use areas in multifamily buildings, existing outdoor lighting for these occupancies, and internally and externally illuminated signs, shall meet the requirements specified in Sections 100.0 through 110.10, and 160.1 through 170.2 that are applicable to the building project, and either the performance compliance approach (energy budgets) in Section 180.1(b) (for additions) or 180.2(c) (for alterations), or the prescriptive compliance approach in Section 180.1(a) (for additions) or 180.2(b) (for alterations), for the Climate Zone in which the building is located. Climate zones are shown in FIGURE 100.1-A.

Covered process requirements for additions, alterations and repairs to existing multifamily buildings are specified in Section 141.1.

Nonresidential occupancies in mixed occupancy buildings shall comply with nonresidential requirements in Sections 120.0 through 141.1.

NOTE: For alterations that change the occupancy classification of the building, the requirements specified in Section 180.2 apply to the occupancy after the alterations.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 180.1 – ADDITIONS

Additions to existing multifamily buildings shall meet the applicable requirements of Sections 110.0 through 110.9, Sections 160.0, 160.1, 160.2(c) and (d), 160.3 through 160.7, and either Section 180.1(a) or 180.1(b).

Exception 1 to Section 180.1: Additions 1,000 square feet or less are exempt from the requirement to provide dwelling unit mechanical ventilation airflow as specified by Section 180.1(a) or 180.1(b).

EXCEPTION 2 to Section 180.1: Additions of 300 square feet or less are exempt from the roofing product requirements of Section170.2(a)1A.

EXCEPTION 3 to Section 180.1: Existing inaccessible piping shall not require insulation as defined under Section 160.4(f)2Aiii.

EXCEPTION 4 to Section 180.1: Space-Conditioning System. When heating or cooling will be extended to an addition from the existing system(s), the existing heating and cooling equipment need not comply with Part 6. The heating system capacity must be adequate to meet the minimum requirements of CBC Section 1204.1.

EXCEPTION 5 to Section 180.1: Space-Conditioning System Ducts. When any length of ducts are extended from an existing duct system to serve the addition, the existing duct system and the extended ducts shall meet the applicable requirements specified in Section 180.1(b)2ai and 180.1(b)2aii.

EXCEPTION ~~7~~ 6 to Section 150.2(a): Photovoltaic and battery storage systems, as specified in Section 170.2(f) through 170.2(h), are not required for additions.

(a) Prescriptive approach. The envelope and lighting of the addition; any newly installed space-conditioning or ventilation system, electrical power distribution system, or water-heating system; any addition to an outdoor lighting system; and any new sign installed in conjunction with an indoor or outdoor addition shall meet the applicable requirements of Sections 110.0 through 110.12, and 160.0, 160.1, 160.2(c) and (d), 160.3 through 170.2.

1. Envelope.

A. Additions that are greater than 700 square feet shall meet the requirements of Section 170.2(a), with the following modifications:

i. Framed Walls Extension. Extensions of existing wood-framed walls may retain the dimensions of the existing walls and shall install cavity insulation of R-15 in a 2x4 framing and R-21 in a 2x6 framing.

ii. The maximum allowed fenestration area shall be the greater of 175 square feet or 20 percent of the addition floor area.

iii. When existing siding of a wood-framed wall is not being removed or replaced, cavity insulation of R-15 in a 2x4 framing and R-21 in a 2x6 framing shall be installed and continuous insulation is not required.

iv. Additions that consist of the conversion of existing spaces from unconditioned to conditioned space shall not be required to perform the air sealing part of QII when the existing air barrier is not being removed or replaced.

B. Additions that are 700 square feet or less shall meet the requirements of Section 170.2(a), with the following modifications.

i. Roof and Ceiling insulation in a ventilated attic shall meet one of the following requirements:

a. In Climate Zones 1, 2, 4, and 8 through 16, achieve an overall assembly U-factor not exceeding 0.025. In wood framed assemblies, compliance with U-factors may be demonstrated by installing insulation with an R-value of R-38 or greater.

b. In Climate Zones 3, and 5 through 7, achieve an overall assembly U-factor not exceeding 0.031. In wood framed assemblies, compliance with U-factors may be demonstrated by installing insulation with an R-value of R-30 or greater.

ii. Radiant Barrier – For buildings three habitable stories or less, radiant barriers shall be installed in attics with exposed attic deck undersides in climate zones 2-15.

iii. Extensions of existing wood-framed walls may retain the dimensions of the existing walls and shall install cavity insulation of R-15 in a 2x4 framing and R-21 in a 2x6 framing; and

iv. Fenestration products must meet the U-factor, RSGHC, and VT requirements of TABLE 180.2-~~A~~B

v. Quality Insulation Installation (QII) requirements of Section 170.2(a)6 do not apply.

EXCEPTION 1 to Section 180.1(a)1B: Insulation in an enclosed rafter ceiling shall meet the requirements of Section 160.1(a).

EXCEPTION 2 to Section 180.1(a)1B: Additions that increase the area of the roof by 2,000 square feet or less are exempt from the requirements of Section 160.8.

2. Mechanical Ventilation for Indoor Air Quality. Additions to existing buildings shall comply with Section 160.2 subject to the requirements specified in subsections A and B below. When HERS field verification and diagnostic testing is required by Section 180.1(a)2, buildings with three habitable stories or less shall use the applicable procedures in the Residential Appendices, and buildings with four or more habitable stories shall use the applicable procedures in Nonresidential Appendices NA1 and NA2.

A. **Whole-dwelling Unit Mechanical Ventilation**.

i. Dwelling units that meet the conditions in subsections a or b below shall not be required to comply with the whole-dwelling unit ventilation airflow specified in Sections 160.2(b)2Aiv or 160.2(b)2Av.

a. Additions to an existing dwelling unit that increase the conditioned floor area of the existing dwelling unit by less than or equal to 1000 square feet.

b. Junior Accessory Dwelling Units (JADU) that are additions to an existing building.

ii. Additions to an existing dwelling unit that increase conditioned floor area by more than 1,000 square feet shall have mechanical ventilation airflow in accordance with Sections 160.2(b)2Aiv or 160.2(b)2Av, as applicable. The mechanical ventilation airflow rate shall be based on the conditioned floor area of the entire dwelling unit comprised of the existing dwelling unit conditioned floor area plus the addition conditioned floor area.

iii. New dwelling units that are additions to an existing building shall have mechanical ventilation airflow provided in accordance with Sections 160.2(b)2Aiv or 160.2(b)2Av as applicable. The mechanical ventilation airflow rate shall be based on the conditioned floor area of the new dwelling unit.

B. Local Mechanical Exhaust. Additions to existing buildings shall comply with all applicable requirements specified in 160.2(b)2Avi and 160.2(b)2B.

3. Water Heater. When additional water heating equipment is installed as part of the addition, one of the following types of water heaters shall be installed:

A. A water-heating system that meets the requirements of Section 170.2(d); or

B. A water-heating system determined by the Executive Director to use no more energy than the one specified in Item A above.

(b) Performance approach. Performance calculations shall meet the requirements of Section 170.0 through 170.2(a), pursuant to the applicable requirements in Items 1, 2, and 3 below.

1. For additions alone. The addition complies if the addition alone meets the energy budgets as specified in Section 170.1.

2. Existing plus alteration plus addition. The standard design for existing plus alteration plus addition energy use is the combination of the existing building's unaltered components to remain; existing building altered components that are the more efficient, in TDV energy, of either the existing conditions or the requirements of Section 180.2(c); plus the proposed addition's energy use meeting the requirements of Section 180.1(a). The proposed design energy use is the combination of the existing building's unaltered components to remain and the altered components' energy features, plus the proposed energy features of the addition.

EXCEPTION to Section180.1(b)2: Existing structures with a minimum R-11 insulation in framed walls showing compliance with Section 180.1(b) are exempt from showing compliance with Section 160.1(b).

3. **Mechanical Ventilation for Indoor Air Quality**. Additions to existing buildings shall comply with Section 160.1(b)2 subject to the requirements specified in subsections A and B below. When HERS field verification and diagnostic testing is required by Section 180.1(b)3, buildings with three habitable stories or less shall use the applicable procedures in the Residential Appendices, and buildings with four or more habitable stories shall use the applicable procedures in Nonresidential Appendices NA1 and NA2.

A. **Whole-dwelling Unit Mechanical Ventilation**.

i. Dwelling units that meet the conditions in subsections a or b below shall not be required to comply with the whole-dwelling unit ventilation airflow specified in Sections 160.2(b)2Aiv or 160.2(b)2Av.

a. Additions to an existing dwelling unit that increase the conditioned floor area of the existing dwelling unit by less than or equal to 1000 square feet.

b. Junior Accessory Dwelling Units (JADU) that are additions to an existing building.

ii. Additions to an existing dwelling unit that increase the conditioned floor area of the existing dwelling unit by more than 1,000 square feet shall have mechanical ventilation airflow in accordance with Section 160.2(b)2Aiv or 160.2(b)2Av as applicable. The mechanical ventilation airflow rate shall be based on the conditioned floor area of the entire dwelling unit comprised of the existing dwelling unit conditioned floor area plus the addition conditioned floor area.

iii. New dwelling units that are additions to an existing building shall have mechanical ventilation airflow provided in accordance with Section 160.2(b)2Aiv or 160.2(b)2Av as applicable. The mechanical ventilation airflow rate shall be based on the conditioned floor area of the new dwelling unit.

B. **Local Mechanical Exhaust**. Additions to existing buildings shall comply with all applicable requirements specified in 160.2(b)2Avi and 160.2(b)2B.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 180.2 – ALTERATIONS

Alterations to components of existing multifamily buildings, including alterations made in conjunction with a change in building occupancy to a multifamily occupancy shall meet item (a), and either Item (b) or (c) below:

EXCEPTION 1 to Section 180.2: When heating, cooling or service water heating for an alteration are provided by expanding existing systems, the existing systems and equipment need not comply with Sections 110.0 through 110.10, 160.0 through 160.7, and Section 170.2(c) or 170.2(d).

EXCEPTION 2 to Section 180.2: When existing heating, cooling or service water heating systems or components are moved within a building, the existing systems or components need not comply with Sections 110.0 through 110.10, 160.0 through 160.7, and Section 170.2(c) or 170.2(d).

EXCEPTION 3 to Section 180.2: Where an existing system with electric reheat is expanded when adding variable air volume (VAV) boxes to serve an alteration, total electric reheat capacity may be expanded not to exceed 20 percent of the existing installed electric capacity in any one permit and the system need not comply Section 170.2(b)4E. Additional electric reheat capacity in excess of 20 percent may be added subject to the requirements of the Section 170.2(b)4E.

EXCEPTION 4 to Section 180.2: The requirements of Section 160.3(a)2H shall not apply to alterations of space-conditioning systems or components.

(a) Mandatory Requirements. Altered components in a multifamily building shall meet the minimum requirements in this Section.

1. Roof/Ceiling Insulation. The opaque portions of the roof/ceiling that separate conditioned spaces from unconditioned spaces or ambient air shall meet the requirements of Section 180.2(b)1B.

2. Wall Insulation. For the altered opaque portion of walls separating conditioned spaces from unconditioned spaces or ambient air shall meet the applicable requirements of Items A through D below:

A. Metal Building. A minimum of R-13 insulation between framing members, or the area-weighted average U-factor of the wall assembly shall not exceed U-0.113.

B. Metal Framed. A minimum of R-13 insulation between framing members, or the area-weighted average U-factor of the wall assembly shall not exceed U-0.217.

C. Wood Framed and Others. A minimum of R-11 insulation between framing members, or the area-weighted average U-factor of the wall assembly shall not exceed U-0.110.

D. Spandrel Panels and Curtain Walls. A minimum of R-4, or the area-weighted average U-factor of the wall assembly shall not exceed U-0.280.

EXCEPTION to Section 180.2(a)2: Light and heavy mass walls.

3. Floor Insulation. For the altered portion of raised floors that separate conditioned spaces from unconditioned spaces or ambient air shall meet the applicable requirements of Items A through B below:

A. Raised Framed Floors. A minimum of R-11 insulation between framing members, or the area-weighted average U-factor of the floor assembly shall not exceed the U-factor of U-0.071.

B. Raised Mass Floors. A minimum of R-6 insulation, or the area-weighted average U-factor of the floor assembly shall not exceed the U-factor of U-0.111.

(b) Prescriptive approach. The altered component and any newly installed equipment serving the alteration shall meet the applicable requirements of Sections 110.0 through 110.9 and all applicable requirements of Section 160.0, 160.1, 160.2(c) and (d), 160.3(a) through 160.3(b)5J, 160.3(b)6, 160.3(c), and 160.5; and

1. Envelope -

A. Roofing Products. Existing roofs being replaced, recovered or recoated, of a multifamily building shall meet the requirements of Section 110.8(i). Roofs with more than 50 percent of the roof area or more

than 2,000 square feet of roof, whichever is less, being altered the requirements of i through ii~~i~~ below apply:

EXCEPTION to Section 180.2(b)1A: Roof area covered by building integrated photovoltaic panels and building integrated solar thermal panels are not required to meet the minimum requirements for solar reflectance, thermal emittance, or SR.

i. Low-sloped roofs in Climate Zones 2,4, and 6 through 15 shall have a minimum aged solar reflectance of 0.63 and a minimum thermal emittance of 0.75, or a minimum SRI of 64.

EXCEPTION 1 to Section 180.2(b)1Ai: An aged solar reflectance less than 0.63 is allowed for low-sloped roofs provided the maximum roof/ceiling U-factor in TABLE 180.2-A is not exceeded.

Table 180.2-A- Roof/Ceiling Insulation Tradeoff for Low-Sloped Aged Solar Reflectance

Minimum Aged Solar Reflectance	Roof Deck Continuous Insulation R-value (Climate Zones 6-7)	Roof Deck Continuous Insulation R-value (Climate Zones 2, 4, 8-15)
0.60	2	16
0.55	4	18
0.50	6	20
0.45	8	22
No requirement	10	24

EXCEPTION 2 to Section 180.2(b)1Ai: Roof constructions with a weight of at least 25 lb/ft² are not required to meet the minimum requirements for solar reflectance, thermal emittance, or SRI.

ii. Steep-sloped roofs Climate Zones 4 and 8 through 15 shall have a minimum aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16.

EXCEPTION 1 TO 150.2(b)1Ji: The following shall be considered equivalent to Subsection i:

a. Buildings with ceiling assemblies with a U-factor lower than or equal to 0.025 or that are insulated with at least R-38 ceiling insulation in an attic; or

b. Buildings with a radiant barrier in the attic, where the radiant barrier is not installed directly above spaced sheathing, meeting the requirements of Section 150.1(c)2; or

c. Buildings that have no ducts in the attic in Climate Zones 2, 4, 9, 10, 12, and 14; or

d. Buildings with R-2 or greater continuous insulation above or below the roof deck.

B. Roof/Ceiling Insulation.

i. Attic Roof. Vented attics shall meet the following:

a. In Climate Zones 1 through 4 and 8 through 16, insulation shall be installed to achieve a weighted U-factor of 0.020 or insulation installed at the ceiling level shall result in an installed thermal resistance of R-49 or greater for the insulation alone; and

EXCEPTION 1 to Section 180.2(b)1Bia: Dwelling units with at least R-19 existing insulation installed at the ceiling level with third party verification of existing conditions in Climate Zones 1, 3, 4, and 9.

b. In Climate Zones 2 and 11 through 16, air seal all accessible areas of the ceiling plane between the attic and the conditioned space in accordance with Section 110.7; and

EXCEPTION 1 to Section 180.2(b)1Bib: Dwelling units with at least R-19 existing insulation installed at the ceiling level with third party verification of existing conditions.

EXCEPTION 2 to Section 180.2(b)1Bib: Dwelling units with atmospherically vented space heating or water heating combustion appliances located inside the pressure boundary of the dwelling unit.

c. In Climate Zones 1 through 4 and 8 through 16, recessed downlight luminaires in the ceiling shall be covered with insulation to the same depth as the rest of the ceiling. Luminaires not rated for insulation contact must be replaced or fitted with a fire-proof cover that allows for insulation to be installed directly over the cover; and

EXCEPTION 1 to Section 180.2(b)1Bic: Dwelling units with at least R-19 existing insulation installed at the ceiling level with third party verification of existing conditions in Climate Zones 1 through 4 and 8 through 10.

d. Attic ventilation shall comply with CBC requirements.

EXCEPTION 1 to Section 180.2(b)1Bi: Dwelling units with at least R-38 existing insulation installed at the ceiling level with third party verification of existing conditions.

EXCEPTION 2 to Section 180.2(b)1Bi: Dwelling units where the alteration would directly cause the disturbance of asbestos, unless the alteration is made in conjunction with asbestos abatement.

EXCEPTION 3 to Section 180.2(b)1Bi: Dwelling units with knob and tube wiring located in the vented attic.

EXCEPTION 4 to Section 180.2(b)1Bi: Where the accessible space in the attic is not large enough to accommodate the required R-value, the entire accessible space shall be filled with insulation provided such installation does not violate Section 806.3 of Title 24, Part 2.5.

EXCEPTION 5 to Section 180.2(b)1Bi: Where the attic space above the altered dwelling unit is shared with other dwelling units and the requirements of Section 150.2(b)1A are not triggered for the other dwelling units.

ii. **Non Attic Roof**. When low-sloped roofs are replaced and recovered, and meets Section 180.2(b)1A or B, the replaced area shall be insulated to R-14 continuous insulation or a U-factor of 0.55 in Climate Zones 1, 2, 4, and 8 through 16.

EXCEPTION 1 to Section 180.2(b)1Bii: Roof recovers with new R-10 insulation added above deck do not need to be insulated to meet R-14.

EXCEPTION 2 to Section 180.2(b)1Bii: Roof replacements. When existing mechanical equipment is located on the roof ~~and~~ will not be disconnected and lifted, insulation added may be limited to the maximum insulation thickness that will allow a height in accordance with manufacturers' instructions from the roof membrane surface to the top of the base flashing or R-10, whichever is greater.

EXCEPTION 3 to Section 1180.2(b)1Bii: At the drains and other low points, tapered insulation with a thermal resistance less than R-14 may be used, provided that insulation thickness is increased at the high points of the roof so that the average thermal resistance equals or exceeds R-14 ~~.~~

C. Fenestration alterations other than repair shall meet the requirements below:

NOTE: Glass replaced in an existing sash and frame or sashes replaced in an existing frame are considered repairs. In these cases, Section 180.2(b) requires that the replacement be at least equivalent to the original in performance.

i. Fenestration products installed to replace existing fenestration products of the same total area shall meet either a or b:

a. The maximum U-factor, RSHGC, and VT requirements of TABLE 180.2-~~A~~B, or

b. The area-weighted U-factor and RSHGC of TABLE 170.2-A.

EXCEPTION 1 to Section 180.2(b)1Ci: In an alteration, where 150 square feet or less of the entire building's vertical fenestration is replaced, RSHGC and VT requirements of TABLE 180.2-~~A~~B shall not apply.

ii. Alterations that add fenestration and skylight area shall meet the total fenestration area requirements of Section 170.2(a) and the U-factor, RSHGC, and VT requirements of TABLE 180.2-~~A~~B.

EXCEPTION 1 to Section 180.2(b)1Cii: Alterations that add fenestration area of up to 50 square feet shall not be required to meet the total fenestration area requirements of Sections 170.2(a), nor the U-factor, RSHGC, and VT requirements of TABLE 180.2-~~A~~B.

EXCEPTION 2 to Section 180.2(b)1Cii: Alterations that add up to 16 square feet of new skylight area per dwelling unit with a maximum U-factor of 0.55 and a maximum RSHGC of 0.30 area shall not be required to meet the total fenestration area requirements of Section 170.2(a)3.

D. Exterior doors. Alterations that add exterior door area shall meet the U-factor requirement of Section 170.2(a)4.

Table 180.2-~~A~~B Altered Fenestration Maximum U-Factor and Maximum SHGC

Climate Zone		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Curtainwall / Storefront / Window Wall and Glazed Doors[1]	U-factor	0.384~~1~~	0.41~~3~~	0.41	0.41~~3~~	0.41	0.41~~7~~	0.41~~7~~	0.41~~3~~	0.41	0.41~~3~~	0.41	0.41	0.41	0.41	0.41	0.384~~1~~
	RSHGC	0.35	0.26	0.26	0.26	0.26	0.26~~31~~	0.26~~31~~	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.25~~6~~
	VT[2]	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
NAFS 2017 Performance Class AW Window – Fixed[1]	U-factor	0.38	0.38	0.38	0.38	0.38	0.47	0.47	0.41	0.41	0.38	0.38	0.38	0.38	0.38	0.38	0.38
	RSHGC	0.35	0.25	0.25	0.25	0.25	0.31	0.31	0.26	0.26	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	VT[2]	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
NAFS 2017 Performance Class AW Window – Operable[1]	U-factor	0.43	0.43	0.43	0.43	0.43	0.47	0.47	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
	RSHGC	0.35	0.24	0.24	0.24	0.24	0.31	0.31	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
	VT[2]	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
All Other Windows and Glazed Doors[1]	U-factor	0.30	0.30	0.30	0.30	0.30	0.30	0.34	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
	RSHGC	0.35	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
Skylights, 3 habitable stories and fewer	U-factor	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
	RSHGC	NA	0.23	NA	0.23	NA	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	NA
Skylights, 4 habitable stories and greater	U-factor	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
	RSHGC	0.35	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	VT[2]	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49

Foot note to Table 180.2-~~A~~B:

1. For fenestration installed in buildings with three or fewer habitable stories, there is no SHGC requirement in Climate Zones 1, 3, 5, and 16.
2. Minimum VT requirements to not apply to multifamily buildings 3 habitable stories or less.

2. Space Conditioning Systems.

A. Space Conditioning Systems Serving Dwelling Units.

i. Entirely New or Complete Replacement Space-Conditioning Systems installed as part of an alteration, shall include all the system heating or cooling equipment, including but not limited to: condensing unit, cooling or heating coil, and air handler for split systems; or complete replacement of a packaged unit; plus entirely new or replacement duct system (Section 180.2(b)2Aiib). Entirely new or complete replacement space-conditioning systems shall meet the requirements of Sections 160.2(a)1, 160.3(a)1, 160.3(b)1 through 3, 160.3(b)5, 160.3(b)6, 160.3(c)1, and 170.2(c)3A and TABLE 180.2-~~B~~C.

ii. Altered Duct Systems - Duct Sealing: In all Climate Zones, when more than 25 feet of new or replacement space-conditioning system ducts are installed, the ducts shall comply with the applicable requirements of subsections a and b below. New ducts located in unconditioned space shall meet the applicable requirements of Sections 160.3(b)5A through ~~K~~J, and the duct insulation requirements of TABLE 180.2-~~B~~C, and

a. The altered duct system, regardless of location, shall be sealed as confirmed through field verification and diagnostic testing in accordance with all applicable procedures for duct sealing of altered existing duct systems as specified in Reference Residential Appendix RA3.1, utilizing the leakage compliance criteria specified in subsection I or II below.

TABLE 180.2-~~B~~C DUCT INSULATION R-VALUE

Climate Zone	3, 5 through 7	1, 2, 4, 8 through 16
Duct R-Value	R-6	R-8

I. Entirely New or Complete Replacement Duct System. If the new ducts form an entirely new or complete replacement duct system directly connected to the air handler, the duct system shall meet one of the following requirements:

A. The total leakage of the duct system shall not exceed 12 percent of the nominal system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1, or

B. The duct system leakage to outside shall not exceed 6 percent of the nominal system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.4.

Entirely new or complete replacement duct systems installed as part of an alteration shall be constructed of at least 75 percent new duct material, and up to 25 percent may consist of reused parts from the dwelling unit's existing duct system, including but not limited to registers, grilles, boots, air handler, coil, plenums, duct material; if the reused parts are accessible and can be sealed to prevent leakage.

Entirely new or complete replacement duct systems shall also conform to the requirements of Sections 160.2(a)1 and 160.3(b)5L.

II. Extension of an Existing Duct System**.** If the new ducts are an extension of an existing duct system serving multifamily dwellings, the combined new and existing duct system shall meet one of the following requirements:

A. The measured duct leakage shall be equal to or less than 15 percent of system air handler airflow as confirmed by field verification and diagnostic testing utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1; or

B. The measured duct leakage to outside shall be equal to or less than 10 percent of system air handler airflow as confirmed by field verification and diagnostic testing utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.4; or

C. If it is not possible to meet the duct sealing requirements of either Section 180.2(b)2AiicI or II then all accessible leaks shall be sealed and verified through a visual inspection and a smoke test by a certified HERS Rater utilizing the methods specified in Reference Residential Appendix RA3.1.4.3.5.

EXCEPTION to Section 180.2(b)2AiibII: Duct Sealing. Existing duct systems that are extended, which are constructed, insulated or sealed with asbestos.

EXCEPTION 1 to 180.2(b)2Aii: The HERS Rater field verification and HERS Provider data registry requirements of Reference Residential Appendix RA2 and RA3 are not required for multifamily dwelling units in buildings four stories and greater. The installer shall certify that diagnostic testing was performed in accordance with the applicable procedures.

~~**EXCEPTION 2 to 180.2(b)2Aii:** Multifamily dwelling units in buildings four stories and greater in Climate Zone 1.~~

iii. Altered Space-Conditioning System – Duct Sealing In all Climate Zones, when a space-conditioning system serving a multifamily dwelling is altered by the installation or replacement of space-conditioning system equipment, including replacement of the air handler, outdoor condensing unit of a split system air conditioner or heat pump, or cooling or heating coil; the duct system that is connected to the altered space-conditioning system equipment shall be sealed, as confirmed through field verification and diagnostic testing in accordance with the applicable procedures for duct sealing of altered existing duct systems as specified in Reference Residential Appendix RA3.1 and the leakage compliance criteria specified in subsections a, b, or c below.

a. The measured duct leakage shall be equal to or less than 15 percent of system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1; or

b. The measured duct leakage to outside shall be equal to or less than 10 percent of system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.4; or

c. If it is not possible to meet the duct sealing requirements of either Section 180.2(b)2Aiiia or b, then, all accessible leaks shall be sealed and verified through a visual inspection and a smoke test by a certified HERS Rater utilizing the methods specified in Reference Residential Appendix RA3.1.4.3.5.

EXCEPTION 1 to Section 180.2(b)2Aiii: **Duct Sealing.** Duct systems that are documented to have been previously sealed as confirmed through field verification and diagnostic testing in accordance with procedures in the Reference Residential Appendix RA3.1.

EXCEPTION 2 to Section 180.2(b)2Aiii: Duct Sealing. Duct systems with less than 40 linear feet as determined by visual inspection.

EXCEPTION 3 to Section 180.2(b)2Aiii: Duct Sealing. Existing duct systems constructed, insulated or sealed with asbestos.

EXCEPTION 4 to Section 180.2(b)2Aiii: The HERS Rater field verification and HERS Provider data registry requirements of Reference Residential Appendix RA2 and RA3 are not required for multifamily dwelling units in buildings four stories and greater. The installer shall certify that diagnostic testing was performed in accordance with the applicable procedures.

~~**EXCEPTION 5 to 180.2(b)2Aiii:** Multifamily dwelling units in buildings four stories and greater in Climate Zone 1.~~

iv. Altered Space-Conditioning System Mechanical Cooling. When a space-conditioning system is an air conditioner or heat pump that is altered by the installation or replacement of refrigerant-containing system components such as the compressor, condensing coil, evaporator coil, refrigerant metering device or refrigerant piping, the altered system shall comply with the following requirements:

a. All thermostats associated with the system shall be replaced with setback thermostats meeting the requirements of Section 110.2(c).

b. In Climate Zones 2, 8, 9, 10, 11, 12, 13, 14, and 15, air-cooled air conditioners and air-source heat pumps, including but not limited to ducted split systems, ducted package systems, small duct high velocity air systems, and minisplit systems, shall comply with subsections I and II, unless the system is of a type that cannot be verified using the specified procedures. Systems that cannot comply with the requirements of Section 180.2(b)2Aivb shall comply with Section 180.2(b)2Aivc.

EXCEPTION to Section 180.2(b)2Aivb: Entirely new or complete replacement packaged systems for which the manufacturer has verified correct system refrigerant charge prior to shipment from the factory are not required to have refrigerant charge confirmed through field verification and diagnostic testing. The installer of these packaged systems shall certify that the packaged system was pre-charged at the factory and has not been altered in a way that would affect the charge. Ducted systems shall comply with minimum system airflow rate requirement in Section 180.2(b)2AivbI, provided that the system is of a type that can be verified using the procedure specified in RA3.3 or an approved alternative in RA1.

I. Minimum system airflow rate shall comply with the applicable subsection A or B below as confirmed through field verification and diagnostic testing in accordance with the procedures specified in Reference Residential Appendix Section RA3.3 or an approved alternative procedure as specified in Section RA1.;

A. Small duct high velocity systems shall demonstrate a minimum system airflow rate greater than or equal to 250 cfm per ton of nominal cooling capacity; or

B. All other air-cooled air conditioner or air-source heat pump systems shall demonstrate a minimum system airflow rate greater than or equal to 300 cfm per ton of nominal cooling capacity; and

EXCEPTION 1 to Section 180.2(b)2AivbI: Systems unable to comply with the minimum airflow rate requirement shall demonstrate compliance using the procedures in Section RA3.3.3.1.5; and the system's thermostat shall conform to the specifications in Section 110.12.

EXCEPTION 2 to Section 180.2(b)2AivbI: Entirely new or complete replacement space conditioning systems, as specified by Section 180.2(b)2Ai, without zoning dampers may comply with the minimum airflow rate by meeting the applicable requirements in TABLE 160.3-A or 160.3-B as confirmed by field verification and diagnostic testing in accordance with the procedures in Reference Residential Appendix Section RA3.1.4.4 and RA3.1.4.5. The design clean-filter pressure drop requirements of Section160.2(a)1C for the system air filter device(s) shall conform to the requirements given in TABLES 160.3-A and 160.3-B.

II. The installer shall charge the system according to manufacturer's specifications. Refrigerant charge shall be verified according to one of the following options, as applicable.

A. The installer and rater shall perform the standard charge verification procedure as specified in Reference Residential Appendix Section RA3.2.2, or an approved alternative procedure as specified in Section RA1; or

B. The system shall be equipped with a fault indicator display (FID) device that meets the specifications of Reference Joint Appendix JA6. The installer shall verify the refrigerant charge and FID device in accordance with the procedures in Reference Residential Appendix Section RA3.4.2. The HERS Rater shall verify FID device in accordance with the procedures in Section RA3.4.2; or

C. The installer shall perform the weigh-in charging procedure as specified by Reference Residential Appendix Section RA3.2.3.1 provided the system is of a type that can be verified using the RA3.2.2 standard charge verification procedure and RA3.3 airflow rate

verification procedure or approved alternatives in RA1. The HERS Rater shall verify the charge using RA3.2.2 and RA3.3 or approved alternatives in RA1

EXCEPTION 1 to Section 180.2(b)2AivbII: When the outdoor temperature is less than 55 degrees F and the installer utilizes the weigh-in charging procedure in Reference Residential Appendix Section RA3.2.3.1to demonstrate compliance, the installer may elect to utilize the HERS Rater verification procedure in Reference Residential Appendix Section RA3.2.3.2. If the HERS Rater verification procedure in Section RA3.2.3.2 is used for compliance, the system's thermostat shall conform to the specifications in Section 110.12. Ducted systems shall comply with the minimum system airflow rate requirements in Section 180.2(b)2AivbI.

EXCEPTION 2 to Section 180.2(b)2Aivb: The HERS Rater field verification and HERS Provider data registry requirements of Reference Residential Appendix RA2 and RA3 are not required for multifamily dwelling units in buildings four stories and greater. The installer shall certify that diagnostic testing was performed in accordance with the applicable procedures.

v. Altered Space-Heating System. Altered or replacement space-heating systems shall comply with Section 170.2(c)3M.

EXCEPTION 1 to Section 180.2(b)2Av: A non-ducted electric resistance space heating system if the existing space heating system is electric resistance.

EXCEPTION 2 to Section 180.2(b)2Av: A ducted electric resistance space heating system where only the electric resistance heating system is being replaced.

EXCEPTION 3 to Section 180.2(b)2Av: An electric resistance space heating system if the existing space heating system is electric resistance in Climate Zones 6, 7, 8, or 15.

B. Common Use Area Space Conditioning Systems

i. New or Replacement Space-Conditioning Systems or Components other than new or replacement space-conditioning system ducts shall meet the requirements of Sections 170.2(c)1, 2, and 4, applicable to the systems or components being altered. For compliance with Section 170.2(c)4A, additional fan power adjustment credits are available as specified in TABLE 180.2-~~C~~D.

TABLE 180.2-~~C~~D Fan Power Limitation Pressure Drop Adjustment

Device	Adjustment Credits
Particulate Filtration Credit: MERV 9 through 12	0.5 in. of water
Particulate Filtration Credit: MERV 13 through 15	0.9 in. of water

EXCEPTION ~~2~~1 to Section 180.2(b)2Bi. Section 180.2(b)2Av does not apply to replacement of electric reheat of equivalent or lower capacity electric resistance space heaters, when natural gas is not available.

EXCEPTION ~~3~~2 to Section 180.2(b)2Bi. Section 170.2(c)4L is not applicable to new or replacement space conditioning systems.

ii. Altered Duct Systems. When new or replacement space-conditioning system ducts are installed to serve an existing building, the new ducts shall meet the requirements of Section 160.3(c)2 and meet a or b below:

a. RESERVED.

b. Entirely new or replacement duct systems installed as part of an alteration shall be leakage-tested in accordance with Section 160.2(c)2H. Entirely new or replacement duct systems installed as part of an alteration shall be constructed of at least 75 percent new duct material, and up to 25 percent may consist of reused parts from the building's existing duct

system, including registers, grilles, boots, air handlers, coils, plenums, and ducts, if the reused parts are accessible and can be sealed to prevent leakage.

c. If the new ducts are an extension of an existing duct system, the combined new and existing duct system meets the criteria in Subsections I, II, and III below. The duct system shall be sealed to a leakage rate not to exceed 15 percent of the nominal air handler airflow rate as confirmed through field verification and diagnostic testing, in accordance with the applicable procedures in Reference Nonresidential Appendices NA1 and NA2:

I. The duct system provides conditioned air to an occupiable space for a constant volume, single zone, space-conditioning system; and

II. The space conditioning system serves less than 5,000 square feet of conditioned floor area; and

III. The combined surface area of the ducts located in the following spaces is more than 25 percent of the total surface area of the entire duct system:

A. Outdoors;

B. In a space directly under a roof that

C. Has a U-factor greater than the U-factor of the ceiling, or if the roof does not meet the requirements of Section 140.3(a)1B, or

D. Has fixed vents or openings to the outside or unconditioned spaces; or

E. In an unconditioned crawlspace; or

F. In other unconditioned spaces.

EXCEPTION 1 to Section 180.2(b)2Biib: When it is not possible to achieve the duct leakage criteria in Section 180.2(b)2Biib, all accessible leaks shall be sealed and verified through a visual inspection and a smoke test performed by a certified HERS Rater utilizing the methods specified in Reference Nonresidential Appendix NA2.1.4.2.2a.

EXCEPTION 2 to Section 180.2(b)2Biib: Duct Sealing. Existing duct systems that are extended, which are constructed, insulated or sealed with asbestos are exempt from the requirements of subsection 180.2(b)2Biib.

iii. Altered Space-Conditioning Systems. When a space-conditioning system is altered by the installation or replacement of space-conditioning system equipment (including replacement of the air handler, outdoor condensing unit of a split system air conditioner or heat pump, or cooling or heating coil:

a. For all altered units where the existing thermostat does not comply with the requirements for demand responsive controls specified in Section 110.12, the existing thermostat shall be replaced with a demand responsive thermostat that complies with Section 110.12. All newly installed space-conditioning systems requiring a thermostat shall be equipped with a demand responsive thermostat that complies with Section 110.12; and

b. The duct system that is connected to the new or replaced space-conditioning system equipment shall be sealed, if the duct system meets the criteria of Section 170.2(c)4Ji, as confirmed through field verification and diagnostic testing, in accordance with the applicable procedures for duct sealing of altered existing duct systems as specified in Reference Nonresidential Appendix NA2, and conforming to the applicable leakage compliance criteria in Section 180.2(b)2Bii.

EXCEPTION 1 to Section 180.2(b)2Biiib: Duct Sealing. Buildings altered so that the duct system no longer meets the criteria of Section 170.2(c)4Ji are exempt from the requirements of Subsection 180.2(b)2Biiib**.**

EXCEPTION 2 to Section 180.2(b)2Biiib: Duct Sealing. Duct systems that are documented to have been previously sealed as confirmed through field verification and diagnostic testing in accordance with procedures in the Reference Nonresidential Appendix NA2 are exempt from the requirements of Subsection 180.2(b)2Biiib.

EXCEPTION 3 to Section 180.2(b)2Biiib: Duct Sealing. Existing duct systems constructed, insulated or sealed with asbestos are exempt from the requirements of Subsection 180.2(b)2Biiib.

3. Hot Water Systems. Altered or replacement water-heating systems or components serving individual dwelling units shall meet the applicable requirements below:

A. Pipe Insulation. For newly installed piping and existing accessible piping, the insulation requirements of Section 160.4(f) shall be met.

B. Distribution System. For recirculation distribution system serving individual dwelling units, only Demand Recirculation Systems with manual on/off control as specified in the Reference Appendix RA4.4.9 shall be installed.

C. Water heating system. The water heating system shall meet one of the following:

i. A natural gas or propane water-heating system; or

ii. ~~For Climate Zones 1 through 15, a~~A single heat pump water heater. The storage tank shall not be located outdoors and be placed on an incompressible, rigid insulated surface with a minimum thermal resistance of R-10. The water heater shall be installed with a communication interface that meets either the requirements of 110.12(a) or has a ANSI/CTA-2045-A communication port; or

iii. ~~For Climate Zones 1 through 15, a~~A single heat pump water heater that meets the requirements of NEEA Advanced Water Heater Specification Tier 3 or higher~~. The storage tank shall not be located outdoors~~; or

iv. If the existing water heater is an electric resistance water heater, a consumer electric water heater.

v. A water-heating system determined by the Executive Director to use no more energy than the one specified in Section 180.2(b)3Ci through iii above; or if no natural gas is connected to the existing water heater location, a water-heating system determined by the executive director to use no more energy than the one specified in Section 180.2(b)3Civ above.

4. Lighting.

A. Dwelling Unit ~~and Common Living Area~~ Lighting. The altered lighting system shall meet the lighting requirements of Section 160.5(a). The altered luminaires shall meet the luminaire efficacy requirements of Section 160.5(a) and TABLE 160.5-A. Where existing screw base sockets are present in ceiling-recessed luminaires, removal of these sockets is not required provided that new JA8 compliant trim kits or lamps designed for use with recessed downlights or luminaires are installed.

B. Common ~~Services~~ Area – Lighting, Sign Lighting, and Electrical Power Distribution Systems.

i. Spaces with lighting systems installed for the first time shall meet the requirements of Sections 110.9, 160.5(b)1, 160.5(b)2, 160.5(b)3, 160.5(b)4, 160.5(c), 160.5(e), 170.2(b), 170.2(e)1, and 170.2(e)2.

ii. When the requirements of Section 160.5(b)4D are triggered by the addition of skylights to an existing building and the lighting system is not recircuited, the daylighting control need not meet the multi-level requirements in Section 160.5(b)4D.

iii. New internally and externally illuminated signs shall meet the requirements of Sections 110.9, 160.5(d) and 170.2(e)3.

iv. Altered Indoor Lighting Systems. Alterations to indoor lighting systems that include 10% or more of the luminaires serving an enclosed space shall meet the requirements below:

a. The alteration shall comply with the indoor lighting power requirements specified in Section 170.2(e)1A and the lighting control requirements specified in TABLE 180.2-~~D~~E;

b. The alteration shall not exceed 80% of the indoor lighting power requirements specified in Section 170.2(e)1, and shall comply with the lighting control requirements specified in TABLE 180.2-D; or

c. The alteration shall be a one-for-one luminaire alteration within a building or tenant space of 5,000 square feet or less, the total wattage of the altered luminaires shall be at least 40% lower compared to their total pre-alteration wattage, and the alteration shall comply with the lighting control requirements specified in TABLE 180.2-~~D~~E.

Alterations to indoor lighting systems shall not prevent the operation of existing, unaltered controls, and shall not alter controls to remove functions specified in Section 160.5(b)4.

Alterations to lighting wiring are considered alterations to the lighting system. Alterations to indoor lighting systems are not required to separate existing general, floor, wall, display, or ornamental lighting on shared circuits or controls. New or completely replaced lighting circuits shall comply with the control separation requirements of Sections 160.5(b)4Aiv and 160.5(b)4Cid.

EXCEPTION 1 to Section 180.2(b)4Biv. Alteration of portable luminaires, luminaires affixed to moveable partitions, or lighting excluded as specified in Section 170.2(e)2C.

EXCEPTION 2 to Section 180.2(b)4Biv. Any enclosed space with only one luminaire.

EXCEPTION 3 to Section 180.2(b)4Biv. Any alteration that would directly cause the disturbance of asbestos, unless the alteration is made in conjunction with asbestos abatement.

EXCEPTION 4 to Section 180.2(b)4Biv. Acceptance testing requirements of Section 160.5(e) are not required for alterations where lighting controls are added to control 20 or fewer luminaires.

EXCEPTION 5 to Section 180.2(b)4Biv. Any alteration limited to adding lighting controls or replacing lamps, ballasts, or drivers.

EXCEPTION 6 to Section 180.2(b)4Biv. One-for-one luminaire alteration of up to 50 luminaires either per complete floor of the building or per complete tenant space, per annum.

v. Alterations to existing outdoor lighting systems in a lighting application listed in TABLES 170.2- R or 170.2- S shall meet the applicable requirements of Sections 160.5(b)1, 160.5(b)2, 160.5(b)3, 160.5(c)1, and 160.5(e), and:

a. In alterations that increase the connected lighting load, the added or altered luminaires shall meet the applicable requirements of Section 160.5(c)2 and the requirements of Section 170.2(e)2 for general hardscape lighting or for the specific lighting applications containing the alterations; and

b. In alterations that do not increase the connected lighting load, where the greater of 5 luminaires or 10 percent of the existing luminaires are replaced in a general hardscape or a specific lighting application, the alterations shall meet the following requirements:

I. In parking lots and outdoor sales lots where the bottom of the luminaire is mounted 24 feet or less above the ground, the replacement luminaires shall comply with Section 160.5(c)2A and Section 160.5(c)2C;

II. For all other lighting applications and where the bottom of the luminaire is mounted greater than 24 feet above the ground, the replacement luminaires shall comply with Section 160.5(c)2A AND EITHER comply with Section 160.5(c)2B or be controlled by lighting control systems, including motion sensors, that automatically reduces lighting power by at least 40 percent in response to the area being vacated of occupants; and

c. In alterations that do not increase the connected lighting load, where the greater of 5 luminaires or 50 percent of the existing luminaires are replaced in general hardscape or a specific application, the replacement luminaires shall meet the requirements of subsection b above and the requirements of Section 170.2(e)2 for general hardscape lighting or specific lighting applications containing the alterations.

EXCEPTION to Section 180.2(b)4Bvc. Alterations where the replacement luminaires have at least 40 percent lower power consumption compared to the original luminaires are not required to comply with the lighting power allowances of Section170.2(e)2.

EXCEPTION to Section180.2(b)4Bv. Acceptance testing requirements of Section 160.5(e) are not required for alterations where controls are added to 20 or fewer luminaires.

vi. Alterations to existing internally and externally illuminated signs that increase the connected lighting load, replace and rewire more than 50 percent of the ballasts, or relocate the sign to a different location on the same site or on a different site shall meet the requirements of Section 140.8.

EXCEPTION to Section 180.2(b)4Bvi. Replacement of parts of an existing sign, including replacing lamps, the sign face or ballasts, that do not require rewiring or that are done at a time other than when the sign is relocated, is not an alteration subject to the requirements of Section 180.2(b)7Evi**.**

vii. Alterations to existing electrical power distribution systems shall meet the applicable requirements of the following Sections:

a. Service Electrical Metering. New or replacement electrical service equipment shall meet the requirements of Section 160.6(a) applicable to the electrical power distribution system altered; and

b. Separation of Electrical Circuits for Electrical Energy Monitoring. For entirely new or complete replacement of electrical power distribution systems, the entire system shall meet the applicable requirements of Section 160.6(b); and

c. Voltage Drop. Alterations of feeders and branch circuits where the alteration includes addition, modification, or replacement of both feeders and branch circuits, the altered circuits shall meet the requirements of Section 160.6(c); and

EXCEPTION to Section 180.2(b) 4Bviic: Voltage drop permitted by California Electrical Code Sections 647.4, 695.6 and 695.7.

d. Circuit Controls for 120-Volt Receptacles and Controlled Receptacles. For entirely new or complete replacement of electrical power distribution systems, the entire system shall meet the applicable requirements of Section 160.6(d).

TABLE 180.2-~~D~~ E – Control Requirements for Indoor Lighting System Alterations for Common Services Areas

Control Specifications		**Projects complying with Section 180.2(b)4Biva**	**Projects complying with Sections 180.2(b)4Bivb and 180.2(b)4Bivc**
Manual Area Controls	160.5(b)4Ai	Required	Required
	160.5(b)4Aii	Required	Required
	160.5(b)4Aii	Only required for new or completely replaced circuits	Only required for new or completely replaced circuits
Multi-Level Controls	160.5(b)4B	Required	Not Required
Automatic Shut Off Controls	160.5(c)4Ci	Required; 160.5(b)4Cid only required for new or completely replaced circuits	Required; 160.5(b)4Cid only required for new or completely replaced circuits
	160.5(c)4Cii	Required	Required
	160.5(c)4Cii	Required	Required
	160.5(c)4Civ	Required	Required
	160.5(b)4Cv	Required	Required
	160.5(b)4Cvi	Required	Required
	160.5(b)4Cvii	Required	Required
Daylighting Controls	160.5(b)4D	Required	Not Required
Demand Responsive Controls	160.5(b)4E	Required	Not Required

5. **Mechanical Ventilation and Indoor Air Quality.** Alterations to existing buildings shall comply with subsections A and B below as applicable. When HERS field verification and diagnostic testing is required by Section 180.2(b)5, buildings with three habitable stories or less shall use the applicable procedures in the Residential Appendices, and buildings with four or more habitable stories shall use the applicable procedures in Nonresidential Appendices NA1 and NA2.

   A. **Entirely New or Complete Replacement Ventilation Systems.** Entirely new or complete replacement ventilation systems shall comply with all applicable requirements in Section 160.2(b)2. Entirely new or complete replacement ventilation systems shall include a new ventilation fan component and an entirely new duct system. An entirely new duct system shall be constructed of at least 75 percent new duct material, and up to 25 percent may consist of reused parts from the dwelling unit's existing duct system, including but not limited to registers, grilles, boots, air filtration devices, and duct material, if the reused parts are accessible and can be sealed to prevent leakage.

   B. **Altered Ventilation Systems**. Altered ventilation system components or newly installed ventilation equipment serving the alteration shall comply with Section 160.2(b)2 as applicable subject to the requirements specified in subsections i and ii below.

      i. **Whole-dwelling Unit Mechanical Ventilation**.

         a. **Whole-dwelling unit airflow**. If the whole-dwelling ventilation fan is altered or replaced, then one of the following subsections 1 or 2 shall be used for compliance as applicable.

1. Dwellings that were required by a previous building permit to comply with the whole-dwelling unit airflow requirements in 160.2(b)2, 120.1(b), or 150.0(o) shall meet or exceed the whole-dwelling unit mechanical ventilation airflow specified in Sections 160.2(b)2Aiv or 160.2(b)2Av as confirmed through HERS field verification and diagnostic testing in accordance with the applicable procedures specified in Reference Appendix RA3.7 or NA2.2.

2. Dwellings that were not required by a previous building permit to have a whole-dwelling unit ventilation system to comply with Section 160.2(b)2, 120.1(b), or 150.0(o) shall not be required to comply with the whole-dwelling unit ventilation airflow specified in Sections 160.2(b)2Aiv or 160.2(b)2Av.

b. **Replacement Ventilation Fans.** Whole-dwelling unit replacement ventilation fans shall be rated for airflow and sound in accordance with the requirements of ASHRAE 62.2 Sections 7.1 and 7.2. Additionally, when conformance to a specified whole-dwelling unit airflow rate is required for compliance, the replacement fans shall be rated at no less than the airflow rate required for compliance.

c. **Air Filters**. If the air filtration device for a whole-dwelling unit ventilation system is altered or replaced, then one of the following subsections 1 or 2 shall be used for compliance.

1. Dwellings that were required by a previous building permit to comply with the ventilation system air filtration requirements in 160.2(b)1, 120.1(b)1, or 150.0(m)12 shall comply with the air filtration requirements in 160.2(b)1.

2. Dwellings that were not required by a previous building permit to comply with the ventilation system air filtration requirements in Section 160.2(b)1, 120.1(b)1, or 150.0(m)12 shall not be required to comply with the air filtration requirements specified in Section 160.2(b)1.

ii. **Local Mechanical Exhaust**.

a. **Bathroom Local Mechanical Exhaust**. Altered bathroom local mechanical exhaust systems shall comply with the applicable requirements specified in Section 160.0(b)2Avi.

b. **Kitchen Local Mechanical Exhaust**. If the kitchen local ventilation fan is altered or replaced, then one of the following subsections 1, 2, or 3 shall be used for compliance.

1. Dwellings that were required by a previous building permit to comply with the kitchen local exhaust requirements in 160.0(b)2Avi, 120.1(b)2vi, or 150.0(o)1G shall meet or exceed the applicable airflow or capture efficiency requirements in Section 160.0(b)2Avi.

2. Dwellings that were required by a previous building permit to install a vented kitchen range hood or other kitchen exhaust fan, shall install a replacement fan that meets or exceeds the airflow required by the previous building permit, or 100 cfm, whichever is greater.

3. Dwellings that were not required to have a kitchen local ventilation exhaust system according to the conditions in either subsection 1 or 2 above shall not be required to comply with the requirements of Section 160.0(b)2Avi.

c. Replacement Ventilation Fans. New or replacement local mechanical exhaust fans shall be rated for airflow and sound in accordance with the requirements of ASHRAE 62.2 Section 7.1 and Title 24, Part 6 Section 160.0(b)2Avif. Additionally, when compliance with a specified exhaust airflow rate is required, the replacement fan shall be rated at no less than the airflow rate required for compliance.

(c) **Performance approach.** The altered component(s) and any newly installed equipment serving the alteration shall meet the applicable requirements of subsections 1, 2, and 3 below.

1. The altered components shall meet the applicable requirements of Sections 110.0 through 110.9, Section 160.0, 160.1, 160.2(c) and (d), 160.3(a) through 160.3(b)5J, 160.3(b)6, 160.3(c), and 160.5. Entirely new or complete replacement mechanical ventilation systems as these terms are used in Section 180.2(b)5A shall comply with the requirements in Section 180.2(b)5A. Altered mechanical ventilation systems shall comply with the requirements of Sections 180.2(b)5B. Entirely new or complete replacement space-conditioning systems, and entirely new or complete replacement duct systems, as these terms are used in Sections 180.2(b)2Ai and 180.2(b)2Aiia, shall comply with the requirements of Sections 160.2(a)1 and 160.3(b)5L**.**
2. The standard design for an altered component shall be the higher efficiency of existing conditions or the requirements of Section 180.2(b). For components not being altered, the standard design shall be based on the unaltered existing conditions such that the standard and proposed designs for these components are identical. When the third party verification option is specified, all components proposed for alteration~~,~~ for which the additional credit is taken~~,~~ shall be verified by a qualified third party.
3. The proposed design shall be based on the actual values of the altered components.

NOTES TO SECTION 180.2(c):

1. If an existing component must be replaced with a new component, that component is considered an altered component for the purpose of determining the standard design altered component energy budget and must meet the requirements of Section 180.2(c)2.
2. The standard design shall assume the same geometry and orientation as the proposed design.
3. The "existing efficiency level" modeling rules, including situations where nameplate data is not available, are described in the applicable Residential or Nonresidential ACM Approval Manual.

EXCEPTION 1 to Section 180.2(c): Any dual-glazed greenhouse or garden window installed as part of an alteration complies with the U-factor requirements in Section 170.2.

EXCEPTION 2 to Section 180.2(c): Where the space in the attic or rafter area is not large enough to accommodate the required R-value, the entire space shall be filled with insulation provided such installation does not violate Section 1203.2 of Title 24, Part 2.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 180.3 – REPAIRS

Repairs shall not increase the preexisting energy consumption of the repaired component, system, or equipment.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 180.4 – WHOLE BUILDING

Any addition or alteration may comply with the requirements of Title 24, Part 6 by meeting the requirements for the entire building.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

CALIFORNIA MECHANICAL CODE, CALIFORNIA CODE OF REGULATIONS, TITLE 24, PART 4 CHAPTER 6, DUCT SYSTEMS

TABLE P4-A ADOPTION TABLE

CODE SECTION		Agency
Adopt Entire Chapter as amended (amended Sections listed below)[1]		CEC
601.0		X
602.0		X
603.0		X
604.0		X
605.0		X
[1] Adopted by reference for Occupancies A, B, E, F, H, M, R S, and U; see Sections 110.8(d)3, 120.4 and 150.0(m).		

APPENDIX 1-A
STANDARDS AND DOCUMENTS REFERENCED IN THE ENERGY CODE

The following documents are incorporated by reference to the extent they are referenced in the Energy Code.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE

AHRI 210/240-~~08~~2017	Performance Rating of Unitary Air Conditioning and Air-Source Heat Pump Equipment (~~2008~~ 2017 with Addendum 1)
AHRI 310/380-~~17~~2017	Packaged Terminal Air-Conditioners and Heat Pumps (2017)
~~AHRI 320-98~~	~~Water-Source Heat Pumps~~
~~AHRI 325-98~~	~~Ground Water-Source Heat Pumps (1998)~~
~~ANSI/~~AHRI 340/360-~~15~~ (I-P)-2019	Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment (~~2015~~2019)
ANSI/AHRI 365 -~~09~~(I-P)-2009	Performance Rating of Commercial and Industrial Unitary Air-Conditioning Condensing Units (2009)
~~ANSI/~~ANSI/AHRI 390-2003	Performance Rating of Single Package Vertical Air Conditioners and Heat Pumps (2003)
ANSI/AHRI 400-~~15~~ (I-P)-2015	Performance Rating of Liquid to Liquid Heat Exchangers (2015)
AHRI 430 (I-P)-2020	Performance Rating of Central Station Air-handling Unit Supply Fans (2020)
AHRI 440 (I-P)-2019	Performance Rating of Fan-coil Units (2019)
ANSI/AHRI 460-2005	Performance Rating of Remote Mechanical-Draft Air-Cooled Refrigerant Condensers (~~2005~~2020)
AHRI 550/590-~~15~~ (I-P)-2020	Performance Rating of Water-Chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle (~~2015~~2020)
~~ANSI/~~AHRI 560-2000	Absorption Water Chilling and Water Heating Packages (2000)
AHRI 680 (I-P)-2017	Performance Rating of Residential Air Filter Equipment (~~2015~~2017)
AHRI 920 (I-P)-2020	Performance Rating of DX-Dedicated Outdoor Air System Units (2020)
AHRI 1060 (I-P)-2018	Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment (2018)
AHRI 1230-~~14~~2014	Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment (w/Addendum 1)
AHRI 1360 (I-P)-2017	Performance Rating of Computer and Data Processing Room Air Conditioners (2017)

Available from: Air-Conditioning, Heating and Refrigeration Institute
2311 Wilson Blvd,, Suite 400
Arlington, VA 22203
(703) 524-8800

ASSOCIATION OF HOME APPLIANCE MANUFACTURERS

AHAM HRH-2-2020	Residential Kitchen Range Hood Performance Test Procedures (2020)
AHAM RKRH-CPPG-2020	Residential Kitchen Range Hood Certification Program Procedural Guide (2020) Version 3.0
Available from:	Association of Home Appliance Manufacturers

1111 19th Street, NW, Suite 402
Washington, DC 20036
(202) 872-5955
www.aham.org

AIR-CONDITIONING CONTRACTORS OF AMERICA

Manual J—Residential Load Calculation, Eighth Edition (2016)

Available from: Air-Conditioning Contractors of America, Inc.
2800 Shirlington Road, Suite 300
Arlington, VA 22206
(703) 575-4477
www.acca.org

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION
CANADIAN STANDARDS ASSOCIATION
WINDOW AND DOOR MANUFACTURERS ASSOCIATION

AAMA/WDMA/CSA 101/I.S.2/A440-~~11~~17
~~NAFS 2011 –~~ North American Fenestration Standard/Specification for Windows, Doors, and Skylights (2017)

Available from:

AAMA
1827 Walden Office Square, Suite 550
Schaumburg, IL 60173-4268
(847) 303-5664
www.aamanet.org

CSA
5060 Spectrum Way, Suite 100
Mississauga, ON, Canada L4W 5N6
(800) 463-6727
www.csagroup.org

WDMA
2025 M Street, NW, Suite 800
Washington, DC 20036-3309
(202) 367-1157
www.wdma.com

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGENISTS

~~2018~~ 2021 Threshold Limit Values (TLVS) and Biological Exposure Indices (BEIS)

Available from:

ACGIH
1330 Kemper Meadow Drive
Cincinnati, Ohio 45240
(513) 742-2020
www.acgih.org

AMERICAN NATIONAL STANDARDS INSTITUTE

ANSI/ASHRAE Standard 154-2016
Ventilation For Commercial Cooking Operations (2016)

ANSI/AMCA 208-18 Calculation of the Fan Energy Index (2018)

ANSI/AMCA 210-16 Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating (2016)

ANSI/AMCA 500-D-18 Laboratory Methods Of Testing Dampers For Rating (2018)

ANSI/ASABE S640 JUL2017 Quantities and Units of Electromagnetic Radiation for Plants (Photosynthetic Organisms

ANSI/ASSE Z9.5-2012 Laboratory Ventilation (2012)

ANSI/CTA-2045-A-2018 Modular Communications Interface for Energy Management (2018)

ANSI/NEMA WD 6-2016 Wiring Devices - Dimensional Specifications (2016)

ANSI Z21.10.3-~~17~~19/CSA 4.3-2019

~~Gas Water Heaters, Volume 1, Storage Water Heaters with Input Ratings above 75,000 Btu/h (2017)~~Gas-Fired Water Heaters, Volume III, Storage Water Heaters With Input Ratings Above 75,000 Btu Per Hour, Circulating And Instantaneous (2019)

ANSI Z21.13-~~17~~2017/CSA 4.9-2017

Gas-Fired Low Pressure Steam and Hot Water Boilers (2017)

ANSI Z21.40.4a-1998 (R2017)/CGA 2.94a-M1998 (R2017)~~-17~~

Performance Testing and Rating of Gas-Fired, Air-Conditioning and Heat Pump Appliances (2017)

ANSI Z21.47-~~16~~2016/CSA 2.3-2016

Gas-Fired Central Furnaces (2016)

ANSI Z83.8-~~16~~2016/CSA 2.6-2016

Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters and Gas-Fired Duct Furnaces (2016)

ANSI C82.6-2020 Ballasts for High-Intensity Discharge Lamps—Methods of Measurement (2020)

Available from:

American National Standards Institute
25 West 43rd Street, 4th floor
New York, NY 10036
(212) 642-4900

ANSI/ APSP/ICC~~NSPI~~ -5a-~~03~~2012 American National Standard For Residential Inground Swimming Pools (~~2003~~2012)

~~ANSI C82.6-15 Ballasts for High-Intensity Discharge Lamps—Methods of Measurement (2015)~~

Available from: Association of Pool & Spa Professionals
2111 Eisenhower Ave.
Alexandria, VA 22314
(703) 838-0083

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (NATIONAL PUBLICATIONS)

ANSI/ASHRAE Standard 52.2-2017

Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size (2017)

ANSI/ASHRAE Standard 55-~~2017~~2020

Thermal Environment Conditions for Human Occupancy (2020)

ANSI/ASHRAE Standard 62.1-2019

Ventilation for Acceptable Indoor Air Quality (2019)

ANSI/ASHRAE Standard 62.2-~~2016~~2019

Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings (2019)

ANSI/ASHRAE 84-2020 Method of Testing Air-to-Air Heat/Energy Exchanger (2020)

ANSI/ASHRAE Standard 154-2016
Ventilation For Commercial Cooking Operations (2016)

ANSI/ASHRAE 193-2010 (RA 2014)
Method of Test for Determining the Air tightness of HVAC Equipment (RA 2014)

ASHRAE Handbooks

HVAC Applications (I-P) (~~2015~~2019)

HVAC Systems and Equipment (I-P) (~~2016~~2020)

Fundamentals (I-P) (2017)

Available from: American Society of Heating,
Refrigerating and Air-Conditioning Engineers
(ASHRAE)
1791 Tullie Circle N.E.
Atlanta, GA 30329
www.ashrae.org

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (REGIONAL PUBLICATION)

ASHRAE Climatic Data for Region × Arizona, California, Hawaii, Nevada, Publication SPCDX, 1982, ISBN #20002196 and Supplement, 1994, ISBN #20002596

Available from: Order Desk
Building News
10801 National Boulevard
Los Angeles, CA 90064
(800) 873-6397 or (310) 474-7771
www.bnibooks.com/

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

ASME A17.1/CSA B44-2019
Safety Code for Elevators and Escalators (2019)

ASME A112.18.1-~~2012~~2018/CSA B125.1-~~12~~18
Plumbing Supply Fittings

~~ASME A17.1-2016 Safety Code for Elevators and Escalators (2016)~~

Available from: ASME
Two Park Avenue
New York, NY 10016-5990
(800) 843-2763
http://www.asme.org/

AMERICAN SOCIETY FOR TESTING AND MATERIALS / ASTM INTERNATIONAL

ASTM C55-17 Standard Specifications for Concrete Brick (2017)

ASTM C177-~~13~~19 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus (~~2013~~2019)

ASTM C272-~~16~~/C272M-18 Standard Test Method for Water Absorption of Core Materials for ~~Structural~~ Sandwich Constructions (~~2016~~2018)

ASTM C335/C335M-17
Standard Test Method for Steady-State Heat Transfer Properties of ~~Horizontal~~ Pipe Insulation (2017)

ASTM C518-17	Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus (2017)
ASTM C731-15	Standard Test Method for Extrudability, After Package Aging, of Latex Sealants (2015)
ASTM C732-17	Standard Test Method for Aging Effects of Artificial Weathering on Latex Sealants (2017)
ASTM C836/C836M-~~15~~18	Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course (~~2015~~2018)
ASTM C1167-~~11~~11(2017)	Standard Specification for Clay Roof Tiles (~~2011~~2017)
ASTM C1371-15	Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers (2015)
ASTM C1492-~~16~~03(2016)	Standard Specification for Concrete Roof Tile (2016)
ASTM C1549-16	Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer (2016)
ASTM C1583-~~13~~/C1583M-20	Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method) (~~2013~~2020)
ASTM D448-~~17~~12(2017)	Standard Classification for Sizes of Aggrergate for Road and Bridge Construction (2017)
ASTM D522/D522M-17	Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings (2017)
ASTM D822-~~13~~13(2018)	Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings (~~2013~~2018)
ASTM D1003-13	Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics (2013)
ASTM D1653-13	Standard Test Methods for Water Vapor Transmission of Organic Coating Films (2013)
ASTM D1863-~~11~~/D1863M-05(2018)	Standard Specification for Mineral Aggregate Used on Built-Up Roofs (~~2011~~2018)
ASTM D2202 - 00(2019)	Standard Test Method for Slump of Sealants (2019)
ASTM D2370-~~16~~16	Standard Test Method for Tensile Properties of Organic Coatings (~~2016~~2016)
ASTM D2824/D2824M-~~13~~18	Standard Specification for Aluminum-Pigmented Asphalt Roof Coatings, Nonfibered, ~~Asbestos Fibered~~, and Fibered without Asbestos (~~2013~~2018)
ASTM D3468/D3468M-~~13~~99(2020)	Standard Specification for Liquid-Applied Neoprene and Chlorosulfonated Polyethylene Used in Roofing and Waterproofing (~~2013~~2020)
ASTM D3805/D3805M-16	Standard Guide for Application of Aluminum-Pigmented Asphalt Roof Coatings (2016)
ASTM D4798/D4798M-11(2021)~~16~~	Standard Test Method Accelerated Weathering Test Conditions and Procedures for Bituminous Materials (Xenon-Arc Method) (~~2016~~2021)
ASTM D5870-16	Standard Practice for Calculating Property Retention Index of Plastics (2016)
ASTM D6083-~~05e1~~/D6083M-21	Standard Specification for Liquid- Applied Acrylic Coating Used in Roofing (~~2005~~2021)
ASTM D6694/D6694M-15	Standard Specification for Liquid- Applied Silicone Coating Used in Spray Polyurethane Foam Roofing (2015)
ASTM E96/E96M-16	Standard Test Methods for Water Vapor Transmission of Materials (2016)

ASTM E283/E283M-~~12~~19	Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen (~~2012~~2019)
ASTM E408-~~13~~13(2019)	Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques (~~2013~~2019)
ASTM E779-~~10~~19	Standard Test Method for Determining Air Leakage Rate by Fan Pressurization (~~2010~~2019)
ASTM E903-20	Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres(2020)
ASTM E972-~~13~~96(2021)	Standard Test Method for Solar Photometric Transmittance of Sheet Materials Using Sunlight (~~2013~~2021)
ASTM E1175-87(2015)	Standard Test Method for Determining Solar or Photopic Reflectance, Transmittance, and Absorptance of Materials Using a Large Diameter Integrating Sphere (2015)
ASTM E1677-19	Standard Specification for Air Retarder (AB) Material or Assemblies for Low-Rise Framed Building Walls (2019)
ASTM E1680-16	Standard Test Method for Rate of Air Leakage through Exterior Metal Roof Panel Systems (2016)
ASTM E1918-16	Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field (2016)
ASTM E1980-~~1~~11(2019)	Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces (~~2011~~2019)
ASTM E2178-~~13~~21	Standard Test Method for ~~Air Permeance of Building Materials~~ Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials (~~2013~~2021)
ASTM E2357-~~17~~18	Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies (~~2017~~2018)
ASTM E3087-18	Standard Test Method for Measuring Capture Efficiency of Domestic Range Hood (2018)
~~ASTM E1677-11~~	~~Standard Specification for an Air Retarder (AR) Material or System for Low-Rise Framed Building Walls (2011)~~
Available from:	ASTM International 100 Barr Harbor Drive West Conshohocken, PA 19428-2959 (800) 262-1373 or (610) 832-9500

CALIFORNIA BUILDING STANDARDS COMMISSION

California Building Code (2022)

California Electrical Code (2022)

California Mechanical Code (2022)

California Plumbing Code (2022)

Available from:	California Building Standards Commission 2525 Natomas Park Drive, Suite 130 Sacramento, CA 95833-2936 (916) 263-0916 www.bsc.ca.gov

CALIFORNIA ENERGY COMMISSION

Appliance Efficiency Regulations

Alternative Calculation Method (ACM) Manual

Available from: California Energy Commission
1516 Ninth Street
Sacramento, CA 95814
(916) 654-5106 or
(800) 772-3300 (in California)
www.energy.ca.gov/title24

CALIFORNIA DEPARTMENT OF CONSUMER AFFAIRS

Standards for Insulating Material

Available from: California Department of Consumer Affairs
Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation
4244 South Market Court, Suite D
Sacramento, California 95834-1243
(916) 999-2041

CERTIFYING ORGANIZATION

CIE 13.3-1995 Method of Measuring and Specifying Colour Rendering Properties of Light Source (1995)

CIE 015-2018 Commission Internationale de l'Eclairage (2018)

COOLING TECHNOLOGY INSTITUTE

CTI ATC-105~~-00~~ (19) Acceptance Test Code for ~~Water~~ Cooling Towers (~~2000~~2019)

CTI ATC-105S (11) Acceptance Test Code for Closed-Circuit Cooling Towers (2011)

CTI ATC-106 (11) Acceptance Test Code for Mechanical Draft Evaporative Vapor Condensers (2011)

CTI STD-201~~-15~~RS (17) Standard for the Certification of Water ~~-~~Cooling Tower Thermal Performance (~~2015~~2017)

Available from: Cooling Technology Institute
2611 FM 1960 West, Suite A101
Houston, Texas 77068-3730
PO Box 73383
Houston, TX 77273-3383
(281) 583-4087

COOL ROOF RATING COUNCIL

CRRC-1 Product Rating Program Manual (~~2018~~2021)

Available from: Cool Roof Rating Council
~~449 15th Street, Suite 400~~2435 N. Lombard Street
~~Oakland, CA 94612~~Portland, OR 97217
(866) 465-2523
www.coolroofs.org

HOME VENTILATING INSTITUTE

HVI Publication 915-2020 HVI Loudness Testing and Rating Procedure (2020)

HVI Publication 916-2020 HVI Airflow Test Procedure (2020)

HVI Publication 920-2020 HVI Product Performance Certification Procedure Including Verification And Challenge (2020)

Available from: Home Ventilating Institute
1740 Dell Range Blvd., Suite H, PMB 450
Cheyenne, WY 82009

(855) 484-8368
www.hvi.org

~~**HYDRONICS INSTITUTE**~~

~~HI Heating Boiler Standard 86, 6th Edition (1989)~~

~~Available from: Hydronics Institute~~
~~35 Russo Place, P.O. Box 218~~
~~Berkeley Heights, New Jersey 07922~~
~~(908) 464-8200~~

ILLUMINATING ENGINEERING SOCIETY

The IES Lighting ~~Handbook~~Library™~~, Tenth Edition (2011)~~

ANSI/IES LM-79-19~~08~~ Approved Method: ~~Electrical and Photometric~~Optical and Electrical Measurements of Solid State Lighting Products (~~2008~~2019)

ANSI/IES LS-1-20 Lighting Science: Nomenclature and Definitions for Illuminating Engineering (2020)

ANSI/IES TM-15-20 Technical Memorandum: Luminaire Classification System for Outdoor Luminaires (2020)

Available from: ~~IES~~Illuminating Engineering Society
120 Wall Street, 17th Floor
New York, NY 10005-~~4001~~4026
(212) 248-5000
www.ies.org

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS

California Mechanical Code

Available from: International Association of Plumbing and Mechanical Officials
4755 E. Philadelphia St.
Ontario, CA 91761
(800) 85-IAPMO (854-2766)
www.iapmo.org

INTERNATIONAL CODE COUNCIL

California Building Code

Available from: International Code Council
Western Regional Office
3060 Saturn St.
Brea, CA 92821
(888) 422-7233
www.iccsafe.org

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO 5801:2017 Fans- Performance testing using standardized airways (2017)

ANSI/AHRI/ASHRAE ISO 13256-1:1998 (RA 2012)~~ISO 13256-1~~

Water-Source Heat Pumps-Testing and Rating for Performance-Part 1: Water-to-Air and Brine-to-Air Heat Pumps (~~1998~~2012)

CAN/CSA C13256-2-01 (R2020)~~ISO 13256-2~~

	Water-Source Heat pumps- —Testing and rating for Performance- —Part 12: Water-to-Water and Brine-to-Water Heat Pumps (19982020)
ISO/IEC 17025:2017	Fans- Performance testing using standardized airways (2017)
Available from:	ISO Chemin de Blandonnet 8 CP 401 1214 Vernier Geneva, Switzerland

INTERNATIONAL WINDOW FILM ASSOCIATION

Visual Quality Standard for Applied Window Film	Visual Quality Standard for Applied Window Film (Re-endorsed 2015)Architectural Visual Inspection Standard Window Film (reindorsed 2018)
Available from:	International Window Film Association P.O. Box 3871 Martinsville, VA 24115-3871 276-666-4932

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION

NEMA LSD 57-2018	Polyurethane Foam Application: Lighting Equipment(2018)
NEMA SSL 7A-2015	"Phase Cut Dimming for Solid State Lighting: Basic Compatibility"(2015)
Available from:	1300 North 17th Street, Suite 1752 Rosslyn, VA 22209 708-841-3200 www.nema.org

NATIONAL FENESTRATION RATING COUNCIL

ANSI/NFRC 100-2020	Procedure for Determining Fenestration Product U-factors (20172020)
ANSI/NFRC 200-2020	Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence (20172020)
ANSI/NFRC 202-2020	Procedure for Determining Translucent Fenestration Product Visible Transmittance at Normal Incidence (20172020)
ANSI/NFRC 203-2020	Procedure for Determining Visible Transmittance of Tubular Daylighting Devices (20172020)
ANSI/NFRC 400-2020	Procedure for Determining Fenestration Product Air Leakage (20172020)
Available from:	National Fenestration Rating Council 6035 Ivy Lane, Suite 140 Greenbelt, MD 20770 (301) 589-1776 www.NFRC.org Email: info@nfrc.org

NSF INTERNATIONAL (FORMERLY NATIONAL SANITATION FOUNDATION)

NSF/ANSI/CAN 50- (2016)2019	Circulation System Components and Related Materials for Swimming Pools, Spas/Hot Tubs Equipment and Chemicals for Swimming Pools, Spas, Hot Tubs, and Other Recreational Water Facilities (20162019)
Available from:	NSF International PO Box 130140

Ann Arbor, MI 48113
(735) 769-8010

RESIDENTIAL ENERGY SERVICES NETWORK

ANSI/RESNET/ICC 380-~~2016~~2019
Standard for Testing Airtightness of Building Enclosures, Dwelling Unit, and Sleeping Unit Enclosures, Airtightness of Heating and Cooling Air Distribution Systems, and Airflow of Mechanical Ventilation Systems (~~2016~~2019)

Available from: Residential Energy Services Network, Inc. (RESNET)
P.O. Box 4561
Oceanside, CA 92052-4561
https://www.resnet.us/

SAE INTERNATIONAL

SAE J1772 201710 SAE Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler (2017)

SHEET METAL AND AIR-CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION

Residential Comfort System Installation Standards Manual, Eighth Edition (2016)

ANSI/SMACNA 006-2006 HVAC Duct Construction Standards - Metal and Flexible (2006)

Available from: Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA)
4201 Lafayette Center Drive
Chantilly, VA 20151-1209
(703) 803-2980
www.smacna.org

UNDERWRITERS LABORATORIES / UL

UL 181 Standard for Safety for Factory-made Air Ducts and Connectors (2017)

UL 181A Standard for Safety for Closure Systems for Use with Rigid Air Ducts ~~and Air Connectors~~ (2017)

UL 18~~I~~1B Standard for Safety for Closure Systems for Use with Flexible Air Ducts and Air Connectors (2017)

UL 723 Standard for Safety for Test for Surface Burning Characteristics of Building Materials (~~2017~~2018)

UL 727 Standard for Safety for Oil-Fired Central Furnaces (~~2006~~2018)

UL 731 Standard for Safety for Oil-Fired Unit Heaters (~~2012~~2018)

UL 1077 Standard for Safety for Supplementary Protectors for Use in Electrical Equipment (2015)

UL 1574 Standard for Safety for Track Lighting Systems (~~2016~~2020)

UL 1598 Standard for Safety for Luminaires (~~2012~~2021)

UL 1741 Standard for Safety for Inverters, Converters, Controllers and Interconnection System Equipment for Safety for Use With Distributed Energy Resources (2018)

UL 1973 Standard for Safety for Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications (2018)

UL 2108 Standard for Safety for Low Voltage Lighting Systems (~~2018~~2019)

UL 8750 Standard for Safety for Light Emitting Diode (LED) Equipment for Use in Lighting Products (~~2018~~2021)

UL 9540 Standard for Safety for Energy Storage Systems and Equipment (~~2016~~2020)

Available from: UL LLC
333 Pfingsten Road
Northbrook, IL 60062-2096
(847) 272-8800

APPENDIX 1-B
ENERGY COMMISSION DOCUMENTS INCORPORATED BY REFERENCE IN THEIR ENTIRETY

The following documents published by the California Energy Commission are incorporated by reference in their entirety into the Energy Code:

Referenced appendices for the Building Energy Efficiency Standards for Residential and Nonresidential Buildings, including the Joint Appendices (JA), the Residential Appendices (RA), and Nonresidential Appendices (NA)

Alternative Calculation Method (ACM) Approval Manual

Available from: California Energy Commission/Publications
1516 Ninth Street
Sacramento, CA 95814
(916) 654-5200
www.energy.ca.gov/title24

DOCKETED	
Docket Number:	21-BSTD-01
Project Title:	2022 Energy Code Update Rulemaking
TN #:	237716
Document Title:	Initial Statement of Reasons 2022 Energy Code Proposed Changes
Description:	Initial Statement of Reasons for the proposed changes to the 2022 Energy Code, Title 24, Part 1, Chapter 10 and Part 6.
Filer:	Adrian Ownby
Organization:	California Energy Commission
Submitter Role:	Energy Commission
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CALIFORNIA ENERGY COMMISSION
1516 Ninth Street
Sacramento, California 95814

Main website: www.energy.ca.gov
CEC-57 (Revised 1/19)

INITIAL STATEMENT OF REASONS

PROPOSED REVISIONS TO THE CALIFORNIA BUILDING ENERGY EFFICIENCY STANDARDS

2022 CALIFORNIA ADMINISTRATIVE CODE
2022 BUILDING ENERGY EFFICIENCY STANDARDS
CALIFORNIA CODE OF REGULATIONS, TITLE 24, PART 1, CHAPTER 10, and PART 6
(2022 CALIFORNIA ENERGY CODE)

California Energy Commission

Docket No. 21-BSTD-01

INTRODUCTION

Notice is hereby given that the California Energy Commission (CEC) proposes to adopt changes to the California Energy Code contained in the California Code of Regulations (CCR), Title 24, Part 6 (also known as the California Energy Code), and associated administrative regulations in Chapter 10 of Part 1, after considering all recommendations, comments, and objections regarding the proposed action. A description of the proposed standards is provided in the Informative Digest below.

The Warren-Alquist Act (California Pub. Res. Code Sections 25001 et seq.) establishes the California Energy Commission (CEC or Energy Commission) as California's primary energy policy and planning agency. Public Resource Code Sections 25213, 25402, 25402.1, 25402.4, 25402.5, 25402.8, 25910, 25942, and 25943 mandate and/or authorize that the CEC adopt rules and regulations, as necessary, to reduce the inefficient consumption of energy and water in newly constructed buildings and certain additions and alterations to existing buildings. One of the ways the CEC satisfies this requirement is through the California Energy Code (California Code of Regulations, Title 24, Part 6) found in the California Building Standards Code. The Energy Code includes all the energy efficiency requirements applicable to newly constructed buildings and additions and alterations to existing buildings. As a part of the California Building Standards Code, the Energy Code follows the same three-year update cycle.

The proposed standards are significant to the state of California in that they support state clean energy goals, policies, and mandates. The amendments will increase the deployment of on-site renewable energy generation, reduce carbon emissions from new buildings (building decarbonization), reduce growth in energy demand, increase energy demand flexibility, and ensure that California buildings are as energy efficient as is found to be technically feasible and cost-effective.

Therefore, the CEC proposes the following amendments to the Energy Code:

- Revise the prescriptive compliance path available for building projects to include only heat pump technology in specific circumstances;
- Revise the "standard design" used for the modeling-based performance compliance path available for building projects to establish the performance baseline based on heat pump technologies in specific circumstances;
- Improve existing residential energy efficiency standards for solar photovoltaic systems, including battery storage, and associated compliance options;
- Add new prescriptive solar photovoltaic and battery requirements for the following newly constructed nonresidential building types: high-rise multifamily, hotel-motel, tenant-space, office, medical office or clinic, restaurant, grocery store, retail store, school, and theater/auditorium/convention center buildings;
- Add new requirements that mixed fuel buildings be electric ready, meaning that electrical connections and other features needed to allow use of non-combustion equipment options are installed at the time of initial construction;
- Establish new energy efficiency standards for lighting, envelope, and space conditioning systems serving controlled environment horticulture spaces;
- Improve energy efficiency standards for commercial and industrial process loads, including, computer room air conditioning, refrigerated areas, fan systems, compressed air systems, and steam traps;
- Improve nonresidential and multifamily efficiency standards for building envelopes (e.g., exterior walls, windows, roofs, and floors), fan and duct systems, HVAC controls, boilers and service water heating systems, indoor and outdoor lighting systems, and grid integration equipment such as demand responsive controls;
- Improve minimum standards for residential kitchen ventilation;
- Update and enhance requirements relating to duct sealing and ventilation; and
- Make numerous minor revisions to existing provisions to improve the clarity of the regulations.

The CEC proposes to adopt these amendments for publication in 2022 with an effective date of January 1, 2023.

STATEMENT OF SPECIFIC PURPOSE, PROBLEM, RATIONALE and BENEFITS

Government Code Section 11346.2(b)(1) requires “a statement of the specific purpose of each adoption, amendment, or repeal, the problem the agency intends to address, and the rationale for the determination by the agency that each adoption, amendment, or repeal is necessary to carry out the purpose and address the problem for which it is proposed. The statement shall enumerate the benefits anticipated from the regulatory action, including the benefits or goals provided in the authorizing statute.”

The problem that the CEC seeks to address in adopting building energy efficiency standards is enumerated in its enabling statute. The legislative findings in the Warren-Alquist Act includes, in part, the following:

§ 25000.1(a) The Legislature further finds and declares that, in addition to their other ratepayer protection objectives, a principal goal of electric and natural gas utilities' resource planning and investment shall be to minimize the cost to society of the reliable energy services that are provided by natural gas and electricity, and to improve the environment and to encourage the diversity of energy sources through improvements in energy efficiency and development of renewable energy resources, such as wind, solar, and geothermal energy.

§ 25001. The Legislature hereby finds and declares that electrical energy is essential to the health, safety and welfare of the people of this state and to the state economy, and that it is the responsibility of state government to ensure that a reliable supply of electrical energy is maintained at a level consistent with the need for such energy for protection of public health and safety, for promotion of the general welfare, and for environmental quality protection.

§ 25002. The Legislature further finds and declares that the present rapid rate of growth in demand for electric energy is in part due to wasteful, uneconomic, inefficient, and unnecessary uses of power and a continuation of this trend will result in serious depletion or irreversible commitment of energy, land and water resources, and potential threats to the state's environmental quality.

§ 25007. It is further the policy of the state and the intent of the Legislature to employ a range of measures to reduce wasteful, uneconomical, and unnecessary uses of energy, thereby reducing the rate of growth of energy consumption, prudently conserve energy resources, and assure statewide environmental, public safety, and land use goals.

§ 25008. It is further the policy of the state and the intent of the Legislature to promote all feasible means of energy and water conservation and all feasible uses of alternative energy and water supply sources.

While the specific purposes of individual amendments are described below, the overall purpose of the adoption of new amendments to the Energy Code is “to reduce the wasteful, uneconomic, inefficient, or unnecessary consumption of energy, including the energy associated with the use of water, and to manage energy loads to help maintain

electrical grid reliability" consistent with the express statutory authority and direction in §25402, which benefits the state by slowing demand growth, reducing depletion of resources, improving reliability, minimizing costs, and mitigating threats to the state's environmental quality – that is, by directly addressing the problems the legislature observed when creating the CEC. Based on the evidence in the record, the CEC has determined that the proposed changes are necessary to provide these benefits by establishing or improving standards for building energy efficiency and improving the likelihood of successful deployment of building design and construction measures that directly cause or indirectly enable improved efficiency during occupancy and operation.

Evidence in the record further shows the proposed efficiency standards to be technically feasible for buildings in California, cost effective where they are proposed to be required, and will save significant energy on an annual statewide basis.

Part 1, Chapter 10 Proposed Changes

Section: 10-102, 10-103(a)4B
Specific Purpose:
The purpose of the changes to these sections is to exclude Certificates of Acceptance recorded by an acceptance test technician certification provider from requiring additional submittal to separate data registries.
Necessity:
These changes are reasonably necessary to prevent unnecessary duplication of data transmittal, processing and recordkeeping ahead of provision to the State of California.

Section: 10-103(a)4C
Specific Purpose:
The specific purpose of the changes to this section is to remove reference to registration or the use of data registries as it relates to Certificates of Acceptance.
Necessity:
These changes are necessary to ensure that the code is agnostic with respect to the various methods of generating or transmitting documentation of compliance with Energy Code requirements; the more general requirement that documentation be "made available" serves to adequately cover electronic means of doing so without implying differential treatment of specific methods.

Section: 10-103(b)4
Specific Purpose:
The purpose of the changes to this section is to broaden its application to include central building systems serving multiple separate dwellings, in part by distinguishing between whole-dwelling ventilation systems and local exhaust systems or equipment.
Necessity:
These changes are necessary to align the provisions of this section to the merging of low-rise and high-rise multifamily buildings into a single category consistent with the proposed migration of multifamily provisions into a separate, dedicated series of

chapters in the Energy Code, and to account for the different approaches to dwelling unit ventilation that can apply at different building scales.

Section: 10-103(d)
Specific Purpose:
The purpose of the changes to this section is to remove reference to a data registry in a provision applying to Certificates of Acceptance, which apply to nonresidential buildings and are not currently (nor have been previously) required to be registered. Because there is no registry available to contain or provide these documents, mentioning use of a registry here is meaningless.
Necessity:
These changes are necessary to remove an inapplicable option from the list of ways in which a Certificate of Acceptance can be made available.

Section: 10-103.1(c)3H
Specific Purpose:
The purpose of the addition of this section is to provide express criteria for electronic storage, within a database system, of compliance forms prepared and collected by Acceptance Test Technicians.
Necessity:
These additions are necessary to apply principles of electronic data storage, maintenance, and accessibility similar to what is expected for residential HERS entities to nonresidential ATTCP entities.

Section: 10-103.1(c)3I
Specific Purpose:
The purpose of the addition of this section is to add specifications for recording, maintaining, and providing building acceptance data collected by Acceptance Test Technician Certification Providers to the Energy Commission.
Necessity:
These changes are reasonably necessary to ensure compatibility and successful provision of collected compliance data to the State of California at such time as a document repository for this information is deployed.

Section: 10-103.2(c)3H
Specific Purpose:
The purpose of the addition of this section is to provide express criteria for electronic storage, within a database system, of compliance forms prepared and collected by Acceptance Test Technicians.
Necessity:
These additions are necessary to apply principles of electronic data storage, maintenance, and accessibility similar to what is expected for residential HERS entities to nonresidential ATTCP entities.

Section: 10-103.2(c)3I
Specific Purpose:
The purpose of the addition of this section is to add specifications for recording, maintaining, and providing building acceptance data collected by Acceptance Test Technician Certification Providers to the Energy Commission.
Necessity:
These changes are reasonably necessary to ensure compatibility and successful provision of collected compliance data to the State of California at such time as a document repository for this information is deployed.

Section: 10-109(i)1B
Specific Purpose:
The purpose of the addition of subsections (ii) through (v) to this section (and the consequential renumbering of existing language as subsection (i)) is to add criteria to the approval of nonresidential data registries that require use of CEC published data formatting and validation guidelines ("schema") and ensure state access to data collected pursuant to building standards code compliance.
Necessity:
These changes are necessary to ensure consistency in application of Energy Code requirements across potentially differing data gathering and validation systems, and to safeguard treatment and availability of data submitted to such systems pursuant to required demonstrations to the State of California of compliance with the California Building Standards Code.

Section: 10-109(k)
Specific Purpose:
The specific purpose of the changes to this section is to extend this section to also apply to the proposed new solar photovoltaic requirements for nonresidential buildings added in Section 140.10, and to allow the Energy Commission to consider other factors in addition to those expressly listed.
Necessity:
These changes are necessary to ensure equivalent treatment of solar photovoltaic systems required for both residential and nonresidential buildings under this section, and to avoid unnecessarily limiting consideration of the effects of implementation of public agency rules upon the cost effectiveness of solar photovoltaic systems.

Section: 10-114 (d)
Specific Purpose:
The specific purpose is to delete the requirements for a local jurisdiction to notify the Commission of any adopted changes by the local jurisdiction to the state default lighting zone designations by providing the materials about the public process and about the area with the adopted changes in lighting zone designations.
Necessity:
These changes are necessary to avoid what could be deemed as a duplication of efforts in keeping and providing materials related to lighting zone designations of the local

areas which are under the local jurisdictions, which could result in unnecessary cost and resources. Public members can reach out to the local jurisdictions for land use information and lighting zone designations deemed to be related to land use.

Section: 10-114 (e)
Specific Purpose:
The specific purpose is to delete the provisions for the Commission to disallow changes to the state default lighting zone designations adopted by local jurisdictions.
Necessity:
These changes are necessary to avoid what could be deemed as a duplication of lighting zone designation efforts by the Commission and a local jurisdiction in adopting any changes to the state default lighting zones by a local jurisdiction, which could result in unnecessary cost and resources.
There are already procedures and the criteria is specific and clear in Other parts of Section 10-114 already specify procedures and criteria that a local jurisdiction is required to go through, including a public process to allow public members to participate in the review of the proposed change and to comment on proposed changes to the state default lighting zones for a local area that are deemed appropriate and necessary.

Section: Table 10-114-A
Specific Purpose:
The specific purpose is to revise default rural lighting zone classifications as lighting zone 1 and to add urban clusters as the default classification for lighting zone 2. Building types deemed appropriate for lighting zones 1, 2 and 3 are added to Table 10-114-A. These changes align, where feasible, to the outdoor lighting zone default classification with the Illuminating Engineering Society/International Dark-sky Association (IES/IDA) Outdoor Lighting Model Ordinance lighting zone classification.
Necessity:
These changes are necessary to maintain, where feasible, consistency of the Energy Code and the document, Model Outdoor Lighting Ordinance (2011) published by the International Dark-Sky Association (IDA) and the Illuminating Engineering Society (IES).

Section: 10-115
Specific Purpose:
The specific purpose of changes to this section is to clarify existing provisions relating to community solar programs and to incorporate lessons learned following implementation of current requirements. This includes:

- Clarifying that Commission approval is required for community shared solar systems in subsection (a);
- Removing language in subsection (a)3 that was determined to be unnecessarily specific and potentially confusing and modified terminology to improve clarity;
- Adding language in subsection (a)4 that guarantees the ability of the building owner to opt out of the program in favor of procuring and installing on-site equipment;
- Adding language in subsection (a)5 that clarifies additionality requirements, including handling of Renewable Energy Credits, and provides allowance for

timing differences between development of building projects and development of community resources intended to serve those buildings;

- Adding a new subsection (a)6 to specify the contextual nearness intended by the term “community”;
- Adding a new subsection (a)7 to specify a maximum size for a community-scale system;
- Adding a new subsection (a)8 that guarantees the ability of the building purchaser to opt out of the program in favor of procuring and installing on-site equipment;
- Adding language in former subsection (a)6, now (a)9, specifying an annual reporting requirement as a part of accountability and recordkeeping;
- Adding language in subsection (b) specifying that applications from public agencies must be locally adopted though a public process prior to submission for approval; and
- Removing subsection (c) as unneeded and replacing it with language specifying when re-approval is required for approved programs and delegating consideration of reapproval applications to the Executive Director.

Necessity:
These changes are necessary to ensure and enhance the viability of community-scale projects as an alternative to on-site installation of renewable energy and energy storage systems, preserve an intended distinction between a “community” program and other types of programs, and incorporate feedback received and lessons learned during consideration of community solar applications submitted under existing requirements.

Part 6 Proposed Changes

Section: 100.0(e) **and Subsections**, Exception 1 to 100.0(f) and Table 100.0-A
Specific Purpose:
The specific purpose of the changes to these Sections, their subsections and associated Table are to relocate provisions describing the application of the Energy Code and, in doing so, to reflect changes occurring later in the document that relocate provisions applicable to multifamily buildings (inclusive of low-rise and high-rise multifamily buildings) into their own subsections. These edits include removing references to “high-rise residential” where no longer applicable, replacing low-rise residential” with “single-family”, and updating references to include the new Sections of the Energy Code relating to multifamily buildings (Sections 160, 170, and 180 inclusive) consistent with the relocation.
Necessity:
These changes are necessary to ensure that the language in the Scope of the Energy Code correctly refers to and parallels the newly separated sections for multifamily buildings.

Section: 100.1(b) – Newly Added Definitions
Specific Purpose:
The specific purpose of the added definitions to the Definitions section is to provide clear and specific definitions for technical terms used within other updates to Part 6, aligned with the use of the term where it is proposed to occur later in the Energy Code. This includes added definitions for new industry standards documents that are incorporated by reference into later portions of the Energy Code. The newly added definitions are:

- AIR CURTAIN UNIT
- ALTERNATING CURRENT-OUTPUT UNINTERRUPTIBLE POWER SUPPLY (AC-OUTPUT UPS)
- AMCA
- ANSI/ASABE S640
- ANSI Z9.5
- ANSI/NEMA WD 6
- ANSI C82.6
- ANSI/CTA-2045-A
- ANSI/ASHRAE 84
- ANSI/AMCA 208
- ANSI/AMCA 210
- AHAM
- AHAM HRH-2
- AHAM RKRH-CPPG
- AHRI 430

- AHRI 440
- AHRI 920
- AHRI 1060
- AHRI 1360
-
- ASCE 7-16
- ANSI/ASHRAE STANDARD 154
- ASTM D2202
- ASTM D6083
- ASTM E1680
- ASTM E3087
- AZIMUTH
- BOILER SYSTEM
- CARBON DIOXIDE ENRICHMENT
- CEILING FAN
- Central Fan Ventilation Cooling System, or CFVCS
- CIRCULATING FAN
- COMMON LIVING AREAS
- COMMON SERVICE AREAS
- COMMON USE AREAS
- CONTROLLED ENVIRONMENT HORTICULTURE (CEH) SPACE
- DEDICATED OUTDOOR AIR SYSTEM (DOAS)
- DESICCANT DEHUMIDIFICATION SYSTEM
- DRAIN WATER HEAT RECOVERY (DWHR)
- DUCT WALL PENETRATIONS
- DWELLING UNIT, ATTACHED
- DWELLING UNIT, JUNIOR ACCESSORY, OR JADU
- DX-DEDICATED OUTDOOR AIR SYSTEM UNITS (DX-DOAS)
- ECONOMIZER, PUMPED REFRIGERANT
- ENERGY STORAGE SYSTEM (ESS)
- ESS READY INTERCONNECTION EQUIPMENT
- ESS READY PANELBOARD
- ENTHALPY RECOVERY RATIO (ERR)
- FAN ARRAYS
- FAN, EMBEDDED
- FAN ENERGY INDEX (FEI)
- FAN ELECTRICAL INPUT POWER (FAN kWdesign)
- FAN NAMEPLATE ELECTRICAL INPUT POWER (kW)
- FAN SYSTEM
- FAN SYSTEM, COMPLEX
- FAN SYSTEM, EXHAUST
- FAN SYSTEM, MULTI-ZONE VARIABLE AIR VOLUME (VAV)
- FAN SYSTEM, RELIEF
- FAN SYSTEM, RETURN

- FAN SYSTEM, SUPPLY-ONLY
- FAN SYSTEM, SINGLE-CABINET
- FAN SYSTEM, TRANSFER
- FAN SYSTEM AIRFLOW (cfm)
- FAN SYSTEM DESIGN CONDITIONS
- FAN SYSTEM ELECTRICAL INPUT POWER (Fan kWdesign,system)
- HEAT PUMP WATER HEATER (HPWH)
- SINGLE-PASS HEAT PUMP WATER HEATER
- MULTI-PASS HEAT PUMP WATER HEATER
- HORTICULTURAL LIGHTING
- INTEGRATED SEASONAL COEFFICIENT OF PERFORMANCE (ISCOP)
- INTEGRATED SEASONAL MOISTURE REMOVAL EFFICIENCY (ISMRE)
- IES LS-1-20
- INDOOR GROWING
- INFORMATION TECHNOLOGY EQUIPMENT (ITE)
- INTEGRATED HVAC SYSTEM
- ISO 5801
- ITE DESIGN LOAD
- LIGHTING definitions:
    - Astronomical Time-Switch Control
    - Automatic Daylight Control
    - Automatic Scheduling Control
    - Automatic Time Switch Control
    - Captive-Key Override
    - Countdown Timer Switch
    - Daylight Continuous Dimming Controls
    - Dimmer
    - Dimmer, Continuous
    - Dimmer, Forward Phase Cut
    - Dimmer, Stepped
    - Lighting Control, Self-Contained
    - Lighting Control System
    - LED Driver
    - Multilevel Astronomical Time Switch
    - Multilevel Lighting Control
    - Multiscene Programmable Control
    - NEMA LSD 57
    - NEMA SSL 7A
    - Occupant Sensing Controls
    - Motion Sensing Control
    - Occupant Sensing Control
    - Partial-ON Occupant or Motion Sensing Control
    - Partial-OFF Occupant or Motion Sensing Control
    - Vacancy Setting Control
    - Photo Control

    - Security Cameras
    - Shut-off Controls
    - Tunable Lighting
    - Dim-to-warm
    - Tunable white
    - Color tunable
- MULTIFAMILY BUILDING
- MUSEUM BUILDING
- PHOTOSYNTHETIC PHOTON EFFICACY (PPE)
- PHOTOSYNTHETIC PHOTON FLUX (PPF)
- ROOF RECOVER
- ROOF REPLACEMENT
- SEAL CLASS A
- SENSIBLE ENERGY RECOVERY RATIO
- STAND-ALONE DEHUMIDIFER
- TRANSIENT
- UL 1741
- UL 1973
- UL 9540
- UNIFORM ENERGY FACTOR (UEF)
- ZONAL

Necessity:
These changes are necessary to ensure that provisions in subsequent sections are clear and unambiguous, and that non-technical readers are able to find and understand the technical meaning of specific terms relating to building design and construction.

Section: 100.1(b) – Deleted Definitions
Specific Purpose:
The specific purpose of the deleted definitions in the Definitions section is to provide clear and specific definitions for technical terms used within other updates to Part 6, aligned with the use of the term where it is proposed to occur later in the Energy Code, and to delete obsolete terms, removing unnecessary complexity. The deleted definitions are:

- ANSI C82.6 2015
- ANSI/IES RP-16-17
- AHRI 320
- AHRI 325
- DUAL-GLAZED GREENHOUSE WINDOWS
- ENERGY FACTOR (EF)
- DECORATIVE LUMINAIRES
- TUNING
- LIGHTING CONTROLS (long list of definitions)

    - Astronomical Time Switch Control
    - Automatic Daylight Control
    - Automatic Multilevel Daylight Control
    - Automatic Scheduling Control
    - Automatic Time Switch Control
    - Captive Key Override
    - Countdown Timer Switch
    - Dimmer
    - Dimmer, Full Range
    - Dimmer, Stepped
    - Dimmer, Forward Phase Cut
    - Lighting Control, Self Contained
    - Lighting Control System
    - Multilevel Astronomical Time Switch
    - Multilevel Lighting Control
    - Multiscene Programmable Control
    - NEMA SSL 7A
    - Occupant Sensing Controls
    - Motion Sensor
    - Occupant Sensor
    - Patrial ON Occupant or Motion Sensor
    - Partial OFF Occupant or Motion Sensor
    - Vacancy Sensor
    - Part Night Outdoor Lighting Control
    - Photo Control
    - Shut off Controls
- DEDICATED RAMPS
- OVERHANG PROJECTION
- OVERHANG RISE

Necessity:
These changes are necessary to ensure that provisions in subsequent sections are clear and unambiguous, and that non-technical readers are able to find and understand the technical meaning of specific terms relating to building design and construction.

Section: 100.1(b) – Amended Definitions to publication dates of industry standards documents
Specific Purpose:
The specific purpose of changes that amend the publication date of industry standards documents already defined within this Section are to ensure definitions relating to industry test standards refer to or otherwise specify the most current available versions of such standards. This includes amendments that update the names of referenced industry standards documents consistent with their current published titles.

Necessity:
The changes to update the referenced versions of industry publications are necessary to ensure alignment of the Energy Code with industry standards upon which it relies, and prevents situations where use of obsolete versions of such standards would be required for compliance with the Energy Code as written.

Section:100.1(b) **–** ANSI/IES LS-1-20, Lighting Science: Nomenclature and Definitions for Illuminating Engineering (was ANSI/IES RP-16-17)
Specific Purpose:
The specific purpose of the change is to update the reference document title and numbering to the most recent version of the document as issued by the Illuminating Engineering Society.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – ANSI/IES LM-79-19, Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products (was IES LM-79)
Specific Purpose:
The specific purpose of the change is to update the reference document title and numbering to the most recent version of the document as issued by the Illuminating Engineering Society.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – ANSI/IES TM-15-20, Technical Memorandum: Luminaire Classification System for Outdoor Luminaires (was IES TM-15-11)
Specific Purpose:
The specific purpose of the change is to update the reference document title and numbering to the most recent version of the document as issued by the Illuminating Engineering Society.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building

Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Accent Lighting
Specific Purpose:
The specific purpose of the change is to update the definition to align, where feasible, with the nomenclature and definitions for Illuminating Engineering of the reference document, ANSI/IES LS-1-20, and to include examples of accent lighting.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) **–** Color Rendering Index (CRI)
Specific Purpose:
The specific purpose of the change is to update the definition to align with the nomenclature and definitions for Illuminating Engineering of the reference document, ANSI/IES LS-1-20.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Correlated Color Temperature (CCT)
Specific Purpose:
The specific purpose of the change is to update the definition to align with the nomenclature and definitions for Illuminating Engineering of the reference document, ANSI/IES LS-1-20.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Colored light source
Specific Purpose:
The specific purpose of the change is to revise the reference measurement methods and the reference calculation method for colored light sources.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Compact Fluorescent Lamp
Specific Purpose:
The specific purpose of the change is to update the definition to align with the nomenclature and definitions for Illuminating Engineering of the reference document, ANSI/IES LS-1-20.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Decorative (Lighting/Luminaires)
Specific Purpose:
The specific purpose of the change is to update the definition to include examples in the definition for decorative lighting/luminaires.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Display Lighting, Floor (was Display Lighting and Floor)
Specific Purpose:
The specific purpose of the change is to revise the definitions to combine both definitions for display lighting and floor as one definition for ‘Display Lighting, Floor’.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building

Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Display Lighting, Wall
Specific Purpose:
The specific purpose of the change is to revise the definitions to combine both definitions for display lighting and wall as one definition for ‘Display Lighting, Wall”.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Display Lighting, Window
Specific Purpose:
The specific purpose of the change is to revise the definitions to combine both definitions for display lighting and window as one definition for ‘Display Lighting, Window”.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Display Lighting, Case
Specific Purpose:
The specific purpose of the change is to revise the definitions to combine both definitions for display lighting and case as one definition for ‘Display Lighting, Case”.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Fenestration Products
Specific Purpose:
The specific purpose of the change is to revise the definitions to provide clarification that glazing used for greenhouses is also considered a fenestration product
Necessity:
This change is necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Illumination
Specific Purpose:
The specific purpose of the change is to update the definition to align, where feasible, with the nomenclature and definitions for Illuminating Engineering of the reference document, ANSI/IES LS-1-20.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Inseparable Solid State Lighting (SSL) Luminaire
Specific Purpose:
The specific purpose of the change is to update the definition to align, where feasible, with the nomenclature and definitions for Illuminating Engineering of the reference document, ANSI/IES LS-1-20, and to add examples to the definition for inseparable solid state lighting luminaires.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Light
Specific Purpose:
The specific purpose of the change is to update the definition to align, where feasible, with the nomenclature and definitions for Illuminating Engineering of the reference document, ANSI/IES LS-1-20.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.
Section: 100.1(b) – Lighting
Specific Purpose:
The specific purpose of the change is to update the definition to align, where feasible, with the nomenclature and definitions for Illuminating Engineering of the reference document, ANSI/IES LS-1-20.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Light Emitting Diode (LED)
Specific Purpose:
The specific purpose of the change is to update the definition to align, where feasible, with the nomenclature and definitions for Illuminating Engineering of the reference document, ANSI/IES LS-1-20.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – LED Driver
Specific Purpose:
The specific purpose of the change is to update the definition to align, where feasible, with the nomenclature and definitions for Illuminating Engineering of the reference document, ANSI/IES LS-1-20.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly

to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – LED Light Engine
Specific Purpose:
The specific purpose of the change is to update the definition to align with the nomenclature and definitions for Illuminating Engineering of the reference document, ANSI/IES LS-1-20.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Luminous Maintenance (was Lumen Maintenance)
Specific Purpose:
The specific purpose of the change is to update the definition to align, where feasible, with the definition of the ENERGY STAR Program Product Specification for Luminaires (Light Fixtures) Version 2.2.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) **–** Mechanical Cooling (Excluding ERV/HRV)
Specific Purpose:
The specific purpose of the change is to clarify that systems solely using energy recovery ventilation (ERV) or heat recovery ventilation (HRV) are not considered to be mechanical cooling.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) **–** Mechanical Heating (Excluding Solar/Heat Recovery)
Specific Purpose:
The specific purpose of the change is to clarify that systems using only solar energy or heat recovery as the heat source are not considered as mechanically heating systems.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) **–** Space-Conditioning System
Specific Purpose:
The specific purpose of the change is to clarify that only mechanical heating and cooling systems qualify as sources for a space-conditioning system.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) **–** Ornamental Lighting/Luminaires (was Ornamental Lighting; Luminaires)
Specific Purpose:
The specific purpose of the change is to combine both definitions for ornamental lighting and luminaires as one definition for “Ornamental Lighting/Luminaires”. The other change is to separate out the sub-definition for decorative luminaires as an independent and separate definition for “Decorative Lighting/Luminaires”.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Pendant Luminaire (Suspended Luminaire) (was Pendant (Suspended))
Specific Purpose:
The specific purpose of the change is to add luminaire to the name of the definition.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Single Zone System
Specific Purpose:
The specific purpose of the change is to clarify that a single zone system needs to be controlled by a single thermostat in each thermal zone.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Task Lighting
Specific Purpose:
The specific purpose of the change is to update the definition to align, where feasible, with the nomenclature and definitions for Illuminating Engineering of the reference document, ANSI/IES LS-1-20.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Track Lighting
Specific Purpose:
The specific purpose of the change is to update the definition to align, where feasible, with the nomenclature and definitions for Illuminating Engineering of the reference document, ANSI/IES LS-1-20.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly

to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Barber, Beauty Salon, Spa Area (was Beauty Salon Area)
Specific Purpose:
The specific purpose of the change is to update the name of the nonresidential function areas to include barber and spa areas for the nonresidential function area definition.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Storage, Commercial and Industrial Area (was Commercial and Industrial Storage Area)
Specific Purpose:
The specific purpose of the change is to reorder the name of the nonresidential function areas with “Storage” as the preceding term for the nonresidential function area definition.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Manufacturing, Commercial and Industrial Area (was Commercial and Industrial Manufacturing Area)
Specific Purpose:
The specific purpose of the change is to reorder the name of the nonresidential function areas with “Manufacturing” as the preceding term for the nonresidential function area definition.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Lobby, Main Entry (was Main Entry Lobby)
Specific Purpose:
The specific purpose of the change is to reorder the name of the nonresidential function areas with “Lobby” as the preceding term for the nonresidential function area definition.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Parking Zone and Ramps (was Parking Zone and Dedicated Ramps)
Specific Purpose:
The specific purpose of the change is to revise the definitions to combine both definitions for parking zone and dedicated ramps as one definition for “Parking Zone and Ramps”.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Daylight Adaptation Zone
Specific Purpose:
The specific purpose of the change is to clarify adjacent areas of a parking garage are applicable to the nonresidential function area definition of daylight adaptation zone.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Laboratory, Scientific Area (was Scientific Laboratory Area)
Specific Purpose:
The specific purpose of the change is to reorder the name of the nonresidential function areas with “Laboratory” as the preceding term for the nonresidential function area definition.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly

to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 100.1(b) – Occupant Sensing Controls (was Occupant sensor)
Specific Purpose:
The specific purpose of the change is to update the definitions (including Motion Sensor; Occupant Sensor; Partial-ON Occupant or Motion Sensor; Partial-OFF Occupant or Motion Sensor; Vacancy Sensor) with a change of phrase from “sensor” to “sensing control” to the terms of definition. These changes are to align with the use of the term in Section 130.1(c) of Automatic Shutoff Controls, and the revised terms more accurately reflects of their characters as lighting controls.
Necessity:
These changes are necessary to ensure that the terms used within the regulations will have clear and unambiguous meaning to readers, including the public, and particularly to the persons and organizations affected by these regulations. Additionally, these new terms ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1.

Section: 110.2(e)
Specific Purpose:
The specific purpose of the proposed change is to remove the word “circuit” where used in reference to cooling towers as unneeded, and to state “open and closed cooling towers” in the Exception to Section 110.2(e) for consistency. Existing language defines the terms “open cooling tower” and “closed-circuit cooling tower”; the purpose in changing these terms is to standardize around one method of phrasing for consistency across terms (i.e., either including the word “circuit” for both open and closed systems, or discarding it for both). The proposed change opts to discard the word “circuit” for simplicity.
Necessity:
The change to remove the word “circuit” in this context is necessary to improve the overall consistency of associated codes and standards. This change does not have any substantive effect.

Section: Tables 110.2-A through K
Specific Purpose:
The specific purpose of the changes to these tables is to update minimum standards to accurately reflect updated federal appliance standards applicable to associated equipment, and to identify the test standard applicable to closed-circuit cooling towers consistent with the other entries in these tables.
Necessity:
These changes are necessary to correctly state the standards applicable to the listed

equipment and ensure that the Energy Code does not conflict with federal appliance laws.

Section: 110.6 Authority and Reference Citation
Specific Purpose:
The specific purpose of the change is to add the Authority and Reference citations to reflect the statutory provisions utilized by the CEC in the preceding section. This is not a substantive change in requirements.
Necessity:
These changes are necessary to provide the public with the CEC's statutory authority for adopting these regulations and to provide notice of the sections that are being implemented, interpreted or made specific by the regulations.

Section: Exceptions 1 & 2 to Section 110.6(a)2
Specific Purpose:
The specific purpose of the changes to Exceptions 1 and 2 to Section 110.6(a)2 is to remove vertical site-built fenestration from the exceptions to the mandatory fenestration U-factor requirement.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402 by increasing the rate of compliance with National Fenestration Rating Council (NFRC certification) and reducing/eliminating the amount of uncertified fenestration products being installed in California.

Section: Exceptions 1 & 2 to Section 110.6(a)3
Specific Purpose:
The specific purpose of the changes to Exceptions 1 and 2 to Section 110.6(a)3 is to remove vertical site-built fenestration from the exceptions to the mandatory fenestration solar heat gain coefficient (SHGC) requirement.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402 by increasing the rate of compliance with National Fenestration Rating Council (NFRC certification) and reducing/eliminating the amount of uncertified fenestration products being installed in California.

Section: Exceptions 1 & 2 to Section 110.6(a)4
Specific Purpose:
The specific purpose of the changes to Exceptions 1 and 2 to Section 110.6(a)4 is to remove vertical site-built fenestration from the exceptions to the mandatory fenestration Visible Transmittance (VT) requirement.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402 by increasing the rate of compliance with National Fenestration Rating Council (NFRC certification) and reducing/eliminating the amount of uncertified fenestration products being installed in California.

Section: 110.6(a)6
Specific Purpose:
The specific purpose of the change to Section 110.6(a)6 is to remove multifamily “low-rise residential” from the scope of this requirement, and to clarify that the requirement now only applies to single family buildings.
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16. For the 2022 Energy Standards, the low-rise and high-rise multifamily requirements are being relocated to a new multifamily specific section of the code: Sections 160, 170, and 180.

Section: Exception to Section 110.8(d)1
Specific Purpose:
The specific purpose of the changes to Exception to Section 110.8(d)1 is to correct the section reference to the California Building Code, Title 24, Part 2, Section 1202.2, and to add a section reference to the California Building Code, Title 24, Part 2.5, Section 806.
Necessity:
These changes are necessary to ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as direct by California Government Code, Sections 11349 and 11349.1.

Section: 110.8(i)4B
Specific Purpose:
The specific purpose of the changes to this section is to add reference to ASTM D6083 to the list of potentially applicable ASTM standards.
Necessity:
These changes are necessary to include this standard consistent with its re-adoption by ASTM, and avoid unnecessarily limiting the available industry standards that may be applied.

Section: Section 110.9(b)
Specific Purpose:
The specific purpose of the change to Section 110.9(b)1Ai is to remove redundant phrasing: the phrase “each connected load” occurs twice in the same sentence with the same meaning.

The specific purpose of the changes to subsection (b)5 is to delete part-night outdoor lighting controls and its functionality requirements. The criteria of this Section define what a control installed to meet “part-night” requirements is required to do, however the underlying requirements to install “part-night” controls (distinct from other outdoor lighting controls) were removed in the 2019 update to the Energy Code. As a result, the definition of the term “part-night outdoor lighting control” as well as the more detailed minimum criteria in this section no longer serve a regulatory purpose, and are redundant with requirements in Section 130.2 applicable to the more general category of outdoor automatic scheduling controls. This section is now reserved in order to prevent changes in subsequent section numbering.
Necessity:
The changes are necessary to remove unused or redundant terms and thereby ensure and improve general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1 and California Code of Regulations, Title 1, Section 16. This change is understood not to have a substantive regulatory effect.

Section: 110.10(a)3
Specific Purpose:
The specific purpose of the change to this Section is to duplicate the phrase “which do not have a photovoltaic system installed” from Sections 110.10(a)1 and 110.10(a) for consistency.
Necessity:
This change is necessary to ensure and improve general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1 and California Code of Regulations, Title 1, Section 16.

Section: 110.10(a)4
Specific Purpose:
The specific purpose of the changes to this section is to replace “healthcare facilities” with “I-2 and I-2.1” in order to specify the occupancy types instead of the phrase “healthcare facilities.” In addition, the changes duplicates the phrase “which do not have a photovoltaic system installed” from Sections 110.10(a)1 and 110.10(a)2 for consistency.
Necessity:
These changes are necessary to ensure and improve general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1 and California Code of Regulations, Title 1, Section 16.

Section: 110.10(b)2
Specific Purpose:
The specific purpose of the changes to this section is to replace the term “orientation” with the phrase “azimuth range,” which provides more information to allow for complying with requirements and provides consistency with the heading of the subsection. Also, orientation consists of Azimuth and tilt where the requirement of this subsection only deals with Azimuth.
Necessity:
These changes are necessary to ensure and improve general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1 and California Code of Regulations, Title 1, Section 16, as well as to increase energy efficiency via clarifying requirements, as directed by California Public Resources Code Sections 25213 and 25402.

Section: 110.12, 110.12(a)
Specific Purpose:
The specific purpose to the changes in these sections is to more clearly state the scope of application of the overall section and to more clearly state the communication requirements applicable to demand responsive controls. The term “hard-wiring” in particular was observed to be a common source of confusion and is adequately covered by “other bi-directional communication pathway”. These changes are understood to be non-substantive.
Necessity:
The change to the scoping language that begins section 110.12 is necessary to preclude unintended readings of the application of this section beyond what was intended at its adoption. The change to the communication provisions in 110.12(a) are necessary to merge and more simply state the contents of subsection 3, to remove the express statement of “hard-wiring” and to instead expressly state CTA-2045 as an additional protocol that may be used consistent with reference to this protocol in other sections of the Energy Code.

Section: 110.12(c)
Specific Purpose:
The specific purpose of the changes to this Section are to change a floor area threshold to an equivalent wattage threshold, and to more clearly state that the requirement of this section applies to general lighting to which multi-level lighting requirements in Section 130.1 also apply.
Necessity:
The change to clarify the scope of application of the requirement is necessary to prevent alternate readings that would apply this section's requirements to lighting that is not required to have the multi-level controls needed for its operation, which would either necessitate installation of additional multilevel controls beyond what was considered in prior rulemaking proceedings or render the addition of the demand responsive controls moot due to the absence of an ability for the lighting to be partially reduced.

The change to replace the square footage threshold with an equivalent wattage threshold is necessary to more transparently link the requirement to its threshold: demand responsive controls are only required where there is a sufficient load to make them cost effective to install, and while 10,000 square feet can be presumed to require a sufficient amount of lighting to represent such a load, there is not a reason to have an indirect threshold (square footage as a proxy for load) when a direct threshold (load itself) can instead be used.

Section: 110.12(e)
Specific Purpose:
The specific purpose of the addition of Section 110.12(e) is to add specific requirements for the behavior of demand responsive controlled receptacles.
Necessity:
This change is necessary to explicitly describe the behavior expected for demand responsive controlled receptacles, in order to support the addition of requirements to install such receptacles in Section 130.5.

Section: 120.0
Specific Purpose:
The specific purpose of the change to this section is to remove reference to high-rise residential (now labeled multifamily buildings), such that the requirements of this section and its subsections now only apply to nonresidential, hotel/motel buildings. This is a non-substantive change: multifamily requirements are being relocated into new Sections 160, 170, and 180. (Any substantive changes made to multifamily requirements are described in the statements for those new Sections.)
Necessity:
These changes are necessary to relocate low-rise and high-rise multifamily requirements to a new multifamily specific section of the code. Consolidating these provisions into a dedicated group of sections ensures clarity and internal consistency

within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 120.1(a)
Specific Purpose:
The specific purpose of the change to this section is to remove reference to high-rise residential (now labeled multifamily buildings), such that the requirements of this section and its subsections now only apply to nonresidential, hotel/motel buildings. This is a non-substantive change: multifamily requirements are being relocated into new Sections 160, 170, and 180. (Any substantive changes made to multifamily requirements are described in the statements for those new Sections.)
Necessity:
These changes are necessary to relocate low-rise and high-rise multifamily requirements to a new multifamily specific section of the code. Consolidating these provisions into a dedicated group of sections ensures clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.
Section: 120.1(b)
Specific Purpose:
The specific purpose of the change to this section is to remove reference to high-rise residential (now labeled multifamily buildings), such that the requirements of this section and its subsections now only apply to nonresidential, hotel/motel buildings. This is a non-substantive change: multifamily requirements are being relocated into new Sections 160, 170, and 180. (Any substantive changes made to multifamily requirements are described in the statements for those new Sections.)
Necessity:
These changes are necessary to relocate low-rise and high-rise multifamily requirements to a new multifamily specific section of the code. Consolidating these provisions into a dedicated group of sections ensures clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 120.1(c)
Specific Purpose:
The specific purpose of the changes to this section is to more completely reference its subsections and to clarify their interaction. This change is not a substantive change, though substantive changes have been made to subsections (c)1 and (c)3 (described below)
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 120.1(c)1
Specific Purpose:
The specific purpose of the changes to this section is to clarify the requirements for air filters by use of language consistent with language previously in 120.1(b)1A instead of referencing said language, to clarify the expected locations of air filters within space conditioning systems, and to require sealing around filters.
Necessity:
These change to copy existing language formerly located in Section 120.1(b) is necessary to maintain the readability of the Energy Code given that the referenced language is being relocated from the immediately preceding section to one occurring much later in the regulations. The change to specify the locations of the filters is necessary to ensure that components benefit from filtration of dust and particles that can impede performance: dust will act as an insulator and reduce thermal efficiency if allowed to deposit on such components. The change to require sealing or gasketing is necessary to ensure that air does not bypass the filters and in doing so defeat the purpose of their installation.

Section: 120.1(c)3
Specific Purpose:
The specific purpose of the change to this section is to better align its provisions with Section 1000.4 of the California Building Code and remove potential conflict between code requirements.
Necessity:
These changes are necessary to prevent the requirements of this section from inadvertently precluding the use of options expressly allowed by the California Building Code, and conversely preventing these additional allowances from being applied more broadly than allowed by the California Building Code.

Section: 120.1(d)3
Specific Purpose: The specific purpose of the changes to this section is to clarify the type of system addressed in these requirements.
Necessity:
The clarifying changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Section 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 120.1(d)5
Specific Purpose:
The specific purpose of the changes to this section are to remove reliance on reference to a later section by instead directly stating where these controls are required, and to clarify the expected interaction between ventilation devices and occupancy sensors installed to also provide lighting control functions. In particular, occupancy sensing controls may delay reporting “unoccupied” for up to 20 minutes to prevent false or

temporary readings from overly affecting controlled equipment behavior, and the intent of this language is to provide an *additional* five minutes from receipt of that signal for ventilation equipment to be staged up or down as appropriate.

Necessity:

These changes are necessary to provide a needed level of additional detail and ensure the requirements are neither vague nor ambiguous, as well as to ensure that ventilation equipment is not required to change speeds at a rate that would be potentially harmful to the equipment or require active braking or similar added costs.

Section: 120.1(f)

Specific Purpose:

The specific purpose of the changes to this section are to clarify that the term airflow rates refers to design airflow rates, clarify that these rates are minimum rates that the system must be capable of achieving (and in so doing preclude an unintended alternate reading that these were the sole and specific rates the equipment was allowed to be operated at), and clarify that the requirement in subsection 3 to “measured … rates” was a reference to required testing.

Necessity:

These changes are necessary to prevent unintended and overly stringent alternate readings of this section’s requirements, and to remove ambiguity relating to when, or by whom, airflow would be measured to comply with subsection 3.

Section: 120.1(g)

Specific Purpose:

The specific purpose of the changes to this Section are to include additional language from ASHRAE 62.1 that describes each air class, and to add a note to make the source of the language more transparent. For context, ASHRAE 62.1 is incorporated by reference into the Energy Code.

Necessity:

These changes are necessary to allow the requirements of this section to be read and understood without needing to additionally access or read ASHRAE 62.1.

Section: 120.1(h)

Specific Purpose:

The specific purpose of the addition of this section is to directly state that ventilation-only systems are still required to comply with Section 120.1(f). While Section 120.1(f) states that it applies to “all mechanical ventilation *and* space-conditioning systems”, questions regarding application of requirements to systems that do not provide heat or cooling arise commonly enough that a separate, direct statement in a dedicated section was found to be needed.

Necessity:

This change is necessary to ensure that application of ventilation requirements to ventilation systems is not misunderstood.

Section: Table 120.1-A
Specific Purpose:
The specific purpose of the changes to this table is to clarify that the outdoor air rate is the total outdoor airflow rate and that the DCV ventilation rates are minimum values.
Necessity:
The clarifying changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 120.2(c)
Specific Purpose:
The specific purpose of the change to this section is to remove reference to high-rise residential (now labeled multifamily buildings), such that the requirements of this section and its subsections now only apply to nonresidential, hotel/motel buildings. This is a non-substantive change: multifamily requirements are being relocated into new Sections 160, 170, and 180. (Any substantive changes made to multifamily requirements are described in the statements for those new Sections.)
Necessity:
These changes are necessary to relocate low-rise and high-rise multifamily requirements to a new multifamily specific section of the code. Consolidating these provisions into a dedicated group of sections ensures clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 120.2(c)2
Specific Purpose:
The specific purpose of the change to this section is to remove reference to high-rise residential (now labeled multifamily buildings), such that the requirements of this section and its subsections now only apply to nonresidential, hotel/motel buildings. This is a non-substantive change: multifamily requirements are being relocated into new Sections 160, 170, and 180. (Any substantive changes made to multifamily requirements are described in the statements for those new Sections.)
Necessity:
These changes are necessary to relocate low-rise and high-rise multifamily requirements to a new multifamily specific section of the code. Consolidating these provisions into a dedicated group of sections ensures clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: Section 120.2(e)3
Specific Purpose:
The specific purpose is to revise functionality requirements for the occupant sensor zone controls to align with the ventilation requirements of Section 120.1 and the occupant sensor ventilation controls devices requirements of Section 120.1(d)5, and to clarify and simplify language regarding occupancy sensing zone controls.

Necessity:
These changes are necessary to ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code Sections 11349 and 11349.1. Occupant sensing controls can be applicable to both space-conditioning systems and lighting systems, and applicable space-conditioning systems with occupant sensing zone controls need to meet the specified functionality requirements before, after and during occupied-standby mode. In addition, the clarifying changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Section 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 120.2(i)
Specific Purpose:
The specific purpose of the changes to this Section is to expand Economizer and Economizer Fault Detection (FDD) and Diagnostic requirements to include mechanical cooling capacities greater than 33,000 Btu/hr.
Necessity:
The proposed expansion of design standards for economizers and FDD are necessary to reduce and prevent wasteful, uneconomic, inefficient, and unnecessary consumption of energy by buildings, consistent with the statutory direction in Public Resources Code Section 25402. Economizers are an effective way to capture free cooling.

Section: 120.2(j)
Specific Purpose:
The specific purpose of the changes to this section are to directly reference Sections 110.12(a) and (b) rather than requiring an unnecessary extra step of travelling to Section 120.2(h). This is not a substantive change: Section 120.2(h) only refers readers to Sections 110.12(a) and (b).
Necessity:
This change is necessary to remove an unneeded step in locating applicable provisions relating to demand responsive behavior.

Section: 120.3
Specific Purpose:
The specific purpose of the change to this section is to remove reference to high-rise residential (now labeled multifamily buildings), such that the requirements of this section and its subsections now only apply to nonresidential, hotel/motel buildings. This is a non-substantive change: multifamily requirements are being relocated into new Sections 160, 170, and 180. (Any substantive changes made to multifamily requirements are described in the statements for those new Sections.)
Necessity:
These changes are necessary to relocate low-rise and high-rise multifamily requirements to a new multifamily specific section of the code. Consolidating these provisions into a dedicated group of sections ensures clarity and internal consistency

within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 120.4
Specific Purpose:
The specific purpose of the change to this section is to remove reference to high-rise residential (now labeled multifamily buildings), such that the requirements of this section and its subsections now only apply to nonresidential, hotel/motel buildings and to include a reference to the newly added section 120.4(g). This is a non-substantive change: multifamily requirements are being relocated into new Sections 160, 170, and 180. (Any substantive changes made to multifamily requirements are described in the statements for those new Sections.)
Necessity:
These changes are necessary to relocate low-rise and high-rise multifamily requirements to a new multifamily specific section of the code. Consolidating these provisions into a dedicated group of sections ensures clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 120.4(b)
Specific Purpose:
The specific purpose of the changes to this Section is to specify Seal Class A construction for all ductwork and plenums with pressure class ratings for factory-fabricated and field-fabricated duct systems while allowing some flexibility for ducts in condition spaces that are in view.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402. Duct leakage wastes energy causing longer run times for HVAC systems trying to meet demand load.

Section: 120.4(b)1D and (b)2D
Specific Purpose:
The specific purpose of the change to this section is to add reference to the specific level of sealing required by the California Mechanical Code and the underlying ASHRAE 90.1 standard, as context for the prohibition on use of certain types of duct tapes.
Necessity:
This change is necessary to allow this section to be read and understood without relying on knowledge of CMC or ASHRAE 90.1 requirements, and to prevent it from being misunderstood as being more permissive than the CMC or allowing the CMC to be ignored if the prohibition on tapes is followed.

Section: 120.4(g)
Specific Purpose:
The specific purpose of the change to these Sections: (See also sections 140.4(l), 141.0(b), 120.5(a), NA 1.1, NA 2.1, and NA7)

- Make the prescriptive Section 140.4(l) a mandatory requirement by moving this language to Section120.4(g), and updating references to Section 140.4(l) present in Section 120.5(a) to refer to this new location.
- Include California Mechanical Code Section 603.10.1 duct testing for systems that do not fall under 120.4(g)1 which took effect January 1, 2020.

Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16. Duct leakage testing was introduced in 2001 in Part 6 and have not been updated since introduction. The prescriptive requirement being moved to a mandatory requirement is necessary to be consistent with recent California Mechanical Code changes as well as duct leakage testing.

Section: 120.5
Specific Purpose:
The specific purpose of the change to this section is to remove reference to high-rise residential (now labeled multifamily buildings), such that the requirements of this section and its subsections now only apply to nonresidential, hotel/motel buildings. This is a non-substantive change: multifamily requirements are being relocated into new Sections 160, 170, and 180. (Any substantive changes made to multifamily requirements are described in the statements for those new Sections.)
Necessity:
These changes are necessary to relocate low-rise and high-rise multifamily requirements to a new multifamily specific section of the code. Consolidating these provisions into a dedicated group of sections ensures clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 120.5(a)
Specific Purpose:
Duct sealing requirements in Sections 140.4(l) have been moved to Sections 120.4(g) as a mandatory requirement (see 120.4(g)). The specific purpose of the change to this section is to refer to sections 120.4(g) and 141.0(b)2D. The addition of sections 120.4(g)1 and 141.0(b)2D clarify the requirements for which NA7.5.3 is required. (See also sections 140.4(l), 141.0(b), 120.4(g), NA 1.1, NA 2.1, and NA7)
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16. Duct

leakage testing was introduced in 2001 in Part 6 and have not been updated since introduction. The prescriptive requirement being moved to a mandatory requirement is necessary to be consistent with recent California Mechanical Code changes as well as duct leakage testing.

Section: 120.5 Authority and Reference Citation
Specific Purpose:
The specific purpose of the changes to the Authority and Reference citations is to correct the statement for this section to match those of the preceding and following sections. This is not a substantive change in requirements.
Necessity:
These changes are necessary to correct an inadvertent error in the citations for this section: the contents of this section are not different in character such that they would be adopted under differing statutory authority, or based on reference to differing supporting statutes.

Section: 120.6
Specific Purpose:
The specific purpose of the change to this section is to remove reference to high-rise residential (now labeled multifamily buildings), such that the requirements of this section and its subsections now only apply to nonresidential, hotel/motel buildings. This is a non-substantive change: multifamily requirements are being relocated into new Sections 160, 170, and 180. (Any substantive changes made to multifamily requirements are described in the statements for those new Sections.)
Necessity:
These changes are necessary to relocate low-rise and high-rise multifamily requirements to a new multifamily specific section of the code. Consolidating these provisions into a dedicated group of sections ensures clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: EXCEPTION 1 to 120.6(a)4A, EXCEPTION 1 to Section 120.6(a)4B, EXCEPTION 120.6(a)4C
Specific Purpose:
This purpose of this non-substantive change is to provide the reader with a reminder about the meaning of “quick chilling/freezing of products” for clarity, consistent with similar language in other sections.

Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 120.6(a)4E
Specific Purpose:
The specific purpose of the changes to this section is to improve phrasing to account for systems that may include mixed equipment or may make use of equipment in ways not relating to heat rejection.
Necessity:
These changes are necessary to ensure that the language accurately represents the intended scope of application of the 70 degree Fahrenheit setpoint requirement and that this requirement applies where it has been demonstrated to be technically feasible and cost effective. Including these systems in the scope of the requirement will reduce overall energy consumption consistent with the statutory directives in Public Resources Code section 25402.

Section: EXCEPTION to Section 120.6(a)4
Specific Purpose:
The specific purpose of the changes to this section is to exempt transcritical CO2 systems from the all of 120.6(a)4 due to new requirements for transcritical CO2 systems in section 120.6(a)8.
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 120.6(a)5A, B, EXCEPTION to Section 120.6(a)5B, C, and D
Specific Purpose:
The specific purpose of the changes to subsection 5 is to establish minimum efficiency requirements for transcritical CO2 refrigeration system compressors located in refrigerated warehouses, consistent with existing regulations applying to traditional refrigeration equipment installed in this context. Transcritical CO2 systems are gaining popularity as the industry moves away from refrigerants with high global warming potential, and an absence of performance standards for this equipment potentially allows inefficient versions of this equipment and wasteful system designs to become commonplace. Other changes are to renumber existing sections to reflect new additions.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402.

Section: EXCEPTION 2 to 120.6(a)5C
Specific Purpose:
This purpose of this non-substantive change is to provide the reader with a reminder about the meaning of “quick chilling/freezing of products” for clarity, consistent with similar language in other sections.
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section:120.6(a)7
Specific Purpose:
The specific purpose of the changes to subsections 7 is to establish minimum efficiency requirements for transcritical CO2 refrigeration system compressors located in refrigerated warehouses, consistent with existing regulations of acceptance testing applying to traditional refrigeration equipment installed in this context. Transcritical CO2 systems are gaining popularity as the industry moves away from refrigerants with high global warming potential, and an absence of performance standards for this equipment potentially allows inefficient versions of this equipment and wasteful system designs to become commonplace. Other changes are to renumber existing sections to reflect new additions.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402.

Section: 120.6(a)8, and Table 120.6-C
Specific Purpose:
The specific purpose of the changes to subsection 8is to establish minimum efficiency requirements for transcritical CO2 refrigeration system compressors located in refrigerated warehouses, consistent with existing regulations applying to traditional refrigeration equipment installed in this context. Transcritical CO2 systems are gaining popularity as the industry moves away from refrigerants with high global warming potential, and an absence of performance standards for this equipment potentially allows inefficient versions of this equipment and wasteful system designs to become commonplace.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402.

Section: 120.6(a)9
Specific Purpose:
The specific purpose of the addition of this section is to require automatic door closers for compliance with Section 120.6(a)6 when doors designed for the passage of people are between refrigerated and nonrefrigerated areas.
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section: 120.6(b)
Specific Purpose:
The specific purpose of the change to expressly state beverage stores in addition to food stores is to improve clarity. Applicable definitions of “food” include beverages, and “food stores” is inclusive of beverage stores in the language as it exists currently, making this inclusion more explicit prevents misreading or misunderstanding of the application of these requirements.
Necessity:
This change is necessary to ensure clarity and internal consistency of the Energy Code, as directed by California Government Code, Section 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.
Section: EXCEPTION 2 to 120.6(b)2B
Specific Purpose:
The specific purpose of this change is to allow transcritical CO2 refrigeration systems be excluded from liquid subcooling requirement.
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section: 120.6(b)2C
Specific Purpose:
The specific purpose of this addition is to establish minimum efficiency requirements for transcritical CO2 refrigeration system compressors.
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section: EXCEPTION to Section 120.6(b)2C
Specific Purpose:
The specific purpose of this change is to allow compressors with a differently designed saturated suction temperature to operate at its appropriate minimum condensing temperature.
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section: EXCEPTION 3 120.6(b)4A
Specific Purpose:
The specific purpose of this change is to exclude stores with total heat of rejection of at most 500,000 Btu/h from the refrigeration heat recovery requirement.
Necessity:
This addition is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section: 120.6(b)5A
Specific Purpose:
The specific purpose of this addition of this section is to prohibit air-cooled gas coolers in Climate Zones 10 through 15.
Necessity:
This addition is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section: 120.6(b)5B
Specific Purpose:
The specific purpose of this addition of this section is to establish a maximum design dry bulb temperature for transcritical CO2 gas coolers.
Necessity:
This addition is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section: 120.6(b)5C
Specific Purpose:
The specific purpose of this addition of Section 120.6(b)5 is to establish a maximum design dry bulb temperature for adiabatic gas coolers.
Necessity:
This addition is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section: 120.6(b)5D
Specific Purpose:
The specific purpose of this addition of this section is to establish requirements for gas cooler fans.
Necessity:
This addition is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section: 120.6(b)5E
Specific Purpose:
The specific purpose of this addition of this section is to specify a gas cooler pressure requirement.
Necessity:
This addition is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section: 120.6(b)5F
Specific Purpose:
The specific purpose of this addition of this addition is to establish a gas cooler pressure setpoint.
Necessity:
This addition is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section: 120.6(b)5G
Specific Purpose:
The specific purpose of this addition of this section is to establish a minimum condensing temperature setpoint for different gas cooler systems.
Necessity:
This addition is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section: EXCEPTION to 120.6(b)5G
Specific Purpose:
The specific purpose of this addition is to allow transcritical CO2 system with a design intermediate suction temperature of at least 30 degree Fahrenheit to meet a more appropriate condensing temperature setpoint for its ideal operation.
Necessity:
This addition is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section: Table 120.6-E
Specific Purpose:
The specific purpose of the addition of this table is to clearly list out minimum efficiencies and rating conditions for different types of condensers as applicable in the transcritical CO2 fan-powered gas coolers.
Necessity:
This addition is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section: 120.6(d)3 and 120.6(d)4
Specific Purpose:
The specific purpose of the changes in the old subsections 120.6(d)3 and 120.6(d)4 is to reduce the excess oxygen concentration requirement to 3 percent for process boilers with input capacity of 5 million BTU per hour to 10 million BTU per hour. Subsequently subsection (d)3 is combined with 120.6(d)4.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402.

Section: EXCEPTION to 120.6(d)3
Specific Purpose:
The specific purpose of the new exception is to exempt from the excess oxygen concentration requirement in 120.6(d)3 if the process boiler has a combustion efficiency of 90 percent of higher.
Necessity:
This change is necessary to account for systems with tightly controlled combustion environments (including oxygen concentrations) where compliance with blanket minimum standards has a potential to decrease rather than improve combustion efficiency.

Section: EXCEPTION 1 to 120.6(e), 120.6(e)3 and EXCEPTION 2 to 120.6(e).
Specific Purpose: The EXCEPTION 1 to Section 120.6(e) was moved to subsection 120.6(e)1, which will require alterations with centrifugal compressors to be subject to the rest of the existing and newly added subsections. EXCEPTION 2 to 120.6(2) has been renumbered and non-substantive language was revised for clarity.
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section: EXCEPTION 1, 2, 3, and 4. to Section 120.6(e)1
Specific Purpose: The purpose of the changes to this section are to revise, expand and update energy efficiency standards for compressed air systems, per the contents of the code change proposal included in the Documents Relied Upon. These changes include revising and adding exceptions for alterations where code requirements would not allow cost effectiveness while tightening the requirements for exclusion. EXCEPTION 2 has been renumbered to 3.
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section:120.6(e)2
Specific Purpose: The purpose of the changes to this section are to revise, expand and update energy efficiency standards controls for compressed air systems, per the contents of the code change proposal included in the Documents Relied Upon.
Necessity: This change is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section:120.6(e)3
Specific Purpose: The purpose of the addition to this section are to expand energy efficiency standards for compressed air systems to include monitoring, per the contents of the code change proposal included in the Documents Relied Upon.
Necessity: This change is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section:120.6(e)4
Specific Purpose: The purpose of the addition to this section are to expand energy efficiency standards for compressed air systems to include leak testing of compressed air piping per the contents of the code change proposal included in the Documents Relied Upon.
Necessity: This change is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section:120.6(e)5
Specific Purpose: The purpose of the addition to this section are to expand energy efficiency standards for compressed air systems to include pipe sizing requirements per the contents of the code change proposal included in the Documents Relied Upon.
Necessity: This change is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section:120.6(e)6
Specific Purpose: The purpose of the revision to this section are to renumber and clean up existing code language.
Necessity: This change is necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Section 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 120.6(h)1A
Specific Purpose:
The specific purpose of the addition of this Section is to set efficiency requirements for stand-alone dehumidifiers used for indoor growing spaces.
Necessity:
This addition is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section: 120.6(h)1B
Specific Purpose:
The specific purpose of the addition of this Section is to set efficiency requirements for integrated HVAC system used as dehumidifier for indoor growing spaces.
Necessity:
This addition is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section: 120.6(h)1C
Specific Purpose:
The specific purpose of the addition of this Section is to set efficiency requirements for chilled water system used as dehumidifier for indoor growing spaces.
Necessity:
This addition is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section: 120.6(h)1D
Specific Purpose:
The specific purpose of the addition of this Section is to set efficiency requirements for solid and liquid desiccant dehumidification systems for indoor growing spaces.
Necessity:
This addition is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section: 120.6(h)2A
Specific Purpose:
The specific purpose of the addition of this Section is to add new horticultural lighting efficiency requirements for indoor growing lighting systems.
Necessity:
This addition is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section: 120.6(h)2B
Specific Purpose:
The specific purpose of the addition of this Section is to add time switch lighting control requirements for indoor growing lighting systems.
Necessity:
This addition is necessary to ensure consistency between the Energy Code and the other Part of the Building Standards Code, as directed by California Government Code, Sections 11349 and 11349.1.

Section: 120.6(h)2C
Specific Purpose:
The specific purpose of the addition of this Section is to add multilevel lighting control requirements for indoor growing lighting systems.
Necessity:
This addition is necessary to ensure consistency between the Energy Code and the other Part of the Building Standards Code, as directed by California Government Code, Sections 11349 and 11349.1.

Section: 120.6(h)3
Specific Purpose:
The specific purpose of the addition of this Section is to require an electrical power distribution system to be capable of allowing a measuring device to monitor the electrical energy usage of aggregate horticultural lighting load in the electrical power distribution systems used for indoor growing spaces.
Necessity:
This addition is necessary to ensure that the 40kW aggregated horticultural lighting load requirement in subsection120.6(h)3 can be determined. This change is necessary to ensure consistency between the Energy Code and the other Part of the Building Standards Code, as directed by California Government Code, Sections 11349 and 11349.1.

Section: 120.6(h)4A
Specific Purpose:
The specific purpose of the addition of this Section is to provide clarifying details that opaque wall and opaque roof assemblies in conditioned greenhouses must meet requirements in Section 120.7.
Necessity:
This addition is necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 120.6(h)4B
Specific Purpose:
The specific purpose of the addition of this Section is to require specific U-factors for fenestration products installed in conditioned greenhouses.
Necessity:
This addition is necessary to provide practical compliance path for conditioned greenhouses and to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 120.6(h)5
Specific Purpose:
The specific purpose of the addition of this Section is to clarify that space conditionings systems for conditioned greenhouses must meet existing applicable requirements in California Code of Regulations, Title 24 Part 6.
Necessity:
This addition is necessary to ensure consistency between the Energy Code and the other Part of the Building Standards Code, as directed by California Government Code, Sections 11349 and 11349.1.

Section: 120.6(h)6
Specific Purpose:
The specific purpose of the addition of this Section is to add new photosynthetic photon efficacy requirements for horticultural lighting systems in greenhouse growing lighting systems.
Necessity:
This addition is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section: 120.6(h)6B
Specific Purpose:
The specific purpose of the addition of this Section is to add time switch lighting control requirements for greenhouse growing lighting systems.
Necessity:
This addition is necessary to ensure consistency between the Energy Code and the other Part of the Building Standards Code, as directed by California Government Code, Sections 11349 and 11349.1.

Section: 120.6(h)6C
Specific Purpose:
The specific purpose of the addition of this Section is to add multilevel lighting control requirements for greenhouse growing lighting systems.
Necessity:
This addition is necessary to ensure consistency between the Energy Code and the other Part of the Building Standards Code, as directed by California Government Code, Sections 11349 and 11349.1.

Section: 120.6(i)
Specific Purpose:
The specific purpose of the addition of this section is to add minimum efficiency standards for steam traps, per the associated code change proposal included in the Documents Relied Upon. Steam traps serving systems of sufficient size are required to include fault detection and diagnostic sensors, strainers, and be subject to acceptance testing.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402.

Section: 120.6(j),
Specific Purpose:
The specific purpose of the addition of this section is to relocate minimum efficiency standards for computer room ventilation from Section 140.9 to this section, and in so doing make the requirements mandatory rather than prescriptive. Computer rooms shall have controls that prevent space heating or conditioning systems from trying to heat and cool at once, shall not use nonadiabatic humidification, and if sufficiently large shall have load-following fan behavior – these requirements are unchanged from existing provisions save for now being required for both the prescriptive and performance compliance approaches. (See also Section 140.9(a)2,3, and 5)
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402.

Section: 120.7
Specific Purpose:
The specific purpose of the change to this section is to remove reference to high-rise residential (now labeled multifamily buildings), such that the requirements of this section and its subsections now only apply to nonresidential, hotel/motel buildings. This is a non-substantive change: multifamily requirements are being relocated into new Sections 160, 170, and 180. (Any substantive changes made to multifamily requirements are described in the statements for those new Sections.)
Necessity:
These changes are necessary to relocate low-rise and high-rise multifamily requirements to a new multifamily specific section of the code. Consolidating these provisions into a dedicated group of sections ensures clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 120.7(a)3
Specific Purpose:
The specific purpose of the change to this section is to remove the word “continuous” as unneeded and potentially a source of confusion. The specification of “continuous” implies the existence of a “*non*continuous roof”, and it is not clear what would constitute a “noncontinuous roof” or what distinction is intended by “continuous”: roofs by their nature must serve to isolate the indoor environment from the outdoor, and do so while also having a variety of necessary penetrations. The removal of this word is understood to be a non-substantive change.
Necessity:
This change is necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Section 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 120.8
Specific Purpose:
The specific purpose of the changes in this Section are to be more consistent in the use of the word “and” in lists of items, and to clarify a necessary link between the Owner’s Project Requirements and the Basis of Design: it was not intended that the Basis of Design omit materials in the Owner’s Project Requirements.
Necessity:
These changes are necessary in order to ensure that the Basis of Design fulfills all of its obligations to the Owner’s Project Requirements, and otherwise improve clarity and consistency of lists by removing unneeded, redundant “and”.

Section: 120.9
Specific Purpose:
The purpose of the changes to this section are to make edits consistent with the changes proposed for Section 120.6(d), including removing the term “excess” in favor of the term “stack-gas” and marginally increasing the threshold of the available exception.
Necessity:
These changes are necessary to maintain consistency with Section 120.6(d), and to improve the stringency of the exception for consistency with anticipated performance of contemporary equipment.

Section: 120.10 and 141.0(b)1D
Specific Purpose:
The specific purpose of this new section is to add new mandatory requirements of Fan Energy Index (abbreviated FEI) for fan and fan arrays for new construction and for additions and alterations when a new fan system is installed. Fan Energy Index is an analysis of fan power draw that accounts for more aspects of overall fan system design (i.e., more of the context into which a fan is installed) than the watts-per-CFM of a given fan taken in isolation. (See

https://www.amca.org/assets/resources/public/documents/Introducing%20the%20Fan%20Energy%20Index%20Metric.pdf for a useful description of the metric provided at a layperson level.) The use of this approach is intended to both provide additional flexibility in achieving efficient performance on a holistic basis, as well as prevent designs that create avoidable inefficiencies that are invisible under an approach that looks exclusively at rated fan performance values.

Necessity:

These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402. Fan Energy Index encourages designers to specify fans that are closer to the fan's peak efficiency.

Section: 130.0, 130.0(a) and 130.0(b)

Specific Purpose:

The specific purpose of the changes to this section is to remove high-rise residential buildings and high-rise residential dwellings from the scoping requirements of Section 130.0 because high-rise residential buildings and dwellings are being moved to new chapters of the proposed Energy Code.

Necessity:

These changes were necessary to ensure clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16. The requirements for high-rise residential buildings and high-rise residential dwellings are specified in new chapters of the proposed Energy Code.

Section: 130.0(c)

Specific Purpose:

The specific purpose of the changes to Section 130.0(c)2 is to update the luminaire classification and luminaire power determination for luminaires with line voltage lamp holders and to revise the requirement to be based on the luminaire maximum rated wattage of Section 130.0(c)1 and to delete the 50 watts per socket threshold for recessed luminaires with line-voltage medium screw base socket.

The specific purpose of the changes to Section 130.0(c)6 is to delete redundant wording, which are non-substantive grammatical changes necessary to effectively communicate the requirements in a precise and clear manner.

Necessity:

The changes to Sections 130.0(c)1 and (c)2 are necessary to reflect the common occurrence that luminaires with line voltage lamp holders can be lamped with LED lamps which are of lower wattage than 50 watts. The changes to Section 130.0(c)6 are necessary to ensure clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section 130.1
Specific Purpose:
The specific purpose of the change to this section is to remove high-rise residential buildings and high-rise residential dwellings from the scoping requirements of Section 130.1.
Necessity:
This change was necessary to ensure clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16. The requirements for high-rise residential buildings and high-rise residential dwellings are specified in new chapters of the proposed Energy Code.

There are also non-substantive grammatical changes and subdivision heading changes necessary to effectively communicate the requirements and standards in a precise and clear manner.

Section: 130.1(a)
Specific Purpose:
The specific purpose of the changes is to clarify the exception, as permitted in this Section 130.1(a), of indoor lighting that are continuously illuminated for the means of egress illumination to be up to the same amount as permitted in Section 130.1(c).
Necessity:
These changes are necessary to ensure and improve general clarity and internal consistency of the Energy Code, as directed by California Government Code Section 11349 and 11349.1 and California Code of Regulations, Title 1, Section 16.

Section: 130.1(b)
Specific Purpose:
The specific purpose of the changes are to relocate certain exceptions to this subsection's multilevel lighting control requirements from Table 130.1-A to the text body of Section 130.1(b).
The multilevel lighting control requirements for these areas as specified in the exceptions are not new requirements as they have been in existing Table 130.1-A as footnotes.
Necessity:
These changes are necessary to allow the requirement to be readily noticeable in text body of the section and can enhance the readability of the code.
These changes are necessary to ensure and improve general clarity and internal consistency of the Energy Code, as directed by California Government Code Section 11349 and 11349.1 and California Code of Regulations, Title 1, Section 16.

Section: EXCEPTION 2 to Section 130.1(c)
Specific Purpose:
The specific purpose of the change is to relocate this EXCEPTION 2 from the end of Section 130.1(c) to be below EXCEPTION 1.
Necessity:
This change is necessary to ensure and improve general clarity and internal consistency of the Energy Code, as directed by California Government Code Section 11349 and 11349.1 and California Code of Regulations, Title 1, Section 16.

Section: EXCEPTION to 130.1(c)1C
Specific Purpose:
The specific purpose of the non-substantive grammatical changes to the EXCEPTION to Section 130.1(c)1C is to effectively communicate the requirements in a precise and clear manner.
Necessity:
This change is necessary to ensure and improve general clarity and internal consistency of the Energy Code, as directed by California Government Code Section 11349 and 11349.1 and California Code of Regulations, Title 1, Section 16.

Section: 130.1(c)1E
Specific Purpose:
This is a non-substantive change to remove language that is duplicative with Section 130.1(a). Because all indoor lighting controls already require compliance with Section 130.1(a), which requires manual on switches, it is not necessary to duplicate that requirement in 130.1(c).
Necessity:
This change is necessary to ensure and improve general clarity and internal consistency of the Energy Code, as directed by California Government Code Section 11349 and 11349.1 and California Code of Regulations, Title 1, Section 16.

Section: EXCEPTION 6 to 130.1(c)1
Specific Purpose:
The specific purpose of this addition is to exempt lighting in stairways designated for egress from shut-off energy saving requirements of Section 130.1(c)1.
Necessity:
This addition is necessary to ensure consistency of the Energy Code and the California Fire Marshall Code. Egress lighting is considered emergency lighting, and thus falls under the California Fire Marshall jurisdiction.

Section: 130.1(c)5
Specific Purpose:
The specific purposes of the changes to subsection 130.1(c)5 are to establish mandatory occupant sensing control requirements for multipurpose rooms, classrooms, conference rooms, restrooms, and offices that are 250 square feet or smaller and to make a non-substantive change by replacing the phrase ‘sensor” with ‘sensing controls’.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Section 25213 and 25402. The multizone occupancy sensing controls requirements for offices greater than 250 square feet will provide the benefit of granular controls of the controlled zones during occupied and non-occupied mode.

Section: 130.1(c)6
Specific Purpose:
The specific purpose of replacing “areas where full or partial” off with “partial” off is to remove redundancy in the code language. This is a non-substantive change. Another specific purpose is to add the mandatory requirements for partial OFF occupancy sensing controls for aisle ways, open area in warehouses, library book stack aisles, corridors and stairwells, and office spaces greater than 250 square feet.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Section 25213 and 25402. These changes are also necessary to ensure and improve general clarity and internal consistency of the Energy Code, as directed by California Government Code Section 11349 and 11349.1 and California Code of Regulations, Title 1, Section 16.

Section: 130.1(c)6A
Specific Purpose:
The specific purpose of the change in this section is to specify the partial OFF occupant sensing control requirements in warehouses.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Section 25213 and 25402.

Section: 130.1(c)6C
Specific Purpose:
The specific purpose of this change is to rephrase the requirements for lighting installed in corridors and stairwells. This is a non-substantive change.
Necessity:
This change is necessary to ensure and improve general clarity and internal consistency of the Energy Code, as directed by California Government Code Section 11349 and 11349.1 and California Code of Regulations, Title 1, Section 16.

Section: 130.1(c)6D
Specific Purpose:
The specific purpose of this addition is to establish requirements for partial OFF occupancy sensing controls in offices greater than 250 square feet.
Necessity:
This addition is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Section 25213 and 25402.

Section: 130.1(c)6Di
Specific Purpose:
The specific purpose of this addition is to provide configuration details for partial OFF occupancy sensing controls in offices greater than 250 square feet to meet Energy Code compliance.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Section 25213 and 25402.

Section: 130.1(c)6Dii
Specific Purpose:
The specific purpose of this addition is to specify the time window for partial OFF occupancy sensing controls to reduce its lighting power in offices greater than 250 square feet to meet Energy Code compliance.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Section 25213 and 25402.

Section: 130.1(c)6Diii
Specific Purpose:
The specific purpose of this addition is to specify the time window for partial OFF occupancy sensing controls to shut off lighting in all zones of offices greater than 250 square feet to meet Energy Code compliance.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Section 25213 and 25402.

Section: 130.1(c)6Div
Specific Purpose:
The specific purpose of this addition is to specify when lighting will be allowed to fully turn on within each control zone in offices greater than 250 square feet to meet Energy Code compliance.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Section 25213 and 25402.

Section: EXCEPTION to Section 130.1(c)6D
Specific Purpose:
The specific purpose of this addition is to allow under-shelf and furniture-mounted task lighting controls to be exempted from the partial OFF occupancy sensing controls for different zones in office spaces greater than 250 square feet.
Necessity:
This change is necessary to ensure and improve general clarity and internal consistency of the Energy Code, as directed by California Government Code Section 11349 and 11349.1 and California Code of Regulations, Title 1, Section 16.

Section: 130.1(c)7
Specific Purpose:
The specific purpose of replacing “areas where full or partial” off with “partial” off is to remove redundancy in the code language. This is a non-substantive change. Another specific purpose is to add the mandatory requirements for partial OFF occupancy sensing controls for specified stairwells and common area corridors, parking garages, parking areas, and loading and unloading areas.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Section 25213 and 25402. These changes are also necessary to ensure and improve general clarity and internal consistency of the Energy Code, as directed by California Government Code Section 11349 and 11349.1 and California Code of Regulations, Title 1, Section 16.

Section: 130.1(c)7A
Specific Purpose:
The specific purpose of the change to this section is to remove high-rise residential buildings and high-rise residential dwellings from the scoping requirements of Section 130.1(c)7A.
Necessity:
These changes are necessary to ensure clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16. The requirements for high-rise residential buildings and high-rise residential dwellings are specified in new chapters of the proposed Energy Code.

Section: 130.1(c)8
Specific Purpose:
The specific purpose of the changes to this section is to rephrase and reorganize the control requirements for hotel motel guest rooms.
Necessity:
These changes are necessary to ensure clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 130.1(d)
Specific Purpose:
The specific purpose of the change is to add secondary sidelit daylit zones to the mandatory automatic daylighting control requirements.
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Section 25213 and 25402.

Section: 130.1(d)1
Specific Purpose:
The specific purpose of the changes is to specify that secondary sidelit daylit zones in parking garages to be shown on plan sets.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Section 25213 and 25402.

Section: 130.1(d)2
Specific Purpose:
The specific purpose of the changes is to rephrase “luminaires” as “general lighting” for clarity. This is a non-substantive change. Another specific purpose of the changes is to explicitly describe how general lighting in overlapping primary and secondary sidelit daylit zones must be controlled.
Necessity:
These changes are necessary to ensure clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16. These changes are also necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Section 25213 and 25402.

Section: 130.1(d)3C
Specific Purpose:
One specific purpose of the changes is to rephrase the daylight requirement in areas other than parking garages to improve clarity and understanding. This is a non-

substantive change. Another specific purpose of the changes is to increase the minimum of controlled lighting power reduction from 65 to 90 percent.
Necessity:
These changes are necessary to ensure clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16. These changes are also necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Section 25213 and 25402.

Section: 130.1(d)3D
Specific Purpose:
The specific purpose of the changes is to clarify that the combination of primary and secondary sidelit daylit zones must be reduced to 100 percent when daylight illuminance is greater than 150 percent of the design illuminance. This is a non-substantive change.
Necessity:
This change is necessary to ensure clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 130.1(d)4
Specific Purpose:
Because a minimum of one photosensor is now required for all daylit zones, it is no longer necessary to include conditional language specifying requirements when a photosensor is located within the daylit zone. This change requires that all photosensors be located such that they are not accessible to unauthorized personnel, rather than at least one in a daylit zone.
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Section 25213 and 25402.

Section: EXCEPTION 3 to 130.1(d)
Specific Purpose:
The specific purpose of the changes is to rephrase the EXCEPTION for rooms with total general lighting power in skylit daylit zone and primary sidelit daylit zone of less than 120 watts.
Necessity:
This change is necessary to ensure clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: EXCEPTION 4 to 130.1(d)
Specific Purpose:
The specific purpose of the changes is to exempt from the automatic daylighting control requirements rooms with total general lighting power in secondary sidelit daylit zone less than 120 watts.
Necessity:
This change is necessary to ensure clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: EXCEPTION 5 to 130.1(d)
Specific Purpose:
The specific purpose of the changes is to exempt from the automatic daylighting control requirements in sidelit daylit zones rooms with total installed general lighting power in primary and secondary sidelit daylit zones less than 240 watts.
Necessity:
This change is necessary to ensure clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: EXCEPTION 6 to 130.1(d)
Specific Purpose:
The specific purpose of the changes is to exempt from the automatic daylighting control requirements in daylit zones parking garage areas with total installed general lighting power in primary and secondary sidelit daylit zones less than 60 watts.
Necessity:
This change is necessary to ensure clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: EXCEPTION 8 to 130.1(d)
Specific Purpose:
The specific purpose of the changes is to remove dedicated ramps in parking garages from being exempted from automatic daylighting control requirements.
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Section 25213 and 25402.
Section: 130.1(f):
Specific Purpose:
The specific purpose of this change is to clarify that Sections 130.1(a) through 130.1(e) are required.
Necessity:
This change is necessary to ensure clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 130.1(f)9
Specific Purpose:
The specific purpose of the change is to add new occupant sensing control requirements for space conditioning systems as specified in Table 120.1-A.
Necessity:
Occupant sensing controls can be applicable to both space-conditioning systems and lighting systems, and applicable space-conditioning systems with occupant sensing zone controls needs to meet the specified functionality requirements. These changes are necessary to ensure and improve general clarify and internal consistency of the Energy Code, as directed by California Government Code Section 11349 and 11349.1 and California Code of Regulations, Title 1, Section 16.

Section: Table 130.1-A
Specific Purpose:
The specific purpose is to make editorial changes in re-ordering the light source technologies so that the LED lighting luminaire types are arranged to the top portion of the table and HID lighting technology types are arranged to the bottom part of the table. The other change is to combine some luminaire types with common character into the same category in order to improve the readability and ease-of-use of the Table.
Necessity:
These changes are necessary to ensure and improve general clarity of the Energy Code, as directed by California Government Code Section 11349 and 11349.1 and California Code of Regulations, Title 1, Section 16.

Section: 130.2, 130.2(b), and EXCEPTION 6 to 130.2(b)
Specific Purpose:
The specific purpose of the change to this section is to remove high-rise residential buildings and high-rise residential dwellings from the scoping requirements of Section 130.2 and provide non-substantive grammatical changes for clarity.
Necessity:
These changes are necessary for the changes to ensure clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16. The requirements for high-rise residential buildings and high-rise residential dwellings are specified in new chapters of the proposed Energy Code. There are also non-substantive grammatical changes and editorial changes necessary to effectively communicate the requirements and standards in a precise and clear manner.

Section: EXCEPTION 2 to 130.2(b)
Specific Purpose:
The specific purpose of this change is to exempt outdoor public art lighting from the luminaire shielding requirements.
Necessity:
This change is necessary to clarify that “public art” as part of public monuments and statues and to ensure clarity and internal consistency within the Energy Code, as

directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.
Section: EXCEPTION 6 to 130.2(b)
Specific Purpose:
The specific purpose of this change is to exempt utility-maintained roadways, sidewalks, and bikeways from the luminaire shielding requirements.
Necessity:
This change is necessary to clarify that “utility-maintained” is part of the public right of way and to ensure clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 130.2(c)3A
Specific Purpose:
The specific purpose of the changes to this section is to relocate the motion sensing control requirements from the bottom of the subsection to the top. This is a non-substantive change for clarity.
Necessity: These changes are necessary for the changes to ensure clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: EXCEPTION 4 to Section 130.2(c)3
Specific Purpose:
The specific purpose of the change to this section is to allow luminaires with a maximum rated wattage of 78 watts to not install motion sensing controls.
Necessity:
This change is necessary to ensure energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402.

Section: 130.3
Specific Purpose:
The specific purpose of the change to this section is to remove high-rise residential buildings and high-rise residential dwellings from the scoping requirements of Section 130.3.
Necessity:
These changes are necessary for the changes to ensure clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16. The requirements for high-rise residential buildings and high-rise residential dwellings are specified in new chapters of the proposed Energy Code.

Section: 130.4
Specific Purpose:
The specific purpose of the change to this section is to remove high-rise residential buildings and high-rise residential dwellings from the scoping requirements of Section 130.4.

Necessity:
These changes are necessary for the changes to ensure clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16. The requirements for high-rise residential buildings and high-rise residential dwellings are specified in new chapters of the proposed Energy Code. There are also non-substantive grammatical changes and editorial changes necessary to effectively communicate the requirements and standards in a precise and clear manner.

Section: 130.4(a)
Specific Purpose:
The specific purpose of the changes is to edit the wordings to clarify how the lighting control acceptance requirements can be met by testing in accordance with Reference Nonresidential Appendix Section NA7.6 and NA7.8. Another specific purpose of the changes to institutional tuning power adjustment factor is to move its references to the requirement from Section NA7, which contains installation requirements, to Section NA7.6, which contains lighting control acceptance test procedures.
Necessity:
The changes are necessary to state clearly without ambiguity the lighting controls as specified by the sections in Title 24 Part 6 shall be tested in accordance with the section in Reference Nonresidential Appendix NA7.6 or NA7.8. Reference Nonresidential Appendix Section NA7.6 and NA7.8 contains details of lighting control acceptance test procedures to be performed in order to meet requirements of lighting control acceptance of Section 130.4(a). The changes are necessary to ensure and improve general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1 and California Code of Regulations, Title 1, Section 16.

Section: 130.4(b)
Specific Purpose:
The specific purpose of the changes to this section are to remove outdated references to track lighting integral current limiters and supplementary overcurrent protection panels. Requirements relating to these two devices were removed as a part of the 2019 update to the Energy Code, and this language was inadvertently left in place. This is not a substantive change in requirements.
Necessity: These changes are necessary to ensure and improve general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1 and California Code of Regulations, Title 1, Section 16.

Section: 130.5
Specific Purpose:
The specific purpose of the change to this section is to remove high-rise residential buildings and high-rise residential dwellings from the scoping requirements of Section 130.5.
Necessity:
These changes are necessary to ensure internal consistency within the Energy Code as the requirements for high-rise residential buildings and high-rise residential dwellings are specified in new chapters of the proposed Energy Code.

Section: 130.5(d)
Specific Purpose:
The specific purpose of the changes is to revise occupancy sensing controls as occupant sensing controls.
Necessity:
The changes are necessary to maintain consistency in using the same terminology, occupant sensing controls for controls requirements in the Energy Code.
The changes are necessary to ensure and improve general clarify and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1 and California Code of Regulations, Title 1, Section 16.

Section: 130.5(e)
Specific Purpose:
The specific purpose of the changes to this section is to expressly state that “demand responsive controls and equipment” includes demand responsive controls associated with controlled receptacles. This change clarifies the existing scope of the requirement and is not a substantive change in requirements.
Necessity:
These changes are necessary to ensure and improve general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1 and California Code of Regulations, Title 1, Section 16.

Section: 140.0
Specific Purpose:
The specific purpose of the change to this section is to remove reference to high-rise residential (now labeled multifamily buildings), such that the requirements of this section and its subsections now only apply to nonresidential, hotel/motel buildings. This is a non-substantive change: multifamily requirements are being relocated into new Sections 160, 170, and 180. (Any substantive changes made to multifamily requirements are described in the statements for those new Sections.)
Necessity:
These changes are necessary to relocate low-rise and high-rise multifamily requirements to a new multifamily specific section of the code. Consolidating these provisions into a dedicated group of sections ensures clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 140.1
Specific Purpose:
The specific purpose of the changes to this section are to include mention of the solar and battery storage systems now required by Section 140.10, as well as the now applicable community solar and battery storage system provisions specified in Part 1 Section 10-115.
Necessity:
These changes are necessary to correctly list and avoid conflict with the newly added section as well as with existing community solar and battery storage provisions that allow for Energy Code compliance with these system requirements to be satisfied by off-site systems meeting specified criteria.

Section: 140.3(a)1Aib1
Specific Purpose:
The specific purpose of the change to Section 140.3(a)1Aib1 is to modify the current steep-sloped cool roof requirement (i.e., aged solar reflectance & thermal emittance) of 0.20/0.75 to only apply to Climate Zones 1 & 3.
Necessity:
This change is necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Section 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 140.3(a)1Aib2
Specific Purpose:
The specific purpose of the addition of Section 140.3(a)1Aib2 is to add a new, more stringent, steep-sloped cool roof requirement (i.e., aged solar reflectance & thermal emittance) of 0.25/0.80 for Climate Zones 2 & 4-16.
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code, Sections 25213 and 25402.

Section: 140.3(a)1Aii
Specific Purpose:
The specific purpose of the change to this section is to remove reference to high-rise residential (now labeled multifamily buildings), such that the requirements of this section and its subsections now only apply to nonresidential, hotel/motel buildings. This is a non-substantive change: multifamily requirements are being relocated into new Sections 160, 170, and 180. (Any substantive changes made to multifamily requirements are described in the statements for those new Sections.)

Necessity:
These changes are necessary to relocate low-rise and high-rise multifamily requirements to a new multifamily specific section of the code. Consolidating these

provisions into a dedicated group of sections ensures clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 140.3(a)1B
Specific Purpose:
The specific purpose of the change to this section is to remove the word “continuous” as unneeded and potentially a source of confusion. The specification of “continuous” implies the existence of a “*non*continuous roof”, and it is not clear what would constitute a “noncontinuous roof” or what distinction is intended by “continuous”: roofs by their nature must serve to isolate the indoor environment from the outdoor, and do so while also having a variety of necessary penetrations. The removal of this word is understood to be a non-substantive change.
Necessity:
This change is necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Section 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: Table 140.3
Specific Purpose:
The specific purpose of the changes to Table 140.3 is to remove the table header row to aid in ADA accessibility, and to modify column 3 to clarify the requirements of this column only applies to Climate Zones 6-8.
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: EXCEPTION to 140.3(a)5
Specific Purpose:
The specific purpose of this addition is to include exceptions related to conditioned greenhouses subject to the standards for controlled environment horticulture spaces added to 120.6(h).
Necessity:
The change to add exceptions for conditioned greenhouses is necessary to ensure these process spaces are not inadvertently held to requirements applicable to standards for non-process spaces in nonresidential buildings (in addition to the standards in 120.6(h)). These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: EXCEPTION 1 to and 140.3(a)6
Specific Purpose:
The specific purpose of this addition is to add an exception that applies a separate exterior window U-factor to school buildings meeting specified criteria, and to provide a credit for vertical fenestration shading provided by exterior horizontal slats when calculating the relative solar heat gain coefficient (RSHGC) using Equation 140.3A.
Necessity:
This addition is necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code, Sections 25213 and 25402. Climate Zones 1 and 16 are very cold climates relative to other California climate zones, and buildings below 25,000 square feet have a low enough surface area to volume ratio to make the improvement to exterior thermal performance cost effective as an energy saving measure.
The change to include horizontal slats in calculating RSHGC is necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code, Sections 25213 and 25402. Horizontal slats have grown in popularity over recent years, and when they are installed on the exterior of a building, they reduce the solar heat gain through the fenestration. Adding exterior horizontal slat to the RSHGC equation would allow designers added flexibility for compliance.

Section: 140.3(a)7
Specific Purpose:
The purpose of the change in this section is to expand the allowance for glass doors to include doors with a smaller portion of glass (one-quarter instead of one-half).
Necessity:
This change is necessary to prevent U-factor requirements from prohibiting use of doors with specific percentages of glass. The intent is that an appropriate U-factor be applied based on the design of the door, not that some fractions of glass be virtually prohibited by a too-tight standard**.**

Section: 140.3(a)9
Specific Purpose:
The purpose of the changes to this section are to add a requirement that air barriers be identified on construction documents (e.g., plans and blueprints) in support of the existing requirement that a continuous air barrier be included in the building, add a specific procedure for projects that elect to verify the installation of air barriers, add an exception for relocatable public school buildings (sometimes called portable classrooms or portables), and making non-substantive changes to enhance the readability of the section such as relocating Table 140.3-A.
Necessity:
The change to require identification of air barriers on construction documents is necessary to ensure a general understanding of which components of the building are serving as its air barrier and better guarantee that a complete barrier is present, to

specify a procedure for verifying the air barrier for projects that elect to request or require verification, and to exempt relocatable public school buildings given that adherence to air barrier performance requirements is potentially technically infeasible for a significant fraction of these buildings.

Section: Equation 140.3-A
Specific Purpose:
The specific purpose of the changes to Equation 140.3-A is to revise the relative solar heat gain coefficient (RSHGC) equation to provide credit for exterior horizontal slats, in addition to overhangs.
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code, Sections 25213 and 25402.

Section: Table 140.3-B
Specific Purpose:
The specific purpose of the changes made to Table 140.3-B are to:

- Increase the stringency of the metal-framed wall U-factor requirement equivalent to the addition of R-2 continuous insulation for all Climate Zones.
- Increase the stringency of the steep-sloped cool roof requirements (i.e., aged solar reflectance & thermal emittance) to 0.25/0.80 for Climate Zones 2 & 4-16.
- Revise fenestration requirements to be broken down by climate zone.
- Increase the stringency of the fixed window fenestration properties (i.e., U-factor, RSHGC, & VT) for Climate Zones 9 & 11-15.
- Increase the stringency of the curtainwall/storefront fenestration properties (i.e., U-factor, RSHGC, & VT) for Climate Zones 1 & 7.

Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402.

Section: Table 140.3-C
Specific Purpose:
The specific purpose of the changes to this section is to remove high-rise residential from the title and add a row reflecting the air barrier requirements present in Section 140.3(a)9, for consistency with this section's contents. This is not a substantive change in requirements: the requirement to include an air barrier is an existing requirement in Section 140.3(a)9.
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: Table 140.3-D
Specific Purpose:
The specific purpose of the changes made to Table 140.3-D is to increase the stringency of the steep-sloped cool roof requirements (i.e., aged solar reflectance & thermal emittance) to 0.25/0.80.
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code, Sections 25213 and 25402.

Section: 140.3(d)2
Specific Purpose:
The specific purpose of the changes made to this Section are to update equation reference number from "Equation 140.3-E" to "Equation 140.3-C", and to relocate a height provision to a more appropriate subsection.
Necessity:
This is a non-substantive ordering change necessary to effectively communicate the requirements and standards in a precise and clear manner. This change is necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 140.3(d)3
Specific Purpose:
The specific purpose of the change made to this Section is to update equation reference number from "Equation 140.3-E" to "Equation 140.3-C", and to remove redundant phrasing in subsection C.
Necessity:
This is a non-substantive ordering change necessary to effectively communicate the requirements and standards in a precise and clear manner. This change is necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as

directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: Equation 140.3-C
Specific Purpose:
The specific purpose of the change made to Equation 140.3-C is to update equation reference number from “Equation 140.3-E” to “Equation 140.3-C”, and to include overhangs to create consistency within Section 140.3 overall.
Necessity:
The change to include overhangs in Equation 140.3-C is necessary to fill a gap in direction about appropriate parameters for window features. The change to equation numbering is a non-substantive ordering change necessary to effectively communicate the requirements and standards in a precise and clear manner. This change is necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 140.4
Specific Purpose:
The purpose of the changes to the introductory sentence for this section is to add the word “prescriptive” for consistency with its title. This is not a substantive change.
Necessity:
These changes are necessary to create consistency between the section’s title and its contents.

Section: 140.4(a):
Specific Purpose:
The specific purpose of the changes to this section is to add new equipment selection requirements for retail, grocery, school, office, financial institution, and library building spaces to a new subsection, and add appropriate subsection numbering and titles to existing provisions as a part of this change.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402. These changes are also necessary to pursue the State’s goals relating to greenhouse gas emissions.

Section: 140.4(b)
Specific Purpose:
The specific purpose of the change to this section is to remove reference to high-rise residential (now labeled multifamily buildings), such that the requirements of this section and its subsections now only apply to nonresidential, hotel/motel buildings. This is a non-substantive change: multifamily requirements are being relocated into new Sections 160, 170, and 180. (Any substantive changes made to multifamily requirements are

described in the statements for those new Sections.)
Necessity:
These changes are necessary to relocate low-rise and high-rise multifamily requirements to a new multifamily specific section of the code. Consolidating these provisions into a dedicated group of sections ensures clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 140.4(c),
Specific Purpose:
The specific purpose of the change to this Section is to change the requirements for fan systems and to expand the requirements to >= 1kW replacing the existing “Fan Power Limits” using look up tables, and to define the types of power allowances per fan system types and components. This will also apply to additions and alterations with additional power allowances. These changes include equations to determine compliance with the new Fan Power Budget, and tables that feed into those equations. (see also Table 140.4-A, Table 140.4B, Table 140.4-C, Table 140.4-D, Table 141.0-D, and Section 141.0(b)2C)
Necessity:
These changes are necessary to equalize stringency between small and large fan systems, account for air density and transmission efficiency, and ultimately increase energy savings. These changes provide a significantly more robust and comprehensive set of system design standards and improve the ability of the regulatory structure to accommodate varying ventilation strategies and components. Providing specific consideration of a far larger number of system components provides the benefit of preventing the regulations from inadvertently and unnecessarily impeding some otherwise efficient system designs and components, while also ensuring that a wider variety of circumstances are held to appropriately stringent efficiency standards.

Section: Equation 140.4-A
Specific Purpose:
The specific purpose of the addition of this equation is to change the requirements for fan systems using look up tables, and Equation 140.4-A to define the types of power allowances per fan system types and components. This will also apply to additions and alterations with additional power allowances. (see also Table 140.4-A, Table 140.4B, Table 140.4-C, Table 140.4-D, Table 141.0-D, and Section 141.0(b)2C)
Necessity:
These changes are necessary to equalize stringency between small and large fan systems, account for air density and transmission efficiency, and ultimately increase energy savings. These changes provide a significantly more robust and comprehensive set of system design standards and improve the ability of the regulatory structure to accommodate varying ventilation strategies and components. Providing specific consideration of a far larger number of system components provides the benefit of preventing the regulations from inadvertently and unnecessarily impeding some

otherwise efficient system designs and components, while also ensuring that a wider variety of circumstances are held to appropriately stringent efficiency standards.

Section: Table 140.4-A, Table 140.4-B, Table 140.4-C, Table 140.4-D
Specific Purpose:
The specific purpose of the changes to this Section is to change the requirements for fan systems and to expand the requirements to >= 1kW, replacing the existing “Fan Power Limits” by using these four new lookup tables, which replace the prior Table 140.4-A, and by defining the types of power allowances per fan system types and components. These new requirements will apply to new construction and to additions and alterations, with additional power allowances. These new tables provide input values for Equation 140.4-A to determine the Fan Power Limit. (see also Section 140.4(c), Table 141.0-D, and Section 141.0(b))
Necessity:
These changes are necessary to equalize stringency between small and large fan systems, account for air density and transmission efficiency, and ultimately increase energy savings. These changes provide a significantly more robust and comprehensive set of system design standards and improve the ability of the regulatory structure to accommodate varying ventilation strategies and components. Providing specific consideration of a far larger number of system components provides the benefit of preventing the regulations from inadvertently and unnecessarily impeding some otherwise efficient system designs and components, while also ensuring that a wider variety of circumstances are held to appropriately stringent efficiency standards.

Section: 140.4(d)
Specific Purpose:
The specific purpose of the changes to this section is to simplify code language by removing the 20% of the peak primary airflow option.
Necessity:
This change is necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Section 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16. This change aligns with the changes that have been made to ASHRAE 90.1 and has been supported by ASHRAE’s research project co-funded by the California Energy Commission PIER program.

Section: Table 140.4-F
Specific Purpose:
The specific purpose of the changes made to this Table is to revise the text to align with ASHRAE 90.1.
Necessity:
This change is necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Section 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 140.4(e)
Specific Purpose:
The specific purpose of the changes to this Section is to expand Economizer requirements to include mechanical cooling capacities greater than 33,000 Btu/hr. The changes to exception 6 amends existing requirements of dedicated outdoor air systems to point towards new requirements in section 140.4(p). This exception excludes economizers requirements for specific dedicated outdoor air system types that are working in conjunction with cooling capacities less than 54,000 Btu/hr. (see also Sections 120.2(i)), and JA 6.3)
Necessity:
The proposed expansion of design standards for economizers are necessary to reduce and prevent wasteful, uneconomic, inefficient, and unnecessary consumption of energy by buildings, consistent with the statutory direction in Public Resources Code Section 25402. Economizers are an effective way to capture free cooling. This ensures economizing is provided on smaller systems where it is still shown to be cost effective.

Section: EXCEPTION 6 to 140.4(e)1
Specific Purpose: The changes to this exception now specify dedicated outdoor air systems that fulfill the new requirements of 140.4(p)1B and 140.4(p)2 through 140.4(p)6 that are working in conjunction with cooling capacities less than 54,000 Btu/hr.
Necessity: These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402.

Section: EXCEPTION 7 to 140.4(e)1
Specific Purpose:
The purpose of adding the exception to this section is to reduce the threshold for system sizes where economizing is required, replace the exception for outdoor air systems with an exception for dedicated ventilation systems, to add an exception to account for controlled environment horticulture spaces where use of an economizer would compromise the ability to control the gas mix of indoor air, and to correct section numbering in subsection 2E.
Necessity:
These changes are necessary to clarify the situations related to horticulture that are intended to be excepted from economizing requirements.

Section: EXCEPTION 5 to 140.4(g)
Specific Purpose:
The specific purpose of the change to this section is to remove reference to high-rise residential (now labeled multifamily buildings), such that the requirements of this section and its subsections now only apply to nonresidential, hotel/motel buildings. This is a non-substantive change: multifamily requirements are being relocated into new Sections 160, 170, and 180. (Any substantive changes made to multifamily requirements are described in the statements for those new Sections.)
Necessity:
These changes are necessary to relocate low-rise and high-rise multifamily requirements to a new multifamily specific section of the code. Consolidating these provisions into a dedicated group of sections ensures clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 140.4(k)8
Specific Purpose:
The specific purpose of the new subsection 8, and the addition of Exceptions in subsection 8 is to add new requirements for high-capacity space heating gas boiler systems for climate zone 1 through 6, 9 through 14, and 16.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402.

Section: 140.4(l)
Specific Purpose:
The specific purpose of the change to this section (see also sections 120.4(g), 120.4(a), 141.0(b), NA1.1, NA 2.1, and NA 7):

- Make the prescriptive Section 140.4(l) a mandatory requirement by moving this language to subsection 120.4(g).

- Update references to subsection 140.4(l) present in subsection 120.5(a) to refer to this new location.

Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16. Duct leakage testing was introduced in 2001 in Part 6 and have not been updated since introduction. The prescriptive requirement being moved to a mandatory requirement is necessary to be consistent with recent California Mechanical Code changes as well as duct leakage testing.

Section: EXCEPTION 4 to 140.4(n)
Specific Purpose:
The specific purpose of the change to this section is to remove reference to high-rise residential (now labeled multifamily buildings), such that the requirements of this section and its subsections now only apply to nonresidential, hotel/motel buildings. This is a non-substantive change: multifamily requirements are being relocated into new Sections 160, 170, and 180. (Any substantive changes made to multifamily requirements are described in the statements for those new Sections.)
Necessity:
These changes are necessary to relocate low-rise and high-rise multifamily requirements to a new multifamily specific section of the code. Consolidating these provisions into a dedicated group of sections ensures clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 140.4(p)
Specific Purpose:
The specific purposes of the changes made to this section are to:

- Add new prescriptive requirements for systems that utilize dedicated outdoor air systems (DOAS).
- Include exemptions for systems that would not be cost effective or that would inhibit occupant safety.

Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402. The current Building Energy Efficiency Standards currently do not have prescriptive requirements for DOAS while market share for DOAS have been increasing since 2012; their broadening adoption and market penetration now means that efficiency standards for this equipment have the potential to save a significant amount of energy on a statewide basis.

Section: 140.4(q), Table 140.4-G, Table 140.4-H
Specific Purpose:
The purpose of the changes made to this section and associated tables are to add new prescriptive requirements for exhaust air heat recovery. This includes providing exemptions matching those in ASHRAE 90.1 related to exhaust, and adding tables for determining energy recovery requirements based on climate zone and percent outdoor air.
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402. There is currently no requirement to install heat recovery for exhaust systems, and the documents relied upon show that installing this equipment is technically feasible for buildings in California, cost effective to install, and capable of saving significant energy on an annual statewide basis.

Section: 140.5(a)
Specific Purpose:
The specific purpose of the changes to subsection 140.5(a), and the addition of subsections 140.5(a)1 and 140.5(a)2 is to separate the water heating requirement for schools from all other nonresidential occupancies. The new prescriptive requirement for schools requires heat pump water heating systems, and all other types of system shall comply through the performance compliance method as specified in Section 140.1.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402. These changes are also necessary to pursue the State’s goals relating to greenhouse gas emissions.

Section: 140.5(b)
Specific Purpose:
The specific purpose of the change to this section is to remove reference to high-rise residential (now labeled multifamily buildings), such that the requirements of this section and its subsections now only apply to nonresidential, hotel/motel buildings, to direct readers to this new location for multifamily requirements applicable to hotel/motel occupancies, and to replace language for clarity. This is not a substantive change in requirements.
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 140.5(c)
Specific Purpose:
The purpose of the changes to this section are to apply minimum thermal efficiency standards to gas water heating systems exceeding a specified size, in a way that excludes individual water heaters that are regulated as appliances and otherwise remains agnostic of the specific composition of equipment or other components included within the system.
Necessity:
These changes are reasonably necessary to apply a feasible and cost-effective efficiency standard to large water heater systems comprised of multiple components.

Section: 140.6
Specific Purpose:
The purpose of the changes to this section are to remove mention of secondary daylit zone provisions, consistent with the relocation of these provisions to mandatory sections.
Necessity:
These changes are reasonably necessary to accurately reflect the proposed content of Section 140.6 and its subsections.

Section: 140.6(a)2
Specific Purpose:
The specific purpose of the change to this subsection H, I and K is to amend the power adjustment factor (PAF) for daylight dimming plus OFF controls, for occupant sensing controls in office, and for demand responsive control.
Necessity:
The change is necessary to allow qualified daylight control system to provide “continuous dimming plus OFF control” for meeting the prescriptive power adjustment factor (PAF) requirement. The change is also necessary to add Secondary Sidelit Daylit Zone as a qualified daylit zone for the PAF requirement.

Section: 140.6(a)3
Specific Purpose:
The purpose of the changes to this section are to remove unneeded parenthetical language and to add reference to lighting requirements for controlled environment horticulture spaces consistent with their proposed addition to Section 120.6(h).
Necessity:
These changes are reasonably necessary to simplify language where possible, and to preclude any potential overlap in lighting requirements applicable to general spaces and lighting requirements applicable specifically to controlled environment horticulture spaces.

Section: 140.6(a)4B
Specific Purpose:
The specific purpose of the changes to subsection 140.6(a)4B is to add the term luminaire aperture to the qualifying luminaire descriptions of small aperture tunable-white and dim-to-warm luminaires lighting power adjustment. Another specific purpose of the changes to subsection 140.6(a)4B is to revise the lighting power adjustment values for these luminaires.
Necessity:
The changes to the qualifying luminaire descriptions and the lighting power adjustment of small aperture tunable-white and dim-to-warm luminaires are necessary to reflect the progress in lighting power efficiency of these luminaires. These changes are also necessary to improve the code's compliance with the clarify and consistency criteria of California Government Code Section 11340 et seq. and Chapter 1, Article 2 of the California Code of Regulations.

Section: 140.6(b)4
Specific Purpose:
The specific purpose of the change is to amend the indoor lighting power allotments for using complete building method, area category method, and tailored method in Table 140.6-B, Table 140.6-C, Table 140.6-D, and Table 140.6-G.
The other changes in the subsection are to replace the term, "ornamental lighting", with the term, "decorative lighting" in the prescriptive section for indoor lighting as this is to align with the changes of both definitions in Section 100.1.
Necessity:
These changes are necessary to maintain, where feasible, consistency of the Energy Code, and the following documents of the American National Standards and the Illuminating Engineering Society (IES).

- Illuminating Engineering Society. 2012. "American National Standard Practice for Office Lighting." ANSI/IES RP-1-12, New York.
- Illuminating Engineering Society. 2013. "American National Standard Practice on Lighting for Educational Facilities." ANSI/IES RP-3-13.
- Illuminating Engineering Society. 2017. "Design Guide for Hospitality Lighting." IES DG- 25-17, New York.
- Illuminating Engineering Society. 2017. "Guide for Security Lighting for People, Property, and Critical Infrastructure." IES G-1-16.
- Illuminating Engineering Society. 2016. "Lighting and the Visual Environment for Seniors and the Low Vision Population." ANSI/IES RP-28-16 .
- Illuminating Engineering Society. 2017. "Lighting for Hospitals and Healthcare Facilities." ANSI/IES RP-29-16.
- Illuminating Engineering Society. 2013. "Recommended Practice for Library Lighting." IES RP-4-13.
- Illuminating Engineering Society. 2017. "Recommended Practice for Lighting Industrial Facilities." ANSI/IES RP-7-17.
- Illuminating Engineering Society. 2015. "Recommended Practice for Lighting Maintenance." IES RP-36-15.

- Illuminating Engineering Society. 2017. "Recommended Practice for Museum Lighting." ANSI/IES RP-30-17.
- Illuminating Engineering Society. 2018. "Recommended Practice for Retail Lighting." IES RP-2-17.
- Illuminating Engineering Society. 2015. "Sports and Recreational Area Lighting." IES RP-6-15.
- Illuminating Engineering Society. 2011. "The Lighting Handbook, 10th Edition."

Further, these changes are also necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402. The non-substantive grammatical changes are necessary to effectively communicate the requirements and standards in a precise and clear manner.

Section: 140.6(c)2Gvii
Specific Purpose:
The specific purpose of the changes to subsection 140.6(c)2Gvii is to delete the specific lighting wattage amount for videoconferencing studio and instead to refer to Table 140.6-C for the lighting power allotment for videoconferencing studio.
Necessity:
These changes are necessary to improve the code's compliance with the clarify and consistency criteria of California Government Code Section 11340 et seq. and Chapter 1, Article 2 of the California Code of Regulations.

Section: 140.6(c)3E and 140.6(c)3I
Specific Purpose:
The proposed change is to replace the term, "ornamental lighting", with the term, "decorative lighting" in the prescriptive section for indoor lighting and to align with the changes of both definitions in Section 100.1.
Necessity:
These changes are necessary to improve the code's compliance with the clarify and consistency criteria of California Government Code Section 11340 et seq. and Chapter 1, Article 2 of the California Code of Regulations.

Section: 140.6(c)3Jiv
Specific Purpose:
The proposed change is to revise the additional allowed lighting power for valuable display case lighting to reflect the progress made in lighting power efficiency of LED lighting for the valuable display case lighting application.
Necessity:
These changes are necessary to improve the code's compliance with the clarify and consistency criteria of California Government Code Section 11340 et seq. and Chapter 1, Article 2 of the California Code of Regulations.

Section: 140.6(d)
Specific Purpose:
The proposed change is to delete the secondary sidelit daylit zone requirements from this section and to move the requirements to Section 130.1(d).
Necessity:
These changes are necessary to improve the code's compliance with the clarify and consistency criteria of California Government Code Section 11340 et seq. and Chapter 1, Article 2 of the California Code of Regulations.

Section: Table 140.6-A
Specific Purpose:
The proposed change is to revise Daylight Continuous Dimming plus OFF control to be the type of control qualified for the power adjustment factors (PAF) as specified in Table 140.6-A. This change to continuous dimming is based on the commonly availability of LED lighting in marketplace and the capability of LED lighting technology to be capable of continuous dimming.
Necessity:
These changes are necessary to improve the code's compliance with the clarify and consistency criteria of California Government Code Section 11340 et seq. and Chapter 1, Article 2 of the California Code of Regulations.

Section: Table 140.6-B
Specific Purpose:
The proposed change is to update the allowed lighting power density values for most building types in the Complete Building Method Table.
The change is also to re-order the building types in an alphabetical order as this arrangement is widely acceptable and thereby would enhance readability of the table.
Additionally, the change is to add Museum Building type and its allowed lighting power density to the whole building method.
Necessity:
These changes are necessary to ensure energy efficiency of the Energy Code can be achieved with the lighting power provisions of the Energy Code and the provisions are sufficient for the industry practice of lighting design and applications.
These changes are also necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Sections 25103 and 25402.
These changes are also necessary to improve the code's compliance with the clarify and consistency criteria of California Government Code Section 11340 et seq. and Chapter 1, Article 2 of the California Code of Regulations.

Section: Table 140.6-C
Specific Purpose:
The proposed change is to update the allowed lighting power density values for most building functional area types in the Area Category Method Table.
The change is a multitude of considerations that are to account for efficacy improvement of high CRI luminaries, for illuminance targets for general lighting and task

lighting, and lighting power level required for the building functional area type based on their specific lumen method model.
The changes are also to re-order the primary function areas in an alphabetical order as this arrangement is widely acceptable and thereby would enhance readability of the table.
Additionally, these changes are to replace the term, ornamental lighting, with decorative/display lighting for additional light power for various primary function area categories in Table 140.6-C.
Further, these changes are in conjunction with the clarification change to ornamental lighting that ornamental lighting are installed outdoor as defined in Sections 100.1 and 140.7, and decorative lighting and display are proposed as additional lighting power for the specified primary function areas.
Necessity:
These changes are necessary to ensure energy efficiency of the Energy Code can be achieved with the lighting power provisions of the Energy Code and the provisions are sufficient for the industry practice of lighting design and applications.
It is also necessary to ensure energy efficiency of the Energy Code with cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402.
Further, these changes are also necessary to improve the code's compliance with the clarify and consistency criteria of California Government Code Section 11340 et seq. and Chapter 1, Article 2 of the California Code of Regulations.

Section: Table 140.6-D
Specific Purpose:
The proposed changes are to adjust lighting power allowance values as follows:

- decrease the "floor and wall display" lighting power allowance of Tailored method. The changes are to account for the effect of an improved efficiency of luminaire products and lamp products used for the "floor and wall display" lighting.
- decrease the "very valuable display" lighting power allowance of Tailored method, in order to account for the effect of an improved efficiency of luminaire products used for the "very valuable display" lighting.
- decrease the tailored lighting "ornamental/special lighting" power allowance of the Tailored method, in order to replace the term "ornamental lighting" with the term "decorative lighting" in conjunction with clarifying changes to the meaning and appropriate use of these terms.

Necessity:
These changes are necessary to ensure energy efficiency of the Energy Code can be achieved with the lighting power provisions of the Energy Code and the provisions are sufficient for the industry practice of lighting design and applications. It is also necessary to ensure energy efficiency of the Energy Code with cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402. Further, these changes are also necessary to improve the code's compliance

with the clarify and consistency criteria of California Government Code Section 11340 et seq. and Chapter 1, Article 2 of the California Code of Regulations.

Section: Table 140.6-G
Specific Purpose:
The proposed changes are to revise and to decrease the tailored method general lighting power allowance values in Table 140.6-G for Tailored method. The changes are to account for the effect of improved effectiveness and efficiency of light sources used for tailored method general lighting.
Necessity:
These changes are necessary to ensure energy efficiency of the Energy Code can be achieved with the lighting power provisions of the Energy Code and the provisions are sufficient for the industry practice of lighting design and applications. It is also necessary to ensure energy efficiency of the Energy Code with cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402.

Section: 140.7 Authority and Reference Citation
Specific Purpose:
The specific purpose of the change is to add the Authority and Reference citations to reflect the statutory provisions utilized by the CEC in the preceding section. This is not a substantive change in requirements.
Necessity:
These changes are necessary to provide the public with the CEC's statutory authority for adopting these regulations and to provide notice of the sections that are being implemented, interpreted or made specific by the regulations.

Section: 140.7
Specific Purpose:
The specific purpose of the change to this section is to amend outdoor lighting general hardscape lighting power allowances and additional outdoor lighting power allowances for specific application.
Necessity:
It was necessary for the changes to maintain, where feasible, consistency of the Energy Code and the following documents of the American National Standards and the Illuminating Engineering Society (IES).

- the Illuminating Engineering Society's (IES) recommended values for parking lot facilities in the document, RP-8-18 Chapter 17 addendum 1
- Illuminating Engineering Society. 2020. "Addendum 1 for ANSI/IES RP-8-18, Recommended Practice for Design and Maintenance of Roadway and Parking Facilities Lighting Chapter 17." http://media.ies.org/docs/errata/ANSI-IES RP-8-18-Addendum-1_20200123.pdf.
- Illuminating Engineering Society and International Dark-Sky Association. 2011. "Model Lighting Ordinance." https://www.darksky.org/wp-content/uploads/bsk-pdf- manager/16_MLO_FINAL_JUNE2011.PDF.

- Illuminating Engineering Society. 2011. "The Lighting Handbook, 10th Edition."

Following are specific changes within Section 140.7:

Section: Table 140.7-A
Specific Purpose:
The specific purpose of the changes is to revise the lighting power allowance values of general hardscape lighting. The concrete and asphalt surface distinction are removed and these LPAs are reduced to align with the lighting levels recommendations in the ANSI/IES documents of Illuminating Engineering Society (IES) for parking lots and general hardscape lighting applications.
Necessity:
These changes are necessary to align the general hardscape lighting power allowance provisions for outdoor lighting with “Addendum 1 for ANSI/IES RP-8-18, Recommended Practice for Design and Maintenance of Roadway and Parking Facilities Lighting Chapter 17”. Further, these changes are necessary to ensure energy efficiency of the Energy Code can be achieved with the lighting power provisions of the Energy Code and the provisions are sufficient for the industry practice of lighting design and applications. It is also necessary to ensure energy efficiency of the Energy Code with cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402.

Section: Table 140.7-B
Specific Purpose:
The specific purpose of the proposed changes is to add a new additional lighting allowance for security cameras. Another proposed change is to update the ornamental lighting 100-watt limit to 50 watts and to correct the reference to Section 130.0(c) for luminaire rated wattage determination.
Necessity:
The changes for the additional lighting allowance for security cameras are to address security concerns for general hardscape areas lighting applications. The changes for the ornamental lighting wattage limit are to align with the current LED luminaire light source baseline. Further, it is also necessary to ensure energy efficiency of the Energy Code with cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402.

Section: 140.8(b)
Specific Purpose:
The specific purpose of the change is to revise the phrasing for the alternate light sources subsection with what light sources a sign shall be equipped.
Necessity:
The changes are necessary to clarify one or more of the light sources are permitted to be equipped in a sign for meeting the prescriptive requirements for signs. The changes also are necessary to ensure and improve general clarify and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1 and California Code of Regulations, Title 1, Section 16.

Section: 140.9 Authority and Reference Citation
Specific Purpose:
The specific purpose of the change is to add the Authority and Reference citations to reflect the statutory provisions utilized by the CEC in the preceding section. This is not a substantive change in requirements.
Necessity:
These changes are necessary to provide the public with the CEC's statutory authority for adopting these regulations and to provide notice of the sections that are being implemented, interpreted or made specific by the regulations.

Section: 140.9(a)
Specific Purpose:
The specific purpose of the changes to this section are to remove unneeded language, and in doing so avoid the need to update reference to specific section numbers. The section already states that it applies to "space conditioning systems" so there is no need to additionally use the term "cooling system", nor is there any need to redundantly state that systems shall comply with this section by complying with its subsections. This is not a substantive change to requirements, though substantive changes have been made to this section's subsections 140.9(a)1A and 1B as described below.
Necessity:
These changes are necessary to ensure and improve general clarify and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1 and California Code of Regulations, Title 1, Section 16.

Section: 140.9(a)1A and 140.9(a)1B
Specific Purpose:
The specific purpose of the changes to this section are to increase the drybulb and wetbulb temperatures, and to specify a supply temperature range for computer room economizers. Non-substantive changes have been made to improve the clarity and consistency of the regulatory language. The updates to the exception are required to provide clarity by referencing the ITE design load.
Necessity:
The changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402. Increasing drybulb and wetbulb temperatures and specifying supply air temperature allows for more hours of economizing enhancing the benefits provided by the economizer.

Section: 140.9(a)1C
Specific Purpose:
The specific purpose of the changes made to this subsection is to include integrated pumped refrigerant economizers as an option for computer rooms, based on a showing that they are capable of providing an equivalent benefit to other allowed economizing

equipment. Existing exceptions relating to additions and alterations have been relocated to a more appropriate location in Section 141.1, and an existing Exception relating to parallel fan systems has been redrafted for clarity. In addition, an exception has been added to account for cases where other applicable laws would act to disallow inclusion of cooling towers. Note that struck provisions relating to fan control, reheat and humidification are in support of relocating requirements to 120.6(j), and are described in the entry for that section.

Necessity:

Integrated pumped refrigerant economizers are currently a compliance option usable as an alternative to water and air economizers for computer rooms; this change is necessary to integrate this allowable compliance option into the Energy Code and formalize the ability to use this equipment for this purpose, consistent with the demonstration required for approval of compliance options under Part 1 Section 10-109 and the materials identified in the Documents Relied Upon. The added exception relating to cooling towers is necessary to avoid conflict with applicable local laws not related to energy efficiency. The relocation of existing provisions and exceptions as well as the redrafting of the exception for parallel fan systems is necessary to enhance the clarity of the Energy Code and ensure consistent organizational structure.

Section: 140.9(a)2 and 140.9(a)3

Specific Purpose:

The specific purpose of the addition of this section is to relocate minimum efficiency standards for computer room ventilation from Section 140.9 to this section, and in so doing make the requirements mandatory rather than prescriptive. Computer rooms shall have controls that prevent space heating or conditioning systems from trying to heat and cool at once, shall not use nonadiabatic humidification, and if sufficiently large shall have load-following fan behavior – these requirements are unchanged from existing provisions save for now being required for both the prescriptive and performance compliance approaches. (see also Section 120.6(j))

Necessity:

These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402.

Section: Table 140.9-A

Specific Purpose:

The specific purpose of the addition of this Table is to explicitly list the minimum average efficiencies for alternating current-output uninterruptible power supplies.

Necessity:

This addition is necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402, and to ensure and improve the general clarity and internal consistency of the

Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: Table 140.9-B and Table 140.9-C
Specific Purpose:
The specific purpose of the changes to these tables is to update numbering consistent with the addition of a new table occurring earlier in Section 140.9.
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 140.9(a)4
Specific Purpose:
The purpose of these additions is to add minimum efficiency requirements for alternating current-output uninterruptible power supply equipment serving computer rooms.
Necessity:
The addition of this code language is required to include minimum efficiency requirements for alternating current-output uninterruptible power supplies. Staff has additionally made non-substantive changes to improve the clarity and consistency of the regulatory language. These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402 et seq.

Section: EXCEPTION to 140.9(a)
Specific Purpose:
The purpose of the deletion of this exception is to include computer rooms located in healthcare facilities under the requirements of 140.9(a).
Necessity:
The removal of this code language is required to include minimum efficiency requirements for computer rooms located in healthcare facilities. These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402 et seq.

Section: 140.9(c)3
Specific Purpose:
The specific purpose of the changes made to this subsection are to:

- Include sonic anemometers as a type of anemometer that can be used to meet the requirements of this section.
- Remove the word “detectable” as nonspecific and potentially confusing.
- Require error logging for anemometers.
- Specify acceptable minimum sample frequencies and signal fail criteria.

Necessity:
This change is necessary to prevent required flow measurement equipment from being installed or configured in such a way as to impede its expected benefit, for example by not sampling flow rates sufficiently frequently or failing to report or log error states. The addition of sonic anemometers is necessary to avoid unnecessarily excluding an effective anemometer technology.

Section: 140.10(a)
Specific Purpose:
The specific purpose of the changes to addition of 140.10(a), including Table 140.10-A, is to add new prescriptive requirements for solar photovoltaic systems for specific nonresidential space types and high-rise multifamily buildings, and establish the minimum required sizes of such systems based on anticipated electrical loads estimated to occur for different building uses.

The purpose of providing exceptions based on Solar Access Roof Area is to ensure that solar photovoltaic requirements do not exceed the roof area that is able to support installation of solar panels, or require panels to be installed on portions of the roof where they will not provide sufficient benefit (such as shaded areas).

The purpose of adding an exception when the required system size is less than four kilowatts of rated capacity is to ensure that solar photovoltaic systems are not required when the fixed costs of the installation would exceed the anticipated benefit provided by the system (i.e., the system will not become cost effective over its design life).

The purpose of adding an exception for snow loads is to exempt buildings from the PV requirement in cases where solar panels and associated mounting equipment are incapable of meeting the requirements of the American Society of Civil Engineers (ASCE), Standard 7-16, Chapter 7, Snow Loads. This avoids situations where panels would be expected to be damaged due to regular anticipated levels of snowfall where replacement costs would cause the system not to be cost effective.

The purpose of adding an exception based on availability of virtual net energy metering or community solar is to account for cases where direct wiring of panels to individual tenant spaces would be required to ensure tenants receive the benefits and associated bill savings of installed equipment. The increase in costs associated with this additional amount of wiring and installation labor was found to cause systems not to be cost effective for their respective tenants.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402. The proposed capacity factors are necessary to ensure that installed solar photovoltaic systems are cost effective based on the estimated energy demands of

associated spaces while limiting net hourly exports – the proposed factors are based on limiting hourly net exports to 20% or less of total annual generation. The proposed exceptions are necessary to prevent these requirements from applying in circumstances where it is reasonable to anticipate that systems will not provide a cost effective level of benefit due to the noted physical or technical factors (lack of available roof area, presence of shading, likelihood of damage due to snow loads, etc.).

Section: 140.10(b)
Specific Purpose:
The specific purpose of the changes to addition of 140.10(b), including Table 140.10-B, is to add new prescriptive requirements for battery storage systems for specific nonresidential space types and high-rise multifamily buildings, and establish the minimum required sizes of such systems based on anticipated electrical loads estimated to occur for different building uses.

The purpose of providing an exception based on the absence of a sufficiently large solar photovoltaic system, or for certain building types in climate zone 1, is to avoid requiring battery storage systems where they will not provide sufficient benefit in terms of capturing on-site generation, maximizing self-utilization, and minimizing both grid demands and grid exports.

The purpose of adding exceptions when the calculated size of the required battery storage system is below a specified value, or when the size of the applicable building space is below a specified value, is to ensure that battery storage systems are not required when the fixed costs of the installation would exceed the anticipated benefit provided by the system (i.e., the system will not become cost effective over its design life).
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402, and to enhance the benefits provided by on-site solar photovoltaic systems particularly as they relate to grid harmonization and resiliency. The proposed capacity factors are necessary to ensure that installed battery storage systems are cost effective based on the estimated energy demands of associated spaces while limiting net hourly exports – the proposed factors are based on limiting hourly net exports to 10% or less of total annual generation. The proposed exceptions are necessary to prevent these requirements from applying in circumstances where it is reasonable to anticipate that systems will not provide a cost-effective level of benefit due to the noted physical or technical factors (absence of on-site generation, insufficient load, etc.).

Section: 141.0
Specific Purpose:
The specific purpose of the change to this section is to remove reference to high-rise residential (now labeled multifamily buildings), such that the requirements of this section and its subsections now only apply to nonresidential, hotel/motel buildings. This is a non-substantive change: multifamily requirements are being relocated into new Sections 160, 170, and 180. (Any substantive changes made to multifamily requirements are described in the statements for those new Sections.)
Necessity:
These changes are necessary to relocate low-rise and high-rise multifamily requirements to a new multifamily specific section of the code. Consolidating these provisions into a dedicated group of sections ensures clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 141.0 Notes
Specific Purpose:
The purpose of the change to this section is to add a second note explaining that relocating a relocatable public-school building does not meet the definition of an alteration. For reference, the definition of “alteration” reads as follows:
ALTERATION is any change to a building's water-heating system, space-conditioning system, lighting system, electrical power distribution system, or envelope that is not an addition. Alteration is also any change that is regulated by Part 6 to an outdoor lighting system that is not an addition. Alteration is also any change that is regulated by Part 6 to signs located either indoors or outdoors. Alteration is also any change that is regulated by Part 6 to a covered process that is not an addition.
Relocating a public school building that is designed and intended to be relocated is not a change to any of its incorporated systems, nor is it a change to any attached exterior lighting or signage, and classroom instruction is not a commercial or industrial process. As this note is explanatory of existing requirements, its addition to this section is not considered to be substantive.
Necessity:
This change is necessary to provide clarification to the reader for a common circumstance, whose answer may otherwise not be immediately evident to persons in charge of locating or relocating portable public-school buildings.

Section: 141.0(a)
Specific Purpose:
The purpose of the addition of EXCEPTIONs 5 and 6 to this section is to prevent proposed standards applicable to large water heater systems in newly constructed buildings from applying to additions.
Necessity:
These changes are necessary to ensure that the requirements are not applied where they have not yet been determined to be feasible and cost effective, noting that existing

design and equipment can impose constraints that do not exist in the context of a newly constructed building.

Section: 141.0(b) and 141.0(b)1C2
Specific Purpose:
The specific purpose of the change made to Sections 141.0(b) and 141.0(b)1C2 is to remove multifamily “high rise residential” from the scope of this requirement.
Necessity:
This change is necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16. For the 2022 Energy Standards, the low-rise and high-rise multifamily requirements are being relocated to a new multifamily specific section of the code: Sections 160, 170, and 180.

Section: 141.0(b)1D
Specific Purpose:
The purpose of the addition of this section is to incorporate reference to new mandatory fan energy requirements and apply them to alteration projects that add new fan systems.
Necessity:
This addition is necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402.

Section: Table 141.0-D
Specific Purpose:
The specific purpose of the change to this Section is to change the requirements for fan systems and to expand the requirements to >= 1kW replacing the existing “Fan Power Limits” using look up tables, and to define the types of power allowances per fan system types and components. This will also apply to additions and alterations with additional power allowances. (see also Sections 140.4(c), Section 141.0(b)2C, Table 140.4-A, Table 140.4-B, Table 140.4-C, Table 140.4-D, and Table 141.0-D)
Necessity:
These changes are necessary to equalize stringency between small and large fan systems, account for air density and transmission efficiency, and ultimately increase energy savings. These changes provide a significantly more robust and comprehensive set of system design standards and improve the ability of the regulatory structure to accommodate varying ventilation strategies and components. Providing specific consideration of a far larger number of system components provides the benefit of preventing the regulations from inadvertently and unnecessarily impeding some otherwise efficient system designs and components, while also ensuring that a wider variety of circumstances are held to appropriately stringent efficiency standards.

Section: 141.0(b)2I
Specific Purpose:
The specific purpose of the change to this section is to revise the lighting type terminology to match the change of the terminology in the new construction section of the standards, clarify the requirements by adding an exception to subsection 141.0(b)2Lii and 141.0(b)2Liii for alterations with less than five existing luminaires, and make non-substantive grammatical changes and editorial changes necessary to effectively communicate the requirements and standards in a precise and clear manner. (see also Table 141.0-F)
Necessity:
The change is necessary to maintain consistency of the standards among the requirements and to ensure and improve clarity, and consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code, Sections 11349 and 11349.1.

Section: 141.0(b)2B
Specific Purpose:
The specific purpose of the changes made to Section 141.0(b)2B are to add language to clarify that this requirement is only applicable to nonresidential and hotel/motel buildings as defined in Title 24, Part 2, Chapter 2.
Necessity:
This change is necessary to ensure and improve clarity, and consistency between the Energy Code and the other Parts of the Building Standards Code, as directed by California Government Code, Sections 11349 and 11349.1. For the 2022 Energy Standards, the low-rise and high-rise multifamily requirements are being relocated to a new multifamily specific section of the code: Sections 160, 170, and 180.

Section: 141.0(b)2Bi, Table 141.0-B
Specific Purpose:
The specific purpose of this change made to Section 141.0(b)2Bi is to modify the cool roof requirement so that altered roofs must comply with the prescriptive new construction cool roof requirements of 140.3(a)1A, and to update allowed tradeoff values in Table 141.0-B accordingly.
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code, Sections 25213 and 25402.

Section: EXCEPTIONS 1 through 3 to Section 141.0(b)2Bi
Specific Purpose:
The specific purpose of the change made to Exception 1 to Section 141.0(b)2Bi is to add language to clarify that this exception is only applicable to low-sloped roofs.
Necessity:
This change is necessary to ensure and improve general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 141.0(b)2Bii (old)
Specific Purpose:
The specific purpose of the change to Section 141.0(b)2Bii is to remove multifamily "high rise residential" from the scope of this requirement, and to clarify that the requirement now only applies to nonresidential and hotel/motel buildings.
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16. For the 2022 Energy Standards, the low-rise and high-rise multifamily requirements are being relocated to a new multifamily specific section of the code: Sections 160, 170, and 180.

Section: 141.0(b)2Bii (new)
Specific Purpose:
The specific purpose of the change to Section 141.0(b)2Bii is to use consistent terminology (i.e., roof recover, and roof replacement) with other parts of the California Building Code (CBC).
Necessity:
This change is necessary to ensure consistency between the Energy Code and the other Parts of the Building Standards Code, as direct by California Government Code, Sections 11349 and 11349.1.

Section: EXCEPTION 1 to Section 141.0(b)2Bii
Specific Purpose:
The specific purpose of the change to EXCEPTION 1 to Section 141.0(b)2Bii is to increase the stringency of the roof recover exception to require R-10 insulation above the roof deck.
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code, Sections 25213 and 25402.

Section: EXCEPTION 2 to Section 141.0(b)2Bii
Specific Purpose:
The specific purpose of the change to EXCEPTION 2 to Section 141.0(b)2Bii is to increase the stringency of the roof replacement exception to require R-10 or the maximum allowable amount of insulation to be installed while preserving the base flashing.
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code, Sections 25213 and 25402.

Section: EXCEPTION 3 to Section 141.0(b)2Bii
Specific Purpose:
This specific purpose of the change to EXCEPTION 3 to Section 141.0(b)2Bii is to provide clarifying details and to reorganize the text for better readability. The exception restates the provisions formerly in Section 141.0(b)2Biiid, changing only that it is now organized as an exception rather than an option. This is not a substantive change.
Necessity:
This is a non-substantive grammatical change necessary to effectively communicate the requirements and standards in a precise and clear manner. This change is necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Section 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 141.0(b)2Biii (now ii)
Specific Purpose:
The specific purpose of the change to this section is to remove reference to high-rise residential (now labeled multifamily buildings), such that the requirements of this section and its subsections now only apply to nonresidential, hotel/motel buildings (as per the overall scope of the subchapter), and to more straightforwardly describe the conditions under which insulation requirements apply. In essence, the change swaps the term “exposed area” for “the area of the roof recover or roof replacement”, and expressly states that roof recoats (which do not create exposed areas, as the term was previously used) are not held to insulation requirements. In addition, the EXCEPTIONs to this Section were redrafted for clarity and to update R-7 thresholds to R-10 to retain equivalency with updated insulation requirements.
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Section 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16, and in the case of updated R-value thresholds for exceptions, to maintain the equivalency between the exception thresholds and the otherwise applicable insulation requirements.

Section: 141.0(b)2D and 141.0(b)2E
Specific Purpose:
The purpose of the changes to these sections are to restructure and reorganize their requirements – these are not anticipated to be substantive changes.
Necessity:
These changes are reasonably necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Section 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 141.0(b)2L
Specific Purpose:
The purpose of the changes to this section are to clarify application, remove unintended alternate readings and move the threshold for limited numbers of luminaires into an exception.
Necessity:
These changes are reasonably necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Section 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 141.0(b)2N
Specific Purpose:
The purpose of the changes to this section is to prevent proposed standards applicable to large water heater systems in newly constructed buildings from applying to alterations.
Necessity:
These changes are necessary to ensure that the requirements are not applied where they have not yet been determined to be feasible and cost effective, noting that existing design and equipment can impose constraints that do not exist in the context of a newly constructed building.

Section: 141.0(b)2Piv
Specific Purpose:
The purpose of the addition of this Section is to require that new controlled receptacles be demand responsive**.**
Necessity:
This addition is necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code, Sections 25213 and 25402.

Section: 141.0(b)2Q
Specific Purpose:
The purpose of the addition of this Section is to apply a threshold for the application of air barrier requirements to alterations.
Necessity:
These changes are reasonably necessary to prevent air barrier requirements from applying to projects making only small or incidental changes to the building envelope where addition of an air barrier would be cost prohibitive.

Section: 141.0(b)2R
Specific Purpose:
The purpose of the addition of this Section is to expressly state that requirements for doors in newly constructed buildings apply to doors added to the building as part of an alteration project.
Necessity:
These changes are reasonably necessary to ensure that added doors possess a feasible and cost-effective thermal efficiency.

Section: 141.0(b)3D
Specific Purpose:
The purpose of the changes to this section are to add specificity to the requirements for modeling an alteration project using building modeling software, including via nonregulatory explanatory notes, and to expressly state that expansions of existing systems do not cause any existing, unaltered heating or cooling equipment from being considered an altered component (as the term is used at the start of 141.0(b)).
Necessity:
These changes are reasonably necessary to ensure accurate modeling of alteration projects using the performance approach to compliance as well as to prevent requirements applicable to alterations from inadvertently applying to unaltered components.

Section: Table 141.0-C
Specific Purpose:
The specific purpose of the changes to Table 141.0-C are to increase the stringency of the U-factor insulation trade off requirement to align with the new time-independent values (TDVs) as well as the revised insulation levels proposed for alterations.
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code, Sections 25213 and 25402.

Section:141.0(b)2C
Specific Purpose:
The purpose of the changes to this section is to replace additional fan power credits based on pressure drop with more general and direct fan power allowances, and to associate the allowances with fan and system types rather than filtration types. In addition, new exceptions are provided that prevent newly proposed standards in Sections 140.4(a)2, 140.4(e), and 140.4(k)8 from applying to alterations.
Necessity:
These changes are necessary to align fan power allowances to updated filtration standards and make them agnostic regarding the source of pressure drop within a fan system, as well as to ensure that newly proposed standards applicable to new construction are not inadvertently applied to alterations where there is a risk that they may not be technically feasible or cost effective to apply.

Section: Table 141.0-D
Specific Purpose:
The purpose of this table is to replace additional fan power credits based on pressure drop with more general and direct fan power allowances, and to associate the allowances with fan and system types rather than filtration types.
Necessity:
These changes are necessary to align fan power allowances to updated filtration standards and make them agnostic regarding the source of pressure drop within a fan system, as well as to ensure that newly proposed standards applicable to new construction are not inadvertently applied to alterations where there is a risk that they may not be technically feasible or cost effective to apply.

Section: Table 141.0-E
Specific Purpose:
The specific purpose of the change made to Table 141.0-E is to include the roof/ceiling insulation requirements of 141.0(b)2Bii.
Necessity:
This change is necessary to achieve greater energy savings in California’s existing nonresidential building stock, as directed by California Public Resources Code Section 25943.

Section: Table 141.0-F
Specific Purpose:
The specific purpose of the changes made to Table 141.0-F is to clarify applicability by replacing “and” with “or” and update section references consistent with changes made elsewhere in the Energy Code (e.g., moving the demand response provisions to Section 110.12). The added language also specifies that new occupancy sensing control requirement added to Section 130.1(c)6D are not intended to apply to alterations meeting specified requirements. In addition changes to this section also revises the lighting type terminology to match the change of the terminology in the new construction section of the standards, clarifies the requirements by adding an exception to

subsection 141.0(b)2Lii and 141.0(b)2Liii for alterations with less than five existing luminaires, and make non-substantive grammatical changes and editorial changes necessary to effectively communicate the requirements and standards in a precise and clear manner. (see also 141.0(b)2I)

Necessity:

These changes are necessary to improve the clarity of the table and ensure its consistency with changes proposed for other sections of the Energy Code.

Section: 141.1

Specific Purpose:

The purpose of the changes to this section are to add two new sections to cover alterations to computer room economizing and controlled environment horticulture spaces and apply requirements that are parallel to the requirements proposed to apply to newly constructed buildings.

Controlled environment horticulture spaces are proposed newly regulated process spaces, and the requirements in this section apply when a new ventilation, space conditioning, or humidification is added to a building with indoor growing, when alterations to horticultural lighting exceed a certain percent of total existing installed horticultural lighting, or when a conditioned greenhouse is added or an existing non-conditioned greenhouse is converted to a conditioned greenhouse (thereby meeting the definition of an “addition” under the Energy Code).

Computer room economizing requirements have been extensively updated in the proposed 2022 amendments, and new requirements for computer room uninterruptible power supplies have been added. The amendment here extends these updated requirements to “newly installed computer room cooling systems and uninterruptible power supply systems in additions/alterations”.

Necessity:

These changes are necessary to ensure that the proposed requirements applicable to newly constructed buildings are also applied to added or altered building spaces where they are shown to be feasible and cost effective to do so, and where they are able to save a significant amount of energy on a statewide basis.

Section: 150.0

Specific Purpose:

The specific purpose of the change to this section is to replace “low rise” with “single family”. This is a non-substantive change; multifamily requirements are being relocated into new Sections 160, 170, and 180. Any substantive changes made to multifamily requirements are described in the statements for those new Sections.

Necessity:

This change is necessary to be consistent with all the other references to single-family residential buildings to ensure clarity and internal consistency within the Energy Code,

as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 150.0(a)
Specific Purpose:
The specific purpose of the changes made to Section 150.0(a)1 is to require a mandatory minimum level of insulation for roof decks equivalent to R-4 continuous above deck insulation. This is not a change to overall thermal performance requirements per se, but rather guarantees that a minimum fraction of required insulation is located at the roof deck for buildings where ducts and air handlers are located in the attic space. Other changes include renumbering to reflect the addition of a new 150.0(a)1 and other non-substantive changes to improve clarity.
Necessity:
Ensuring that attic areas housing ducting and air handling equipment are not thermal concentrators in climate zones with significant cooling loads reduces wasteful, uneconomic, inefficient, or unnecessary consumption of energy, and therefore this change is necessary to increase energy efficiency and conservation via cost-effective building design standards, as directed by California Public Resources Code, Sections 25213 and 25402.

Section: 150.0(j)1
Specific Purpose:
The specific purpose of the changes to subsection 150.0(j)1 is to change the external wrap requirement to R-4. The alternative for internal insulation of R-16 is rewritten as an exception.
Necessity:
These changes are necessary to update the legacy external wrap requirement in relation to the federal minimum insulation requirement for unfired storage tank, which is now R-12.5. The alternative for R-16 internal insulation is written as an exception for clarity.

Section: 150.0(j)2A
Specific Purpose:
The specific purpose of the changes to subsection 150.0(j)2 is to delete pipe insulation requirements in subsections 150.0(j)2Ai, 150.0(j)2Aii, and 150.0(j)2Aiii.
Necessity:
These changes are necessary to align with the California Plumbing Code pipe insulation requirement. The changes will simplify the language and streamline compliance to the Building Standard.

Section:150.0(k)
Specific Purpose:
The specific purpose of the changes to this section is to reorganize the residential lighting subsection by consolidating similar subject-area requirements together, where feasible, to the three existing subsections - about luminaires, indoor lighting controls and outdoor lighting, and both reordering and redrafting the language within each section to more logically organize and clearly state applicable requirements. With the exception of specific changes to subsections noted below, these are intended to be non-substantive amendments.
Necessity:
The changes are necessary to improve clarity of the requirements and thereby enhance code compliance and enforcement of the standards. There are also non-substantive grammatical changes and editorial changes necessary to effectively communicate the requirements and standards in a precise and clear manner.
Following are specific changes within Section 150.0(k):

Section: 150.0(k)1A
Specific Purpose:
The specific purpose of the proposed change is to relocate three existing subsections that effectively act as exceptions to luminaire installation requirements - specifically with regards to integrated device lighting, navigation lighting (including night lights, step lights and path lights), and cabinet lighting – to be stated as exceptions to this section. In addition, the criteria relating to cabinet lighting and navigation lighting has been simplified, and the list of integral device lighting has been expanded.
Necessity:
These changes are necessary to ensure energy efficiency of the Energy Code can be achieved with the provisions of the Energy Code and the provisions are sufficient for the industry practice of lighting design and applications without being unnecessarily intricate or cumbersome. It is also necessary to ensure energy efficiency of the Energy Code with cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402.

Section:150.0(k)1B
Specific Purpose:
The specific purpose of the change is to reorganize and reorder the items of the lighting requirements and to arrange the screw-based luminaires requirement to this subsection of the Energy Code. The specific purpose of the change to this section is to amend the screw-based luminaire requirements by adding new categories of light sources as provisions – new generation of light source technologies for residential building lighting applications have been considered for their relevancy and physical characters. Dim-to-warm, tunable-white and color-tunable LED light sources, as well as Title-20 compliant LED lamps, are categories of light sources added.
Necessity:
These changes are necessary to ensure energy efficiency of the Energy Code can be achieved with the provisions of the Energy Code and the provisions are sufficient for the industry practice of lighting design and applications. It is also necessary to ensure energy efficiency of the Energy Code with cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402.

Section:150.0(k)1C
Specific Purpose:
The specific purpose of the proposed change is to delete the zero-clearance insulation contact (IC) specificity and instead to add to a new reference to California Electrical Code about meeting the clearance and installation requirements for installations of recessed luminaires in ceilings. Another proposed change is to add a provision for providing air-tightness installation per manufacturer's instructions to maintain airtightness. Another proposed change is to add an exception for recessed downlight luminaires marked for use in fire-rated installations and recessed luminaires installed in non-insulated ceilings.
Necessity:
These changes are necessary to ensure energy efficiency of the Energy Code can be achieved with the provisions of the Energy Code and the provisions are sufficient for the industry practice of lighting design and applications. It is also necessary to ensure energy efficiency of the Energy Code with cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402. Further, it ensures requirements of the Energy Code be consistent with other Part of California Building Codes.

Section: 150.0(k)2A
Specific Purpose:
The specific purpose of the proposed change is to reorganize and reorder the items of the lighting requirements and to arrange the wall-mounted controls for lighting to this subsection of the Energy Code.
The changes are also to add an exception for energy management control system (EMCS) that it may provide the required manual on and off controls as required by Energy Code.
Necessity:
These changes are necessary to ensure energy efficiency of the Energy Code can be achieved with the provisions of the Energy Code and the provisions are sufficient for the industry practice of lighting design and applications. It is also necessary to ensure energy efficiency of the Energy Code with cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402. Further, it ensures requirements of the Energy Code be consistent with other Part of California Building Codes.

Section:150.0(k)2D
Specific Purpose:
The specific purpose of the proposed change is to reorganize and reorder the items of the lighting requirements and to arrange the energy management control system (EMCS) for lighting to this subsection of the Energy Code.
The proposed changes are also to add multi-scene programmable controller to the energy management control system (EMCS) requirement, and both the multi-scene programmable controller and the energy management control system are specified to be required with the lighting control functionality of Section 1510.0(k)2 in order to be installed for meeting the lighting control requirement of the Energy Code.
Necessity:
These changes are necessary to ensure energy efficiency of the Energy Code can be achieved with the provisions of the Energy Code and the provisions are sufficient for the industry practice of lighting design and applications. It is also necessary to ensure energy efficiency of the Energy Code with cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402.

Section: 150.0(k)2E
Specific Purpose:
The specific purpose of the proposed change is to reorganize and reorder the items of the lighting requirements and to arrange the automatic off control requirement to this subsection of the Energy Code.
The proposed changes are also to specify the automatic off control requirement for the specified luminaire in bathrooms, garages, laundry rooms, utility rooms, and walk-in closets, and for the lighting internal to drawers and specified cabinetry.
Necessity:
These changes are necessary to ensure energy efficiency of the Energy Code can be achieved with the provisions of the Energy Code and the provisions are sufficient for the industry practice of lighting design and applications. It is also necessary to ensure

energy efficiency of the Energy Code with cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402.

Section: 150.0(k)2F
Specific Purpose:
The specific purpose of the proposed change is to reorganize and reorder the items of the lighting requirements and to arrange the dimming controls requirement to this subsection of the Energy Code.
The proposed changes are also to add the dimming control requirement for the lighting in habitable spaces including living rooms, dining rooms, kitchens, and bedroom. Further, the proposed changes are to add an exception for ceiling fans with remote-controlled integrated lighting and an exception for luminaires connected to a circuit with controlled lighting power below the specified wattage level.
Necessity:
These changes are necessary to ensure energy efficiency of the Energy Code can be achieved with the provisions of the Energy Code and the provisions are sufficient for the industry practice of lighting design and applications. It is also necessary to ensure energy efficiency of the Energy Code with cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402.

Section: Section 150.0(k)2G
Specific Purpose:
The specific purpose of the proposed change is to reorganize and reorder the items of the lighting requirements and to arrange the independent controls requirement to this subsection of the Energy Code.
The changes are also to specify the independent control requirement for the lighting of exhaust fans and kitchen hoods and for undercabinet lighting, undershelf lighting, interior lighting of display cabinets and switched outlets.
Necessity:
These changes are necessary to ensure energy efficiency of the Energy Code can be achieved with the provisions of the Energy Code and the provisions are sufficient for the industry practice of lighting design and applications. It is also necessary to ensure energy efficiency of the Energy Code with cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402.

Section: 150.0(k)3A
Specific Purpose:
The specific purpose of the changes is to move automatic time switch control from item 150.0(k)3Aii to item 150.0(k)3Aiii (for astronomical time clock control) of this subsection of the Energy Code.
Necessity:
These changes improve and ensure the general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 150.0(k)6
Specific Purpose:
The specific purpose of the changes is to delete this item about the Interior Common Areas for Low-rise Multifamily Residential Buildings from this subsection of the Energy Code because they are being moved to new chapters of the proposed Energy Code.
Necessity:
These changes improve and ensure the general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 150.0(m)1
Specific Purpose:
The purpose of the changes to this section are to align duct insulation requirements applicable to ducts in indoor spaces to minimum values needed to prevent condensation, to clarify the exception to this section's requirement, and to add a criteria expressly linking the exception to an absence of available space for insulation.
Necessity:
These changes are necessary to ensure that required R-values are not more stringent than needed to provide expected benefits, and to ensure that associated exceptions are not overly broad. Insulation has a reduced value when the associated ducts are transiting through conditioned spaces, as any heat or cooling "lost" via attenuation is still delivered into an indoor space. Insulation is still necessary to prevent condensation and to prevent distant rooms from being under-served and requiring more extreme thermostat settings (with associated additional energy use) to achieve temperatures matching those of rooms that are nearer to the source of heating or cooling.

Section: Table 150.0-A
Specific Purpose:
The specific purpose of the changes to the Table is to revise the headings of the column and to clarify the light sources in the left column are classified as high efficacy and the light sources in the right column are required to comply with Reference Joint Appendix JA8. The other specific purpose of the change to this section is to reorganize the light source types in the Table and also to add new categories of light sources. LED lighting technologies are listed to the upper top part of the Table. These proposed changes are to add the following to the left column of the Table as qualified as high efficacy and are not required to comply with Reference Joint Appendix JA8:

- qualified inseparable solid-state lighting (SSL) luminaires, qualified colored light sources,
- qualified dim-to-warm LED light sources, qualified tunable-white LED light sources,
- color-tunable LED light sources,
- qualified LED lamps compliant with Title 20,
- infrared light sources, and ultraviolet light sources.

These proposed changes are to add the following to the right column of the Table and these types of ceiling recessed downlight luminaires are exempted to meet Reference Joint Appendix JA8:

- color-tunable LED light sources;
- dim-to-warm LED light sources;
- tunable-white LED light sources.

Necessity:
New generation of light source technologies for residential building lighting applications have been considered for their relevancy and physical characters. These changes are also necessary to ensure energy efficiency of the Energy Code can be achieved with the provisions of the Energy Code and the provisions reflects and aligns, where feasible, with the development of lighting technologies and the products as available to the building sector marketplace. Further, the changes are necessary to ensure energy efficiency of the Energy Code with cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402.

Section: 150.0(m)11
Specific Purpose:
The specific purpose of the changes to this section is to improve the clarity and consistency of the regulatory language without making substantive changes to underlying requirements.
Necessity:
The changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 150.0(m)12
Specific Purpose:
The specific purpose of the changes to this section is to clarify that all outside air and recirculated air supplied to occupiable spaces must be filtered, and to add a requirement that filter racks or grilles be gasketed or sealed to prevent air from bypassing the filter.
Necessity:
These changes are necessary to ensure public health and safety for occupants of dwelling units complying with the energy efficiency requirements of the Energy Code, consistent with State statutes and policies of protecting and enhancing the indoor environmental quality in buildings.

Section: 150.0(n)1
Specific Purpose:
The specific purpose of the changes to subsection 150.0(n)1 is to add requirements for designated space for future installations of heat pump water heaters, as well as additional plumbing and electrical requirements if the designated space is more than 3 feet away.
Necessity:
These changes are necessary to prepare the building for future installation of heat pump water heater to more cost-effectively allow compliance with State of California State clean energy goals, policies, and legislation.

Section: 150.0(o)
Specific Purpose:
The specific purpose of the changes to this section is to maintain, where feasible, consistency between the Energy Code and the most current versions of The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 62.2, and to specify California-specific amendments to the ASHRAE 62.2 requirements.
Necessity:
These changes are necessary to ensure public health and safety for occupants of dwelling units complying with the energy efficiency requirements of the Energy Code, consistent with State statutes and policies of protecting and enhancing the indoor environmental quality in buildings.

Section: 150.0(o)1B
Specific Purpose:
The specific purpose of the changes to this section is to clarify which Central Fan Integrated (CFI) ventilation system component configurations and airflow control configurations are allowed by the Energy Code, and which configurations are not allowed.
Necessity:
These changes are necessary to prohibit dysfunctional CFI system configurations, thereby ensuring public health and safety for occupants of dwelling units complying with the energy efficiency requirements of the Energy Code, consistent with State statutes and policies of protecting and enhancing the indoor environmental quality in buildings.

Section: 150.0(o)1C and 150.0(o)1D
Specific Purpose:
The specific purpose of the changes to these sections is to add section titles and, for 150.0(o)1C, remove redundant reference to ASHRAE 62.2 Sections 4.1.1 and 4.1.2 (as these are more visibly referenced in the titles of subsections i and iii). This is not a substantive change to requirements.
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 150.0(o)1E
Specific Purpose:
The specific purpose of the changes to this section is to specify that balanced ventilation systems with heat recovery or energy recovery are required to have a fan efficacy less than or equal to 1.0 W/cfm, and to improve the overall clarity of section language.
Necessity:
Establishing a fan efficacy standard for HRV / ERV systems is necessary to increase energy efficiency via cost-effective building design standards, as directed mandated by California Public Resources Code Sections 25213 and 25402. Making additional changes to improve the clarity of section language is necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 150.0(o)1F
Specific Purpose:
The specific purpose of the changes to this section is to clarify the design specification for ventilation airflow shall be shown on the building design plans, and to improve the overall clarity of section language.
Necessity:
These changes are necessary to ensure compliance with Energy Code requirements by requiring complete documentation on plans, and to improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 150.0(o)1G through K, and Tables 150.0-E, 150.0-F, 150.0-G, 150.0-H
Specific Purpose:
The specific purpose of the changes to this section is to make ASHRAE 62.2 Section 5 requirements for local ventilation exhaust explicit in 150.0(o)1 rather than adopted by reference, add use of a new capture efficiency rating metric as an alternative to minimum rated airflow performance, update new compliance targets for airflow and

capture efficiency for demand-controlled kitchen range hood ratings requirements based on cooking fuel type and dwelling unit floor area, prohibit atmospherically vented or solid fuel burning appliances inside the pressure boundary of dwelling units less than 1000 ft^2, and clarify airflow measurement procedures required for ventilation systems.

Necessity:

These changes are necessary to ensure public health and safety for occupants of dwelling units complying with the energy efficiency requirements of the Energy Code, consistent with State statutes and policies of protecting and enhancing the indoor environmental quality in buildings. The changes to fully incorporate ASHRAE 62.2 Section 5 requirements and to clarify airflow measurement procedures are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 150.0(o)2

Specific Purpose:

The specific purpose of the changes to this section is to add a proposed kitchen range hood verification alternative for minimum capture efficiency into the specifications for HERS verification, and to require that fan efficacy is subject to verification when less than or equal to 1.0 W/cfm.

Necessity:

These changes are necessary to ensure public health and safety for occupants of dwelling units complying with the energy efficiency requirements of the Energy Code, consistent with State statutes and policies of protecting and enhancing the indoor environmental quality in buildings.

Section: 150.0(q)

Specific Purpose:

The purpose of the changes to this section are to lower the maximum U-factor requirement from 0.58 to 0.45, consistent with materials in the Documents Relied Upon showing these values to be feasible and cost effective, as well as to add the word “area” for clarity.

Necessity:

These changes are necessary to achieve energy savings associated with improved thermal performance of window products.

Section: 150.0(s)

Specific Purpose:

The specific purpose of addition of subsection 150.0(s) is to add Energy Storage Systems (ESS) ready requirements to low-rise single-family buildings.

Necessity:

These changes are necessary to prepare the main electrical panel for future installation of battery storage system or back-up generator.

Section: 150.0(t)
Specific Purpose:
The specific purpose of addition of subsection 150.0(t) is to add heat pump space heater ready requirements to low-rise single-family buildings.
Necessity:
These changes are necessary to prepare the building for future installation of heat pump space heater.

Section: 150.0(u)
Specific Purpose:
The specific purpose of addition of subsection 150.0(u) is to add electric cooktop ready requirements to low-rise single-family buildings.
Necessity:
These changes are necessary to prepare the building for future installation of electric cooktop.

Section: 150.0(v)
Specific Purpose:
The specific purpose of addition of subsection 150.0(v) is to add electric clothes dryer ready requirements to low-rise single-family buildings.
Necessity:
These changes are necessary to prepare the building for future installation of electric clothes dryer.

Section: 150.1
Specific Purpose:
The specific purpose of the change to this section is to replace “low rise” with “single family” such that the requirements of this section and its subsections now do not apply to multi-family buildings. This is a non-substantive change; multifamily requirements are being relocated into new Sections 160, 170, and 180. Any substantive changes made to multifamily requirements are described in the statements for those new Sections.

Necessity:
This change is necessary to be consistent with all the other references to single-family residential buildings to ensure clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 150.1(a)
Specific Purpose:
The specific purpose of the change to this section is to remove reference to multifamily buildings, such that the requirements of this section and its subsections now only apply to single-family buildings. This is a non-substantive change: multifamily requirements are being relocated into new Sections 160, 170, and 180. (Any substantive changes

made to multifamily requirements are described in the statements for those new Sections.)

Necessity:
These changes are necessary to relocate low-rise and high-rise multifamily requirements to a new multifamily specific section of the code. Consolidating these provisions into a dedicated group of sections ensures clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 150.1(b)3Bi
Specific Purpose:
The purpose of the changes to this section is to generalize the language of Bi to cover the full suite of energy performance statistics that potentially apply to heating and cooling equipment under state and federal law, and allow for repetitive language in section 150.1(b)3Bii and the entirety of section 150.1(b)3Biv to be deleted (as they are effectively merged into 150.1(b)3Bi).
Necessity:
These changes are necessary to accurately state the values that must be reported for differing types of heating and cooling equipment in order to verify compliance with minimum standards, in a manner that is clearer and more concise than existing language.

Section: 150.1(b)3Bii and 150.1(b)3Biv
Specific Purpose:
The specific purpose of the changes to this section is to delete language in section Bii and the entirety of section 150.1(b)3Biv consistent with the change to 150.1(b)3Bi and to incorporate reference to HERS procedures that are required for determining compliance with the variable capacity heat pump compliance option as adopted by the Energy Commission on November 13, 2019.
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 150.1(c)7
Specific Purpose:
The specific purpose of changes to subsection 150.1(c)7 is to add new equipment selection requirements for heat pumps in climate zones 3, 4, 10, 13, and 14.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402. These changes are also necessary to pursue the State’s goals relating to greenhouse gas emissions.

Section: 150.1(c)8Ai, 150.1(c)8Aii, and 150.1(c)8Aiii
Specific Purpose:
The specific purpose of changes of subsection 8 is to remove 3 prescriptive water heating options for gas water heaters
Necessity:
These changes are necessary to simplify code language and reduce redundancy. Gas water heaters can be used in the performance compliance method or if EXCEPTION 1 to Section 150.1(c)8 is met.

Section: 150.1(c)8A, 150.1(c)8B, and 150.1(c)8C
Specific Purpose:
The specific purpose of changes of subsection 150.1(c)8 is to simplify the existing electric water heating options and add a new option for electric water heater coupled with a solar water heating system.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402.

Section: EXCEPTION 1 to Section 150.1(c)8
Specific Purpose:
The specific purpose of addition of EXCEOTION 1 is to allow gas instantaneous water heaters in climate zones 3, 4, 10, 13, and 14.
Necessity:
These changes are necessary to align with changes to heat pump space heaters in section 150.1(c)8 and to pursue the State's goals relating to greenhouse gas emissions.

Section: EXCEPTION 2 to Section 150.1(c)8
Specific Purpose:
The specific purpose of addition of EXCEPTION 2 is to allow electric instantaneous water heaters for newly constructed dwelling units with conditioned floor area of 500 square feet or less.
Necessity:
These changes are necessary to add flexibility for small dwellings that might not have the physical space to accommodate a storage water heater.

Section: 150.1(c)10
Specific Purpose:
The purpose of the changes to this section are to add a fan efficacy standard specific to small duct high velocity systems.
Necessity:
These changes are necessary to prevent these systems from being held to existing standards applicable to all air handling units that are not gas furnaces, which would

pose technical challenges to attain at the higher flow rates high-velocity systems are intended to operate at.

Section: EXCEPTION s 1 & 2 to Section 150.1(c)11
Specific Purpose:
The specific purpose of the change made to EXCEPTION s 1 and 2 to Section 150.1(c)11 is to maintain consistency in terminology used, by changing “solar reflectance” to “aged solar reflectance”.
Necessity:
This is a non-substantive grammatical change necessary to effectively communicate the requirements and standards in a precise and clear manner. This change is necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Section 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 150.1(c)12 & EXCEPTION to 150.1(c)(12)
Specific Purpose:
The specific purpose of the changes to this section and its subsections is to improve grammar, punctuation, and capitalization, to reference a Home Ventilating Institute product directory in place of an Energy Commission product directory, and to add an exception for accessory dwelling units (ADUs).
Necessity:
These changes are necessary to prevent requiring whole house fans for small-volume dwellings where the presence of such fans would provide little to no added benefit, to ensure product criteria can be verified at a robust independent listing of such devices, and to otherwise ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Section 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 150.1(c)14
Specific Purpose:
The specific purpose of changes of subsection 14 is to add a definition for Solar Access Roof Area (SARA) and clarify the minimal photovoltaic (PV) requirements.
Necessity:
These changes are necessary to eliminate confusion and to clarify the direction for applicability of the PV requirement without changing the stringency of the current requirements.

Section: EXCEPTION 1, 2, 3, and 4 to Section 150.1(c)14
Specific Purpose:
The specific purpose of changes of EXCEPTIONS 1, 2, 3, and 4 is to remove and replace these exceptions.
Necessity:
The purpose of the deletion of these exceptions is to coordinate with the changes made to references to Solar Access Roof Area (SARA) in EXCEPTION 1. As a result of the definition of SARA, and the changes in EXCEPTION 1, these exceptions are no longer necessary.

Section: EXCEPTION 2 to Section 150.1(c)14
Specific Purpose:
The specific purpose of addition of EXCEPTION 2 is exempt buildings from the PV requirement if the PV system size specified by section 150.0(c)14 is less than 1.8 kWdc.
Necessity:
These changes are necessary to add flexibility for small dwellings where a small PV system might not be cost effective.

Section: EXCEPTION 3 to Section 150.1(c)14
Specific Purpose:
The specific purpose of addition of EXCEPTION 2 is exempt buildings from the PV requirement if the building is determined to not able to meet the requirements of the American Society of Civil Engineers (ASCE), Standard 7-16, Chapter 7, Snow Loads.
Necessity:
These changes are necessary to exempt building site where the design snow load exceeds the PV system rating and are unable to comply with the California Building Code and California Residential Code snow load structural requirements.

Section: 150.2
Specific Purpose:
The specific purpose of the change to this section is to replace “low rise” with “single family” such that the requirements of this section and its subsections now do not apply to multi-family buildings. This is a non-substantive change; multifamily requirements are being relocated into new Sections 160, 170, and 180. Any substantive changes made to multifamily requirements are described in the statements for those new Sections.
Necessity:
This change is necessary to be consistent with all the other references to single-family residential buildings to ensure clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 150.2(a)
Specific Purpose:
The purpose of the changes to this section are to relocate the provisions in EXCEPTION 1 to a more appropriate location within the subsection dedicated to mechanical ventilation, and to clarify EXCEPTION 5 as well as update it for consistency with changes to later sections.
Necessity:
The changes to this section are necessary to improve the clarity and organization of its provisions.

Section: 150.2(a)1B
Specific Purpose:
The specific purpose of the changes made to Section 150.2(a)1B is to increase the stringency of the roof/ceiling insulation requirement to R-38 for Climate Zones 1, 2, 4, & 8-16, and to add language to provide an equivalent U-factor requirement for non-wood framed assemblies.
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code, Sections 25213 and 25402.

Section: EXCEPTION 5 to 150.2(a)
Specific Purpose:
The specific purpose of the change to EXCEPTION 5 is to revise the trigger for duct requirements when ducts are extended to serve an addition.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402 by reducing the energy loss through ducts. The current exception can be used to bypass sealing and insulation requirements when ducts are extended to serve a new addition. This is a prime opportunity to save energy and is cost-effective.

Section: 150.2(a)1C, 150.2(a)2C, 150.2(b)1D, 150.2(b)1G, 150.2(b)1L, 150.2(b)1M, and 150.2(b)2A
Specific Purpose:
The specific purpose of the changes to this section is to:

- clarify the requirements for alterations to existing buildings for mechanical ventilation system components and mechanical ventilation airflow. The clarification is needed due to new requirements in 150.0(o) for range hood local exhaust systems, and due to the reconfiguration of previously adopted references to ASHRAE 62.2 requirements specified in 150.0(o) which now instead incorporate sections of ASHRAE 62.2 language directly into 150.0(o).

- clarify/specify that dwellings previously required to meet whole-building mechanical ventilation for indoor air quality shall also be required to meet the whole-dwelling unit mechanical ventilation airflow requirement when the dwelling's ventilation system undergoes alteration.
- provide exclusions from requirements for mechanical ventilation for the new junior accessory dwelling units (JADU).
- clarify the definition of "new or complete replacement ventilation systems" and require that these systems comply with the same requirements as are applicable to newly constructed ventilation systems.
- clarify that dwellings that were not required by a previous building permit to have a whole-dwelling unit ventilation system shall not be required to comply with the whole-dwelling unit ventilation airflow specified in 150.0(o).
- clarify that replacement ventilation fans must be rated according to ASHRAE 62.2 Sections 7.1 and 7.2.
- specify that for dwellings which were required by a previous building permit to comply with the ventilation system air filtration requirements in 150.0(m)12, any alterations to the air filtration device shall also comply with the air filtration requirements in 150.0(m)12.
- specify that for dwellings that were not required by a previous building permit to comply with the ventilation system air filtration requirements in 150.0(m)12, any alterations to the air filtration device shall not be required to comply with the air filtration requirements specified in Section 150.0(m)12
- clarify that altered local mechanical bathroom exhaust systems shall comply with the requirements in Section150.0(o)1G
- specify that dwellings that were required by a previous building permit to comply with the kitchen local exhaust requirements in Section 150.0(o)1G shall meet or exceed the applicable airflow or capture efficiency requirements in Section 150.0(o)1G, otherwise dwellings that were required by a previous building permit to install a vented kitchen range hood or other kitchen exhaust fan, shall install a replacement fan that meets or exceeds the airflow required by the previous building permit, or 100 cfm, whichever is greater; otherwise dwellings that were not required to have a kitchen local ventilation exhaust system by a previous building permit are not be required to comply with the requirements of Section 150.0(o)1G.

Necessity:

These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16, as well as to ensure public health and safety for occupants of dwelling units complying with the energy efficiency requirements of the Energy Code, consistent with State statutes and policies of protecting and enhancing the indoor environmental quality in buildings.

Section: 150.2(b)
Specific Purpose:
The specific purpose of the change to this section is to replace “low rise” with “single family” such that the requirements of this section and its subsections now do not apply to multi-family buildings. This is a non-substantive change; multifamily requirements are being relocated into new Sections 160, 170, and 180. Any substantive changes made to multifamily requirements are described in the statements for those new Sections.
Necessity:
This change is necessary to relocate low-rise and high-rise multifamily requirements to a new multifamily specific section of the code. Consolidating these provisions into a dedicated group of sections ensures clarity and internal consistency within the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 150.2(b)1A
Specific Purpose:
The specific purpose of the changes to this section is to add the word “Added” to its title for consistency with the section’s contents (its lone sentence begins, “Alterations that add vertical fenestration and skylight area shall …”) and with the title of the immediately subsequent section (which is “Replacement Fenestration”). This is not a substantive change in requirements.
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: 150.2(b)1D, 150.2(b)1E
Specific Purpose:
The specific purpose of the changes to subsections150.2(b)1D and 150.2(b)1E are to revise the trigger for duct requirements when ducts are altered or replaced and to increase stringency to duct leakage targets confirmed by field verification and diagnostic testing when existing ducts are extended, altered or replaced.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402 by reducing the energy loss through ducts. The duct leakage target of 15 percent was introduced in 2005 and has not changed since then. Data and feedback from stakeholders indicate that 10 percent duct leakage target is achievable and a good opportunity to achieve greater energy savings. This measure is cost-effective.

Section: TABLE 150.2-A
Specific Purpose:
The specific purpose of the change to this table is to increase stringency in duct insulation R-value by specifying which climate zones require R-6 and R-8 duct insulation for additions and alterations.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402 by reducing the energy loss through ducts. The change aligns the prescriptive duct insulation requirements with new construction and is cost-effective.

Section: 150.2(b)1C
Specific Purpose:
The specific purpose of the changes made to this section are to require entirely new or complete replacement duct systems to comply with the attic insulation requirements of 150.2(b)1J, provided the air handler and ducts are located within a ventilated attic.
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code, Sections 25213 and 25402. When a new duct system is installed in an existing attic the work is disruptive to the existing attic insulation. At a minimum existing insulation must be moved to access certain areas and later replaced. Worst case, the attic insulation is disrupted and not fixed, resulting in uneven insulation levels across the attic. If new registers are added as part of the scope of work, new penetrations in the ceiling plane may need to be properly air sealed.

Section: 150.2(b)1G
Specific Purpose:
The specific purpose of the change to subsection 150.2(b)1G is to add a new requirement for altered space heating systems that prohibits electric resistance heating, except under certain conditions.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402 by prohibiting electric resistance heating. This measure targets a cost-effective opportunity to remove old electric resistance equipment and replace it with new efficient heat pump systems.

Section: 150.2(b)1G, 150.2(b)1H
Specific Purpose:
The purpose of the changes to this section are to ensure that prescriptively installed equipment relies on heat pump technology where feasible, and does not require on-site combustion.
Necessity:
These changes are necessary to ensure that installed equipment is able to make use of on-site or grid-supplied renewable energy.

Section: 150.2(b)1Ii
Specific Purpose:
The specific purpose of the changes made to Section 150.2(B)1Ii are to:

- Remove multifamily “low-rise residential” from the scope of this requirement, and to clarify that the requirement now only applies to single family buildings.
- Increase the stringency of the steep-sloped cool roof requirement to encompass Climate Zones 4 & 8-16.

Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16. For the 2022 Energy Standards, the low-rise and high-rise multifamily requirements are being relocated to a new multifamily specific section of the code: Sections 160, 170, and 180. This change is necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code, Sections 25213 and 25402.

Section: EXCEPTION 1 to Section 150.2(b)1Ii
Specific Purpose:
The specific purpose of the changes made to EXCEPTION 1 to Section 150.2(b)1Ii are to:

- Remove the exception for 1-inch of air space to create consistency in the requirements applying equally to all roofs regardless of product type.
- Remove the exception for products with a profile ratio of rise to width of 1 to 5 for 50 percent or greater of the width of the roofing product to create consistency in the requirements applying equally to all roofs regardless of product type.
- Remove the exception for existing ducts in the attic that are insulated and sealed according to 150.1(c)9 because this exception is no longer valid. Section 150.1(c)9 no longer references duct sealing requirements, only duct insulation requirements. Duct sealing requirements have been moved from Section 150.1 to Section 150.0 and are now mandatory for new homes in addition to the prescriptive requirements for cool roof.

- Provide an equivalent U-factor to the R-38 ceiling insulation exception for non-wood framed assemblies.
- Clarify that the exception for buildings with a radiant barrier in the attic only applies to radiant barriers that are not installed directly above space sheathing.
- Increase the stringency of the exception for buildings that do not have ducts in the attic to limit it to Climate Zones 2, 4, 9, 10, 12 & 14.
- Remove the Climate Zone limitation for the exception for buildings with R-2 or great continuous insulation.

Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code, Sections 25213 and 25402, and achieve greater energy savings in California's existing residential building stock, as directed by California Public Resources Code Section 25943.

Section: EXCEPTION 2 to Section 150.2(b)1Ii
Specific Purpose:
The specific purpose of the change made to EXCEPTION 2 to Section 150.2(b)1Ii is to provide an exception for roof areas covered by building integrated photovoltaic panels or building integrated solar thermal panels in alignment with the prescriptive new construction requirements of Section 150.1(c)11.
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16. This exception which currently exists for new construction should also apply to alterations.

Section: EXCEPTION 3 to Section 150.2(b)1Ii
Specific Purpose:
The specific purpose of the change made to Exception 3 to Section 150.2(b)1Ii is to provide an exception for roof constructions with a weight of at least 25 lb/ft^2 in alignment with the prescriptive new construction requirements of Section 150.1(c)11.
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16. This exception which currently exists for new construction should also apply to alterations.

Section: 150.2(b)1Iiia
Specific Purpose:
The specific purpose of the changes made to Section 150.2(b)1Iiia are to:
Increase the stringency of the low-sloped cool roof requirement in Climate Zones 4 & 6-15, and to maintain consistency in terminology used, by changing "solar reflectance" to

“aged solar reflectance”.

Necessity:

This change is necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code, Sections 25213 and 25402. This change is necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Section 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section EXCEPTION 1 to Section 150.2(b)1Iii (old)

Specific Purpose:

The specific purpose of the change made to Exception 1 to Section 150.2(b)1Iii is to remove the exception for buildings with no ducts in the attic because buildings with low-sloped roofs do not have an attic space and the cost-effectiveness calculations conducted for the 2022 CASE Report are based on a building with ducts in conditioned space

Necessity:

This change is necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Section 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: Table 150.2-B

Specific Purpose:

The specific purpose of the changes made to Table 150.2-B are to increase the stringency of the U-factors for low-sloped cool roof insulation trade off to reflect the new roof insulation requirements of 150.2(b)1Iiib.

Necessity:

This change is necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code, Sections 25213 and 25402.

Section: EXCEPTION 2 to Section 150.2(b)1Iiia

Specific Purpose:

The specific purpose of the change made to EXCEPTION 2 to Section 150.2(b)1Iiia is to provide an exception for roof areas covered by building integrated photovoltaic panels or building integrated solar thermal panels in alignment with the prescriptive new construction requirements of Section 150.1(c)11.

Necessity:

These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16. This exception which currently exists for new construction should also apply to alterations.

Section: EXCEPTION 3 to Section 150.2(b)1Iiia
Specific Purpose:
The specific purpose of the change made to EXCEPTION 3 to Section 150.2(b)1Iiia is to provide an exception for roof constructions with a weight of at least 25 lb/ft^2 in alignment with the prescriptive new construction requirements of Section 150.1(c)11.
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16. This exception which currently exists for new construction should also apply to alterations.

Section: 150.2(b)1Iiib
Specific Purpose:
The specific purpose of the change made to Section 150.2(b)1Iiib is to require R-14 continuous insulation at the roof deck at time of roof replacement or recover in Climate Zones 1, 2, 4, & 8-16.
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code, Sections 25213 and 25402. When performing a roof replacement or recover, it represents an ideal time to add above deck insulation.

Section: 150.2(b)1Ji
Specific Purpose:
The specific purpose of the change made to Section 150.2(b)1Ji is to require R-49 ceiling insulation when an entirely new or complete replacement duct system is installed in Climate Zones 1-4, 6, & 8-16 in vented attics.
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code, Sections 25213 and 25402. When duct replacement work is completed, it represents an ideal time to address the attic as a system, including air sealing the ceiling plane and adding attic insulation.

Section: 150.2(b)1Jii
Specific Purpose:
The specific purpose of the change made to Section 150.2(b)1Jii is to require air sealing of the ceiling plane between the attic and conditioned space in accordance with Section 110.7 when an entirely new or complete replacement duct system is installed in Climate Zones 2, 4, & 8-16.
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code, Sections 25213 and

25402. When duct replacement work is completed, it represents an ideal time to address the attic as a system, including air sealing the ceiling plane and adding attic insulation.

Section: 150.2(b)1Jiii
Specific Purpose:
The specific purpose of the change made to Section 150.2(b)1Jiii is to require the insulating and/or retrofitting and insulating of all recessed downlight luminaires when an entirely new or complete replacement duct system is installed in Climate Zones 1-4, and 8-16.
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code, Sections 25213 and 25402. When duct replacement work is complete, it represents an ideal time to address the attic as a system, including air sealing the ceiling plane and adding insulation.

Section: 150.2(b)1Jiv
Specific Purpose:
The specific purpose of the change made to Section 150.2(b)1Jiv is to require attic ventilation to be maintained when an entirely new or complete replacement duct system is installed.
Necessity:
This change is necessary to ensure consistency between the Energy Code and the other Part of the Building Standards Code, as directed by California Government Code, Sections 11349 and 11349.1.

Sections: 160.0 through 180.2 Authority and Reference Citation
Specific Purpose:
The specific purpose of the change is to add the Authority and Reference citations to reflect the statutory provisions utilized by the CEC in the preceding section. This is not a substantive change in requirements.
Necessity:
These changes are necessary to provide the public with the CEC's statutory authority for adopting these regulations and to provide notice of the sections that are being implemented, interpreted or made specific by the regulations.

Sections: 160.0 through 180.4 -
Specific Purpose:
The specific purpose of the additions of Sections 160.0 through 180.4 is to relocate requirements applicable to multifamily buildings to one area of the Energy Code, and merge requirements where cost effective and technically feasible. The mandatory requirements for multifamily buildings have been relocated to the newly created Subchapter 10, Sections 160.0 through 160.9. The performance and prescriptive

requirements for multifamily buildings have been relocated to the newly created Subchapter 11, Sections 170.0 through 170.2. The requirements for additions and alterations to multifamily buildings have been relocated to the newly created Subchapter 12, Sections 180.0 through 180.4.

The majority of this relocation is non-substantive, though note that substantive changes proposed for residential and/or nonresidential building standards in sections 120-150.2 are duplicated here where applicable, for consistency as well as for the reasons stated in the statements for changes made to those sections. Additional substantive changes have been made where feasible to create consistency across the former categories of low-rise and high-rise buildings, i.e. buildings with three or fewer habitable / residential stories and those with four or more (respectively). Specific changes requiring additional detail are described below.

Necessity:
This modification was reasonably necessary to facilitate navigation of the Energy Code when determining its applicability to multifamily buildings. All requirements applicable to multifamily buildings, whether dwelling units or common areas, have been removed from previous subsections of the Energy Code and reproduced within these sections, permitting a reader to understand the requirements applicable to a multifamily building project without needing to refer to other chapters or to hunt for relevant provisions amongst provisions applicable to nonresidential or single family buildings. Requirements for high-rise (greater than three habitable stories) and low-rise (less than four habitable stories) multifamily buildings have been grouped together, and differentiations between requirements based on number of floors have been streamlined where found to not be necessary for ensuring efficient building designs. Where there is a delineation between these two types of buildings, language was added to specify that the requirements apply to only one or the other based on the number of habitable stories, consistent with existing requirements. Otherwise, requirements apply regardless of the number of stories of the multifamily building (though criteria based on other relevant aspects of the building's design, such as use of metal versus wood framing or central versus decentralized water heating, may apply). This change is necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Section 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16, to remove use of number of floors as an imprecise proxy for other aspects of building design, to retain proposed updates intended to apply across building types, and to best position builders to be able to find, understand, and follow code requirements applicable to multifamily building projects.

Section: 160.2(b)2Bi
Specific Purpose:
The specific purpose of the change to subsection Bi is to add a new requirement for balanced ventilation systems that serve multifamily dwelling units for fan efficacy. Unitary heat or energy recovery ventilators must have a fan efficacy of less than or equal to 1.0 W/cfm.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402. The fan efficacy requirement is intended to eliminate the least efficient heat or energy recovery ventilators from use.

Section:160.2(b)2
Specific Purpose:
The specific purpose of the change to subsection D is to add a new requirement for multifamily central ventilation system duct sealing.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402. This measure provides energy savings from reducing duct leakage and also result in indoor air quality benefits. Energy savings come from both reduced fan energy and reduction in heating and cooling loads. Tighter central ventilation ducts ensure that all dwelling units receive adequate ventilation airflow and that air does not leak from one dwelling unit to another.

Section: 160.9(a)
Specific Purpose:
The specific purpose of addition of subsection (a) is to add heat pump space heater ready requirements to multifamily buildings.
Necessity:
These changes are necessary to prepare the building for future installation of heat pump space heater.

Section: 160.9(b)
Specific Purpose:
The specific purpose of addition of subsection (b) is to add electric cooktop ready requirements to multifamily buildings.
Necessity:
These changes are necessary to prepare the building for future installation of electric cooktop. The documents relied upon for this rulemaking show the proposed efficiency standards to be technically feasible for buildings in California and cost effective as compared to future modification and retrofit of electrical circuit to an existing building.

Section: 160.9(c)
Specific Purpose:
The specific purpose of addition of subsection 160.9(c) is to add electric clothes dryer ready requirements to multifamily buildings.
Necessity:
These changes are necessary to prepare the building for future installation of electric clothes dryer. The documents relied upon for this rulemaking show the proposed efficiency standards to be technically feasible for buildings in California and cost effective as compared to future modification and retrofit of electrical circuit to an existing building.

Section: 170.2(a)1Biv – Envelope Requirements, Buildings Without Attics
Specific Purpose:
The specific purpose of the addition of this language was to provide a new prescriptive compliance option for multifamily buildings without an attic.
Necessity:
This addition was necessary to create an option for compliance for multifamily buildings without an attic. This option includes specific attic insulation and roofing product requirements, which vary depending on climate zone.

Section: 170.2(a)3i
Specific Purpose:
The specific purpose of the modification to this language is to apply both the 20 percent of conditioned floor area fenestration limitation and the 40% window-to-wall ratio fenestration area limitation to multifamily buildings.
Necessity:
This modification was necessary to ensure that the minimum efficiency requirements for fenestration area in low-rise high-rise residential buildings were applied to all multifamily buildings. This ensures that the negative impacts of excessive glazing in these buildings is appropriately captured and recognizes the benefits of applying both low-rise and high-rise residential limits to all multifamily buildings.

Section: Table 170.2-A
Specific Purpose:
The specific purpose of the changes to the prescriptive requirements for walls of multifamily buildings is to separate insulation requirements based on the fire rating requirements for those walls.
Necessity:
This modification was necessary to recognize the insulation challenges of walls when the California Fire Code requires high fire ratings. As fire rating requirements increase, materials used to satisfy both fire rating and insulation level requirements increase in cost and decrease in cost effectiveness and product availability. Assembly insulation and u-factor requirements will vary depending on the wall’s fire rating requirement.

Section: Table 170.2-A
Specific Purpose:
The specific purpose of the changes to the prescriptive requirements for fenestration of multifamily buildings is to create separate requirements based on the fenestration product assembly type.
Necessity:
This modification was necessary to recognize the energy efficiency challenges of fenestration products when they must meet higher durability, wind and water penetration, load deflection, and forced entry requirements, as described in the North American Fenestration Standard (NAFS 2017). As these values increase for fenestration products, their ability to achieve high-efficiency requirements decreases. This change creates a Performance Class Architectural Window (AW) classification. This classification of window will have lower efficiency requirements because of cost-effective and technical feasibility challenges.

Section: 170.2(c)3A
Specific Purpose:
The specific purpose of the new subsection 170.2(c)3A is to add new equipment selection requirements for single zone heating systems in multifamily buildings.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402. These changes are also necessary to pursue the State’s goals relating to greenhouse gas emissions.

Section: 170.2(d)2
Specific Purpose:
The specific purpose of the new subsection 170.2(d)2 is to add a new prescriptive option for heat pump water heating systems serving multiple dwelling units.
Necessity:
This change is necessary to add flexibility to the prescriptive options without changing the stringency of the current requirements.

Section: 170.2(d)3A
Specific Purpose:
The specific purpose of the new subsection 170.2(d)3A is to add a 90 percent thermal efficiency requirement in climate zones 1 through 9, for gas water heating systems serving multiple dwelling units above 1 million BTU per hour.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402.

Section: 170.2(e)1
Specific Purpose:
The specific purpose of the change is to relocate the prescriptive lighting requirements for common use areas in multifamily buildings.
Necessity:
These changes are necessary to improve the code's compliance with the clarify and consistency criteria of California Government Code Section 11340 et seq. and Chapter 1, Article 2 of the California Code of Regulations.

Section: 170.2(c)
Specific Purpose:
The specific purpose of the change to subsection 170.2(c)3Bv is to add new prescriptive requirements for balanced ventilation systems requiring minimum sensible heat recovery efficiencies and fan efficacies for heat or energy recovery ventilators.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402. The sensible heat recovery signifies how much sensible energy in the outgoing airstream is transferred to the incoming airstream. The measure would provide cost-effective energy savings through preheating or precooling ventilation air.

Section: 180.1
Specific Purpose:
The specific purpose of the change to EXCEPTION 5 is to revise the trigger for duct requirements when ducts are extended to serve an addition in multifamily dwelling units. The trigger is revised from 40 feet to any length of ducts extended.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402 by reducing the energy loss through ducts. The current exception can currently be used to bypass sealing and insulation requirements when ducts are extended to serve a new addition. This is a prime opportunity to save energy and is cost-effective.

Section: 180.1(a)2, 180.1 (b)3; 180.2(b)2, 180.2(b)5
Specific Purpose:
The specific purpose of the changes to this section is to:

- incorporate the requirements for multifamily dwelling units into this new multifamily section that were previously located in Sections 150.0(m)12, 150.0(o), and 120.1.
- clarify the requirements for alterations to existing buildings for mechanical ventilation system components and mechanical ventilation airflow. The

clarification is needed due to new requirements in Section 150.0(o) for range hood local exhaust systems, and due to the reconfiguration of previously adopted references to ASHRAE 62.2 requirements specified in Section 150.0(o) which now instead incorporate sections of ASHRAE 62.2 language directly into Section 150.0(o).

- clarify/specify that dwellings previously required to meet whole-building mechanical ventilation for indoor air quality shall also be required to meet the whole-dwelling unit mechanical ventilation airflow requirement when the dwelling's ventilation system undergoes alteration.
- provide exclusions from requirements for mechanical ventilation for the new junior accessory dwelling units (JADU).
- clarify the definition of "new or complete replacement ventilation systems" and require that these systems comply with the same requirements as are applicable to newly constructed ventilation systems.
- clarify that dwellings that were not required by a previous building permit to have a whole-dwelling unit ventilation system shall not be required to comply with the whole-dwelling unit ventilation airflow specified in Section 150.0(o).
- clarify that replacement ventilation fans must be rated according to ASHRAE 62.2 sections 7.1 and 7.2.
- specify that for dwellings which were required by a previous building permit to comply with the ventilation system air filtration requirements in Section 150.0(m)12, any alterations to the air filtration device shall also comply with the air filtration requirements in Section150.0(m)12.
- specify that for dwellings that were not required by a previous building permit to comply with the ventilation system air filtration requirements in 150.0(m)12, any alterations to the air filtration device shall not be required to comply with the air filtration requirements specified in Section 150.0(m)12
- clarify that altered local mechanical bathroom exhaust systems shall comply with the requirements in Section 150.0(o)1G
- specify that dwellings that were required by a previous building permit to comply with the kitchen local exhaust requirements in Section 150.0(o)1G shall meet or exceed the applicable airflow or capture efficiency requirements in Section 150.0(o)1G, otherwise dwellings that were required by a previous building permit to install a vented kitchen range hood or other kitchen exhaust fan, shall install a replacement fan that meets or exceeds the airflow required by the previous building permit, or 100 cfm, whichever is greater; otherwise dwellings that were not required to have a kitchen local ventilation exhaust system by a previous building permit are not be required to comply with the requirements of Section 150.0(o)1G.

Necessity:

These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16, as well as

to ensure public health and safety for occupants of dwelling units complying with the energy efficiency requirements of the Energy Code, consistent with State statutes and policies of protecting and enhancing the indoor environmental quality in buildings.

Section: 180.2(b)
Specific Purpose:
The specific purpose of the change to subsection 180.2(b)2Aii is to revise the trigger for duct requirements when ducts are altered or replaced in multifamily dwelling units. The trigger is revised from 40 feet to 25 feet of altered or replaced ducts.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402 by reducing the energy loss through ducts. This is a prime opportunity to save energy and is cost-effective when ducts are altered or replaced. The 25 feet was determined by the typical length of ducts in one package.

Section: TABLE 180.2-B
Specific Purpose:
The specific purpose of the change to this table is to increase stringency in duct insulation R-value by specifying which climate zones require R-6 and R-8 duct insulation in multifamily dwelling units.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402 by reducing the energy loss through ducts. The change aligns the prescriptive duct insulation requirements with new construction and is cost-effective.

Section: 180.2(b)2Av
Specific Purpose:
The specific purpose of the change to subsection 180.2(b)2Av is to add a new requirement for altered space heating systems that prohibits electric resistance heating in multifamily dwelling units, except under certain conditions.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code Sections 25213 and 25402 by prohibiting electric resistance heating. This measure targets a cost-effective opportunity to remove old electric resistance equipment and replace it with new efficient heat pump systems.

Section: JA1-A
Specific Purpose:
The specific purpose of the changes to this section are to update titles and editions or versions of documents incorporated by reference, consistent with changes to such

references occurring throughout the Express Terms, to remove documents that are no longer incorporated by reference, and to update availability information.
Necessity:
These changes are necessary to ensure that this Appendix accurately describes the documents incorporated by reference into the main body of the Energy Code and to maintain the currency of contact information for various publishers and other sources.

Section: JA1-B
Specific Purpose:
The Index that was part of the code template is not part of the Adopted Energy Code. A 2022 Index will be created at a later date to assist searches of the adopted 2022 Energy Code.
Necessity: This was deleted from the template because it is not part of the Adoption package**.**

Section: JA1 – new definitions
Specific Purpose:
The specific purpose of changes that add new definitions to the Definitions section is to provide clear and specific definitions for technical terms used within other updates to Part 6, aligned with the use of the term where it is proposed to occur later in the Energy Code. This includes added definitions for new industry standards documents that are incorporated by reference into later portions of the Energy Code.
Necessity:
These changes are necessary to ensure that provisions in subsequent sections are clear and unambiguous, and that non-technical readers are able to find and understand the technical meaning of specific terms relating to building design and construction.

Section: JA1 – amended definitions of industry standards documents
Specific Purpose:
The specific purpose of changes that amend the publication date of industry standards documents already defined within this Section are to ensure definitions relating to industry test standards refer to or otherwise specify the most current available versions of such standards. This includes amendments that update the names of referenced industry standards documents consistent with their current published titles.
Necessity:
The changes to update the referenced versions of industry publications are necessary to ensure alignment of the Energy Code with industry standards upon which it relies, and prevent situations where use of obsolete versions of such standards would be required for compliance with the Energy Code as written.

Section: JA1 – other amended definitions
Specific Purpose:
The specific purpose of changes that amend existing definitions within the Definitions

section is to maintain consistency with terms defined in Section 100.1 and otherwise add references or improve clarity to ensure consistency with the Energy Code.
Necessity:
These changes are necessary to ensure that provisions in subsequent sections are clear and unambiguous, and that non-technical readers are able to find and understand the technical meaning of specific terms relating to building design and construction.

Section: JA2
Specific Purpose:
The purpose of the changes to this section are to update the description of data fields and formats consistent with updates made to the weather files used by the Energy Commission's modeling software, and to update JA2.1.1 to rely on the Energy Commission's published climate zone mapping tool rather than on previously published Excel files.
Necessity:
These changes are necessary to ensure that the content of the Appendix accurately describes the more accurate and contemporary weather files now used within the Energy Commission's modeling software, and to update the method of climate zone determination to rely on the newer and more advanced tool developed and published by the Energy Commission.

Section: JA3
Specific Purpose:
The purpose of the changes to this section are to update the description of time-dependent valuation (TDV) figures consistent with updates made to the TDV calculations performed by the Energy Commission's modeling software.
Necessity:
These changes are necessary to ensure that the content of the Appendix accurately describes the more accurate and contemporary TDV calculations now used within the Energy Commission's modeling software.

Section: JA4.1.1
Specific Purpose:
The specific purpose of the change made to Appendix JA4.1.1 is to clarify that insulation installed in California must be certified in accordance with Section 110.8(a) of the Energy Standards.
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: JA4.1.7
Specific Purpose:
The purpose of the changes to this section are to state the location and means of accessing certified documentation, rather than stating only that the documentation must be obtained.
Necessity:
These changes are reasonably necessary to ensure readers are instructed as to where and how to obtain necessary documentation, rather than only stating that documentation must be obtained, so as to ensure that the means of compliance is readily understandable for the reader.

Section: JA4.2, Table 4.2.1
Specific Purpose:
The specific purpose of the changes made to Table 4.2.2 is to provide columns for R-17, R-20, and R-23 continuous insulation, and to remove one occurrence of the term “low-rise”.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code, Sections 25213 and 25402. As part of the nonresidential roof alterations proposal, R-17 and R-23 are now prescriptive requirements and therefore should be included in the prescriptive tables. R-20 was added to aid in design flexibility. Removal of the term “low-rise” with respect to residential construction is reasonably necessary to recognize that four and five story wood-framed construction is becoming increasingly common, and in so doing ensuring that the paragraph remains accurate.

Section: JA 6.3
Specific Purpose:
The specific purpose of the changes to these Sections are to expand Economizer and Economizer Fault Detection (FDD) and Diagnostic requirements to include mechanical cooling capacities greater than 33,000 Btu/hr. The specific change is to reference the new threshold of 33,000Btu/hr in FDD Certification Submittal Requirements.
Necessity:
The proposed expansion of design standards for economizers and FDD are necessary to reduce and prevent wasteful, uneconomic, inefficient, and unnecessary consumption of energy by buildings, consistent with the statutory direction in Public Resources Code Section 25402. Economizers are an effective way to capture free cooling.

Section: JA7
Specific Purpose:
The purpose of the changes to this section are to add specifications relating to use of an Application Programming Interface (API), improve phrasing and consistency of statements referring the reader to the Data Registry Requirements Manual for additional information, and ensure consistency via use of CEC-developed schemas.
Necessity:
These changes are reasonably necessary to create consistent processes that allow for greater automation of data submittal and processing.

Section: JA7.2
Specific Purpose:
The specific purpose of the changes to this Appendix is to add a definition for External Digital Data Source (EDDS) Provider, and to clarify the distinction between an EDDS service and the organization that administers the EDDS (including correcting one use of the word “shall” to its intended “may”). Additional changes to specific subsections are described below.
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: JA7.4.8
Specific Purpose:
The purpose of the addition of this section is to obligate Registration Providers to allow CEC staff access to documents that they are required to maintain, and to specify procedures and subsequent actions to be taken if access is not provided.
Necessity:
These changes are reasonably necessary to provide CEC with the means to engage in oversight, compliance and enforcement with regards to Registration Providers.

Section: JA7.7.1.2.2, JA7.8.2.6
Specific Purpose:
The specific purpose of the changes to this section is to clarify the distinction between EDDS services and EDDS providers.
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: JA7.8.4.1 and JA7.8.4.2
Specific Purpose:
The purpose of the changes to this section are to improve phrasing and more clearly state the actions and roles specified in the existing language: the revised language makes it clear that the action is taken by the Executive Director of the CEC, but may be initiated based on a request (petition) submitted by any party (as opposed to the prior language which could be read that any party may directly act to deactivate a data registry). The revised language also clarifies that both errors and violations are grounds for action (as opposed to an unintended reading that errors were actionable but intentional violations were not).
Necessity:
These changes are reasonably necessary to ensure actions relating to review and oversight of Registration Providers are undertaken by appropriately authorized persons within the CEC, even when requests for action are received from outside parties, and to ensure that both errors and outright violations are clearly specified to be grounds for further action.

Section: JA7.8.5
Specific Purpose:
The purpose of the changes to this section are to clarify that help screens for data registries do not need to be separately or additionally published in order to satisfy the requirements of this section.
Necessity:
These changes are reasonably necessary to prevent unneeded physical reproduction or duplication of help screens and text done in pursuit of demonstrating compliance with this section’s requirements.

Section: JA8
Specific Purpose:
The purpose of the changes to this section are to add the word “luminous” where needed for clarity, clarify that “drivers” refers to LED drivers, replace the phrase “participating in” with the more accurate and specific phrase “accredited to”, and update the year associated with the specified marking requirement to 2022 for consistency with the overall update to the Energy Code. These are not substantive changes.
Necessity:
These changes are necessary to enhance the clarity of the section and ensure that marking requirements are kept consistent with the published editions of the Energy Code.

Section: JA9
Specific Purpose:
The purpose of the changes to this section are to remove an unneeded Table of Contents given that the section, in its entirety, is less than two pages long.
Necessity:
These changes are necessary to ensure that navigation aids such as tables of contents are not included where they would be counterproductive or otherwise without benefit.

Section: JA11
Specific Purpose:
The purpose of the changes to this section are to more clearly delineate the requirements applicable to prescriptive versus performance-based requirements, to add language relating to low-sloped roofs and alternate orientations of equipment on steep-sloped roofs, to include building owners and managers consistent with the proposed addition of nonresidential prescriptive photovoltaic system requirements to the Energy Code, and to simplify the language relating to solar assessment tools in part by incorporating the “alternative methods” provisions directly into the criteria for certification and by removing unneeded specificity of details inherent in requiring that weighted average solar access be determined (i.e., determining this value necessarily requires locating and measuring the entire proposed area of the array.) Additional non-substantive changes are also provided to enhance clarity and update section references.
Necessity:
These changes are necessary to clarify and expressly state that issues of facing / azimuth of solar panels are only applicable when installed on a sloped roof, to acknowledge the building modeling software’s ability to model a complete range of panel orientations (including non-ideal orientations), to align language within the appendix with the proposed addition of nonresidential prescriptive solar photovoltaic requirements to the Energy Code, and to ensure that the provisions of this appendix are clear, unambiguous and not more prescriptive than needed to ensure compliance with the Energy Code. The prescriptive standards for orientation and shading are necessary to ensure that in-situ system performance of prescriptive systems matches equivalent systems meeting performance-based standards – in particular, the 98% solar access requirement is based on a threshold below which performance-based systems would need to add capacity to achieve energy generation requirements.

Section: JA12
Specific Purpose:
The purpose of the changes to this section are to create a prescriptive compliance path for battery storage systems based on the existing performance criteria, to clarify that the existing control provisions are intended for systems paired with on-site solar photovoltaic systems, to add specifications applicable to battery storage systems installed without on-site solar equipment, and to specify that greenhouse gas emissions

benefits can qualify as an alternative control strategy for approval by the Executive Director.

Necessity:

These changes are necessary to apply JA12 to building projects irrespective of whether they are following a prescriptive or performance-based compliance path; because battery storage systems are proposed to be prescriptively required for some nonresidential buildings, a set of prescriptive standards paralleling the performance standards is needed to support this change. Similarly, clarifying that the existing control specifications were designed around an assumption of a paired solar photovoltaic system made it necessary to provide specifications for “standalone” battery storage systems to ensure equivalent treatment of such systems and eliminate risks of confusion or misapplication of provisions. Battery storage systems promote energy efficiency and conservation, pursuant to the directive of Sections 25213 and 25402, and including greenhouse gas benefits as a potential method of compliance is necessary to promote state policies regarding climate change, given that one of the stated goals of transitioning to renewable energy sources is to reduce greenhouse gas emissions and associated impacts on climate and the environment.

Section: JA13

Specific Purpose:

The specific purpose of adding this appendix is to support updates to the Standard language relating to installation of a heat pump water heater with demand management capability.

Necessity:

This appendix is necessary to describe in specific detail the qualification and certification requirements for Heat Pump Water Heater Demand Management Systems.

Section: JA14

Specific Purpose:

The specific purpose of adding this appendix is to support updates to the Standard language relating to installation of a central heat pump water heaters.

Necessity:

This appendix is necessary to describe in specific detail the qualification and certification requirements for Central Heat Pump Water Heating Systems.

Section: NA1.1
Specific Purpose:
The specific purpose of the changes to this section is to update the reference to the Standards where the duct leakage requirements are located, and update Table NA1-1 to include references to verifications for kitchen range hoods located in NA2.2.4.1.4, and HRV/ERV systems located in NA2.2.4.1.5.
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: NA1.5
Specific Purpose:
The specific purpose of the changes to this section is to remove an out of place sentence at the beginning of the section – this section is not specific to duct testing, and it is not appropriate to have language specific to duct testing or its documentation within this section.
Necessity:
These changes are necessary to prevent confusion or cause the misapplication of requirements to perform testing and document results.

Section: NA1.7.6 (d)
Specific Purpose:
The specific purpose of the changes to this section is to replace the word “the” with “a” for consistency with the immediately subsequent sections.
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: NA1.9
Specific Purpose:
The specific purpose of the changes to this section is to clarify the alternative procedure that must be followed when an acceptance test technician (ATT) performs field verifications in nonresidential occupancies that were specified to be performed by HERS Raters, and to clarify that the alternative procedure is applicable to all HERS procedures specified in NA2.
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: NA2.1
Specific Purpose:
The specific purpose of the change to this section (see also Sections 120.4(g), 120.5(a), 140.4(l), 141(b), NA1.1, NA7):

- Update reference in NA2.1 to reference Section120.4(g) instead of Section140.4(l).

Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16. Duct leakage testing was introduced in 2001 in Part 6 and have not been updated since introduction. The prescriptive requirement being moved to a mandatory requirement is necessary to be consistent with recent California Mechanical Code changes as well as duct leakage testing.

Section: NA2, NA2.1.1
Specific Purpose:
The purpose of the changes to these sections are to add HERS to the section title, consistent with its contents, and update references to sections of the Energy Code that are proposed to be amended. These are not substantive changes.
Necessity:
These changes are necessary to maintain the accuracy of references to other Energy Code sections and to ensure that section titles are fully reflective of their contents.

Section: NA2.1.4.1
Specific Purpose:
The purpose of the changes to this section are to provide specific air handler airflow values for multi-split systems and small duct high velocity systems, instead of holding these systems to airflow rates applicable to packaged systems with a single indoor unit.
Necessity:
These changes are necessary to permit systems to operate at lower target values where appropriate, avoiding unnecessary energy use, as well as to maintain consistency with updates to CFM target values specified in the Energy Code.

Section: NA2.1.4.2, Table NA2.1-1
Specific Purpose:
The purpose of the changes to this section and table are to remove a column that redundantly states a standards value applied by the Energy Code.
Necessity:
These changes are necessary to ensure that material within the Appendices is not duplicative of material in the Energy Code, and to avoid a situation where the Energy Code values may be amended without also causing these values to be amended.

Section: NA2.2.1, Table NA2.2-1
Specific Purpose:
The purpose of the changes to this section are to improve consistency in phrasing, remove unneeded reference to ASHRAE 62.2, and add two rows to the table consistent with the addition of specified procedures to NA2.2.4 (described below).
Necessity:
These changes are reasonably necessary to better direct readers as to the location and contents of the subsections to which it refers, and to avoid implying that review of ASHRAE 62.2 is necessary for understanding the content or specifications of NA2 or its subsections.

Section: NA2.2.4
Specific Purpose:
The specific purpose of the changes to this section is to add Heat Recovery Efficiency as a new verification metric for HRV and ERV system types in Section NA2.2.4.1.5, incorporate into the NA2.2.4.1.4 kitchen range hood verification the specification for use of capture efficiency as an alternative for compliance in addition to airflow rate, clarify the specification of existing HERS verification procedures for verification of IAQ ventilation systems, and clarify that compliance with the kitchen local mechanical exhaust vented range hood protocol may be determined by use of ratings published in CEC-approved directories and the AHAM directory in addition to the HVI directory.
Necessity:
These changes are necessary to achieve greater energy savings in California's existing residential and nonresidential building stock, as directed by California Public Resources Code Section 25943 and, for the clarifying changes, to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: NA2.4
Specific Purpose:
The purpose of the addition of this section is to describe a field verification and diagnostic test procedure for testing whole building air leakage. The Energy Code does not require performance of this test.
Necessity:
These changes are necessary to establish a consistent formula for determining whole building air leakage for persons interested in incorporating such testing into their building projects, and for enabling future consideration of compliance credit or other measures based on the results of such testing.

Section: NA2.5
Specific Purpose:
The purpose of the addition of this section is to specify a procedure for verifying that an air barrier has been installed, noting that verification of air barrier installation is not required for compliance with minimum efficiency requirements but may be electively performed in projects.
Necessity:
These changes are reasonably necessary to ensure that a consistent verification method exists for this building component for cases where it would provide value.

Section: NA6
Specific Purpose:
The specific purpose of the changes made to Appendix NA6.1 and NA6.5 are to clarify that the scope of this requirement applies to non-rated site-built skylights and alterations to vertical fenestration (i.e., repairs or replacement of glass), and to remove the 200 square foot exception for nonresidential compliance.
Necessity:
These changes are necessary to increase energy efficiency via cost-effective building design standards, as directed by California Public Resources Code Sections 25213 and 25402 by increasing the rate of compliance with National Fenestration Rating Council (NFRC certification) and reducing/eliminating the amount of uncertified fenestration products being installed in California, as well as to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Section 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: NA6
Specific Purpose:
The purpose of the changes to this section are to update acceptance testing procedures and define new procedures where necessary to support the Energy Code.
Necessity:
These changes are necessary to ensure that acceptance testing procedures are kept current with regards to industry standards and best practices, and to provide defined testing protocols for new types of systems and equipment proposed to be regulated by the Energy Code.

Section: NA7
Specific Purpose:
The specific purpose of the change to this section (see also sections 120.4(g), 120.5(a), 140.4(l), 141(b), NA 1.1, NA 2.1):

- Include new functional testing for duct leakage in NA7
- Include California Mechanical Code Language for duct leakage testing in NA7f

- Include eligible criteria of whom can perform testing NA7

Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16. Duct leakage testing was introduced in 2001 in Part 6 and have not been updated since introduction. The prescriptive requirement being moved to a mandatory requirement is necessary to be consistent with recent California Mechanical Code changes as well as duct leakage testing.

Section: NA7.4.5
Specific Purpose:
The specific purpose of the changes made to Appendix NA7.4.5 are to clarify that these procedures apply to all interior and exterior horizontal slats, not just those being installed for compliance with the Power Adjustment Factors (PAF) requirement.
Necessity:
These changes are necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code, Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: NA7.5.4
Specific Purpose:
The specific purpose of the changes made to this section are to include appropriate acceptance testing of heat recovery bypassing HRV/ERV or DOAS systems (see also Sections 140.4(e), and 140.4(p)).
Necessity:
This change is necessary to increase energy efficiency via cost-effective building design standards, as mandated by California Public Resources Code, Sections 25213 and 25402. The current Building Energy Efficiency Standards currently does not have prescriptive requirements for DOAS while market share for DOAS have been increasing since 2012; their broadening adoption and market penetration now means that efficiency standards for this equipment have the potential to save a significant amount of energy on a statewide basis.

Section: Table RA2-1
Specific Purpose:
The specific purpose of the changes to this section is to add references and descriptions to the table for the new HERS procedures for variable capacity heat pumps, kitchen local exhaust, heat recovery and energy recovery ventilation systems, and multifamily dwelling unit enclosure leakage.
Necessity:
The change is necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: Table RA3.1-1
Specific Purpose:
The specific purpose of the changes to this section is to add references and descriptions to the table for the new HERS procedures for variable capacity heat pumps, kitchen local exhaust, heat recovery and energy recovery ventilation systems, and multifamily dwelling unit enclosure leakage.
Necessity:
The change is necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: RA3.1.3.4.7
Specific Purpose:
The purpose of the addition of this Section is to specify that verification will include a quick visual inspection to ensure that all dwelling spaces are receiving ventilation.
Necessity:
These changes are reasonably necessary to prevent a situation where an absence of visible equipment or ducting may cause a dwelling to pass verification (based on having nothing to verify) despite receiving inadequate ventilation.

Section: RA3.1.3.4.8
Specific Purpose:
The purpose of the addition of this Section is to specify verification that ductless systems are entirely within conditioned spaces.
Necessity:
These changes are reasonably necessary to allow said systems to qualify for credit available for ducted systems located entirely within conditioned spaces.

Sections: RA3.1.4.1.7, RA3.1.4.1.8
Specific Purpose:
The specific purpose of the changes to these sections is to include within RA3 these HERS procedures for determining compliance with the variable capacity heat pump compliance option that was adopted by the Energy Commission on November 13, 2019.
Necessity:
The change is necessary to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: RA3.1.4.2
Specific Purpose:
The specific purpose of the changes to this section is to include an alternative calculation method for nominal air handler airflow for multiple split systems, and to clarify the language that specifies use or the default and nominal air handler airflow calculations used as part of the calculation used for determining duct leakage field test compliance results.
Necessity:
These changes are necessary to enable field verification of multiple-split system indoor unit airflow and duct leakage compliance target values in order to achieve greater energy savings in California's existing residential building stock, as directed by California Public Resources Code Section 25943, and for the clarifying changes to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: RA3.1.4.3
Specific Purpose:
The purpose of the changes to this section are to specify that for central systems leakage measurement shall be based on leakage present when installed dampers are closed, and not based on artificial or temporary sealing of duct branches.
Necessity:
These changes are reasonably necessary to ensure that leakage testing results are accurate to the conditions that will exist during occupancy.

Section: RA3.1.4.7; RA3.1.4.8, RA3.3.3.4.1, RA3.4.4.3, 3.4.5, 3.4.6
Specific Purpose:
The specific purpose of the changes to these sections is to:

- provide specification for a HERS field verification procedure for determining compliance with air filter sizing according to a face velocity specification;
- provide specification for HERS field verification of compliance with air filter minimum clean filter pressure drop requirement;

- provide specification for calculating airflow compliance values for HERS field tests of indoor units of multiple-split air conditioners and heat pumps;
- provide specification for verification of variable capacity heat pump performance compliance option eligibility;
- provide specification for HERS field verification of wall-mounted thermostats;
- provide specification for HERS field verification of non-continuous indoor unit fan operation; and
- include within RA3 these HERS procedures that are required for determining compliance with the variable capacity heat pump compliance option as adopted by the Energy Commission on November 13, 2019.

Necessity:
These changes are necessary to provide procedures for HERS raters that cover all system configurations allowed by the Energy Code, and to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: RA3.5.6.1.1, RA3.5.6.1.2, and RA3.5.6.1.5
Specific Purpose:
The purpose of the changes to this section are to state the location and means of accessing certified documentation, rather than stating only that the documentation must be obtained.
Necessity:
These changes are reasonably necessary to ensure readers are instructed as to where and how to obtain necessary documentation, rather than only stating that documentation must be obtained, so as to ensure that the means of compliance is readily understandable for the reader.

Section: RA3.5.6.3
Specific Purpose:
The purpose of the changes to this section are to simplify phrasing by referring to underlying standards requirements, and in so doing to identify the most current version of said standards.
Necessity:
These changes are reasonably necessary to ensure the consistency of requirements with the industry standards from which they originated.

Section: RA3.7
Specific Purpose:
The specific purpose of the changes to this section is to incorporate into the RA3.7.4.3 kitchen range hood verification the specification for use of capture efficiency as an alternative for compliance in addition to airflow rate; include verification procedures for HRV/ERV equipment and add Heat Recovery Efficiency as a new verification metric for

HRV and ERV system types; clarify the specification of existing HERS verification procedures including where measurements are expected to occur; and clarify that compliance with the kitchen local mechanical exhaust vented range hood protocol may be determined by use of ratings published in CEC-approved directories and the AHAM directory in addition to the HVI directory.

Necessity:

These changes are necessary to achieve greater energy savings in California's existing residential and nonresidential building stock, as directed by California Public Resources Code Section 25943, as well as to ensure and improve the general clarity and internal consistency of the Energy Code, as directed by California Government Code Sections 11349 and 11349.1, and California Code of Regulations, Title 1, Section 16.

Section: RA3.8

Specific Purpose:

The purpose of the changes to this section are to update referenced RESNET procedures to their most current version, ensure consistency of section language with the most current RESNET requirements, and improve the phrasing, organization, and flow of specifications.

Necessity:

These changes are reasonably necessary to maintain consistency with RESNET and ensure section language clearly communicates specifications and requirements.

Section: RA3.9.4.1.1

Specific Purpose:

The specific purpose of the changes to this section is to delete a verification protocol that used blower door airflow and pressure matching of dwelling unit with respect to outdoors, and to add a verification protocol that uses a fan flowmeter and pressure matching of the dwelling unit with respect to the attic to measure flow through the whole house fan (WHF) grille. The blower door protocol was reevaluated by field researchers who determined the protocol yields results that are inconsistent with those of procedures using measurement of flow through the WHF grille.

Necessity:

These changes are necessary to ensure the protocols specified for use for measuring WHF airflow provide equivalent results, and in doing so achieve greater energy savings in California's existing residential and nonresidential building stock, as directed by California Public Resources Code Section 25943.

Section: RA4.4
Specific Purpose:
The purpose of the changes to this section are to remove obsolete language referring to differences in pipe insulation requirements between the Energy Code and the Plumbing Code that are proposed to be resolved via amendment to the Energy Code, and to remove unneeded phrasing in three subsections. These are not substantive changes.
Necessity:
These changes are necessary to ensure that unneeded language is removed from the Appendices where it occurs.

TECHNICAL, THEORETICAL, AND EMPIRICAL STUDIES, REPORTS, OR SIMILAR DOCUMENTS RELIED UPON

The CEC relied on input from various stakeholders, subject matter experts, and interested parties that provided information, feedback, and subject matter expertise, including but not limited to:

The groups and organizations that participated include:

California Building Standards Commission, California Independently Owned Utilities, California Business Properties Association, California Building Industry Association, Home Ventilating Institute, Air Conditioning, Heating and Refrigeration Institute, Sheet Metal and Air Conditioning Contractors National Association, National Electrical Manufacturing Association, American Society of Heating, Refrigerating and Air Conditioning Engineers, California Department of Consumer Affairs Illuminating Engineering Society, and Building Owners and Managers Association.

The CEC relied upon the following documents:

Document Number (if applicable)	**Report Title**
	Code Change Proposals
	Integrated Pumped Refrigerant Economizer for Computer Rooms
	Demand Management – Controlled Receptacles
2022-MF-AEP-F	All-Electric Multifamily Compliance Pathway
2022-MF-DHW-F	Multifamily Domestic Hot Water Distribution
2022-MF-ENV-D	Multifamily High Performance Thermal Envelope
2022-MF-IAQ-D	Multifamily Indoor Air Quality
	Market Analysis in Support of Single-family and Updated Multifamily
2022-MF-RESTRUC-D	Multifamily Restructuring
2022-SF-EAA-D	Residential Energy Savings and Process Improvements for Additions and Alterations
2022-SF-HVAC1-D	Enhanced Air-to-Water Heat Pump Compliance Options
2022-SF-GRID-INT-F	Single Family Grid Integration

2022-SF-HVAC3-D	Variable Capacity HVAC Compliance Software Revisions
2022-NR-HVAC3-F	High Efficiency Boilers and Service Water Heating
2022-NR-COV-PROC4-F	Controlled Environment Horticulture
2022-NR-COV-PROC1-F	Pipe Sizing, Monitoring, and Leak Testing for Compressed Air Systems
2022-NR-HVAC1-F	Nonresidential Computer Room Efficiency
2022-NR-LIGHT1-F	Nonresidential Daylighting
2022-NR-DWHR-F	Nonresidential Drain Water Heat Recovery
2022-NR-GRID-INT-F	Nonresidential Grid Integration
2022-NR-HVAC2-F	Air Distribution: High Performance Ducts and Fan Systems
2022-NR-LIGHT2-F	Nonresidential Indoor Lighting
2022-NR-ENV1-F	Nonresidential High-Performance Envelope
2022-NR-HVAC4-D	Nonresidential HVAC Controls
2022-NR-ENV2-F	Reduced Infiltration
2022-NR-LIGHT3-F	Nonresidential Outdoor Lighting Sources
2022-NR-COV-PROC2-F	Refrigeration System Opportunities
2022-NR-COV-PROC3-F	Steam Trap Monitoring
	Additional Documents Relied Upon
	Brett Singer comment in response to UCLA paper on Gas combustion in buildings
	Technical Memo on Updated Analysis from NO2 and PM25 Cooking Simulation
	Simulations of short-term exposure to NO2 and PM2.5 to inform capture efficiency standards
	Effective Kitchen Ventilation for Healthy Zero Net Energy Homes with Natural Gas
	Development of a standard capture efficiency test method for residential kitchen ventilation
HVI 920	Product Performance Certification Procedure (updated as of February 28, 2020)

The listed documents have been filed in this proceeding's docket, number 21-BSTD-01, and are available to the public unless subject to copyright or other restrictions. https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2022-building-energy-efficiency

In addition, all documents, including those protected by copyright, are available at the California Energy Commission, located at 1516 9th Street, in Sacramento, California.

STATEMENT OF JUSTIFICATION FOR PRESCRIPTIVE STANDARDS

The proposed changes to mandatory requirements have, where possible, avoided mandating use of specific technologies or equipment, or prescribing the performance of specific actions or procedures. The requirements are generally performance-based efficiency metrics. However, the Standards include both a prescriptive option, allowing

builders to comply by using methods known to be efficient, and a performance option, allowing builders complete freedom in their designs provided the building achieves the same overall efficiency as an equivalent building using the prescriptive option.

CONSIDERATION OF REASONABLE ALTERNATIVES, INCLUDING THOSE THAT WOULD LESSEN ANY ADVERSE IMPACT ON SMALL BUSINESS

No reasonable alternatives to the proposed regulations have been proposed that would lessen any adverse impact on small businesses or that would be less burdensome and equally effective in achieving the purposes of the regulation in a manner that achieves the purposes of the statute being implemented.

During the initial, informal stage of the rulemaking process, the Commission conducted an extensive pre-rulemaking public process where it considered many suggestions from numerous stakeholders about (1) alternatives that could improve the feasibility of the Commission's preliminary versions of the proposed regulations or could reduce their adverse impacts; (2) the technical and cost-effectiveness analyses of those preliminary proposals; and (3) the language in those proposals. Based on the comments received, the Commission developed Preliminary Draft Standards and held comprehensive and numerous pre-rulemaking public workshops to obtain public comment on those; in turn, many more comments were received and, in response to them, the Commission has produced the proposed regulations.

FACTS, EVIDENCE, DOCUMENTS, TESTIMONY, OR OTHER EVIDENCE OF NO SIGNIFICANT ADVERSE IMPACT ON BUSINESS

The CEC has made an initial determination that the proposed regulations are unlikely to have a statewide adverse economic impact directly affecting business, including the ability of California businesses to compete with businesses in other states.

California's Energy Code is part of the California Building Standards Code and therefore, impact nearly all newly constructed buildings, as well as to specific additions and alterations to nearly all existing buildings. Therefore, the Energy Code may eventually impact all business in the state that own buildings. However, California's Energy Code applies to buildings built in the state of California. Therefore, no California construction businesses should be at a disadvantage versus businesses in other states when all builders and manufacturers must meet the same standards to build or sell building products in California.

While there are initial up-front costs imposed by the Energy Code, there are long-term savings that typically repay those costs by a significantly positive ratio. Past changes to the Energy Code continue to generate benefits even as the latest version of Energy Code increases initial costs. More simply, the Energy Code helps create long-term economic growth and stability by increasing the disposable income of Californians and California businesses in the longer term. These long-term benefits far outweigh the initial upfront costs and, therefore, California businesses are not disadvantaged in competing with businesses from other states by these regulations. California has aggressively pursued environmental and energy regulations for well over a decade

now, while simultaneously out-performing the overall United States growth in per-capita personal income.

ASSESSMENT OF EFFECT OF REGULATIONS UPON JOBS AND BUSINESS EXPANSION, ELIMINATION OR CREATION

The CEC has assessed whether and to what extent this proposal will affect the following:

A. **The creation or elimination of jobs within the State of California.**
The evidence in the record indicates that employment impacts based on the implementation of the 2022 Energy Code may result in an estimated 781 jobs created and 6,868 jobs eliminated. California businesses producing energy efficient products and technology that meet or exceed the proposed Standards are likely to expand their sales of those products and technologies due to the implementation of these proposed Standards. Construction related jobs and occupations and companies that provide energy efficient products and services will likely benefit from increased demand for those products and services likely creating jobs. Any jobs eliminated may be the result of a single measure that will reduce indoor nonresidential lighting power requirements. This estimate is based on an analysis by Evergreen Economics. Therefore, the CEC concludes that it is likely the proposal may both create and eliminate jobs within California.

B. **The creation of new businesses or the elimination of existing businesses within the State of California.**
California's Energy Code is part of the California Building Standards Code and therefore, impact nearly all newly constructed buildings, as well as to specific additions and alterations to nearly all existing buildings. Therefore, the Energy Code may eventually impact all business and individuals in the state that own buildings. However, while the increased energy efficiency in California's buildings may have short term initial costs, there are long-term benefits from reduced utility costs. California's Energy Code applies to buildings built in the state of California. As such, no California construction businesses should be at a disadvantage when all builders and manufacturers must meet the same standards to build or sell building products in California. More broadly, while there are initial up-front costs imposed by the Energy Code, there are long-term savings that typically repay those costs by a significantly positive ratio. The Energy Code helps create long-term economic growth and stability by increasing the disposable income of Californians and California businesses in the longer term making it possible that new businesses may be created to provide compliance services and to supply energy efficient products. Therefore, based on the evidence in the record, the CEC concludes that it is likely the proposal will create new businesses and unlikely the proposal will eliminate existing businesses within the State of California.

C. **The expansion of businesses currently doing business within the State of California.**
California businesses producing energy efficient products and technology that meet or exceed the proposed Standards are likely to expand their sales of those products and technologies due to the implementation of these proposed Standards. Therefore, the CEC concludes that it is likely that Businesses currently doing business in California to provide energy-efficient products and services are likely to be expanded.

D. **The benefits of the regulation to the health and welfare of California residents, worker safety, and the state's environment**.
The benefits of this proposed action are costs savings to California residents and businesses, lower statewide energy use, and lower statewide greenhouse gas emissions.

The proposed regulations will not affect the health and welfare of California residents, worker safety, or the state's environment.

ESTIMATED COST OF COMPLIANCE, ESTIMATED POTENTIAL BENEFITS, AND RELATED ASSUMPTIONS USED FOR BUILDING STANDARDS

Due to the complexity of the analysis, refer to the Economic and Fiscal Impact Statement (STD. 399) for the estimated cost of compliance, estimated potential benefits, and related assumptions used for building standards found on the CEC website at: https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2022-building-energy-efficiency

DUPLICATION OR CONFLICTS WITH FEDERAL REGULATIONS

These proposed regulations do not duplicate or conflict with any federal regulations contained in the Code of Federal Regulations.

FOR FURTHER INFORMATION

Please direct general inquiries concerning aspects of the rulemaking process including requests for copies of the proposed text (express terms), the initial statement of reasons (ISOR), any modified version of the regulations, the substance of the proposed regulations, or any other information upon which the rulemaking is based to:

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Specific questions regarding the substantive and/or technical aspects of the proposed changes to the building standards should be addressed to:

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Nonresidential Outdoor Sources

2022-NR-LIGHT3-F | Nonresidential Lighting | September 2020 FINAL CASE REPORT

Prepared by Clanton & Associates, Energy Solutions,
and TRC Companies, Inc.

Please submit comments to info@title24stakeholders.com.

CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

This report was prepared by the California Statewide Codes and Standards Enhancement (CASE) Program that is funded, in part, by California utility customers under the auspices of the California Public Utilities Commission.

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Executive Summary

This document presents recommended code changes that the California Energy Commission will be considering for adoption in 2021. If you have comments or suggestions prior to the adoption, please email info@title24stakeholders.com. Comments will not be released for public review or will be anonymized if shared.

Introduction

The Codes and Standards Enhancement (CASE) Initiative presents recommendations to support the California Energy Commission's (Energy Commission) efforts to update the California Energy Code (Title 24, Part 6) to include new requirements or to upgrade existing requirements for various technologies. Three California Investor Owned Utilities (IOUs) – Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison – and two Publicly Owned Utilities – Los Angeles Department of Water and Power and Sacramento Municipal Utility District (herein referred to as the Statewide CASE Team when including the CASE Author) – sponsored this effort. The program goal is to prepare and submit proposals that will result in cost-effective enhancements to improve energy efficiency and energy performance in California buildings. This report and the code change proposals presented herein are a part of the effort to develop technical and cost-effectiveness information for proposed requirements on building energy-efficient design practices and technologies.

The Statewide CASE Team submits code change proposals to the Energy Commission, the state agency that has authority to adopt revisions to Title 24, Part 6. The Energy Commission will evaluate proposals submitted by the Statewide CASE Team and other stakeholders. The Energy Commission may revise or reject proposals. See the Energy Commission's 2022 Title 24 website for information about the rulemaking schedule and how to participate in the process: https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2022-building-energy-efficiency.

The overall goal of this CASE Report is to present a code change proposal for nonresidential and multifamily outdoor lighting sources. The report contains pertinent information supporting the code change.

Measure Description

Proposed Submeasure History

The nonresidential lighting zone reclassification proposed submeasure is based on a joint recommendation by the International Dark-Sky Association (IDA) and the Illuminating Engineering Society (IES) to lower outdoor lighting use levels and aims to protect the environment and reduce unnecessary outdoor lighting energy use. Five

lighting zones (LZ0-LZ4) are currently defined in Title 24, Part 6 by using the definitions of rural and urban areas in United States (U.S.) Census. This method has resulted in the misclassification and subsequent over lighting of much of the state. Several cities nationwide have already adopted lighting zone classifications lower than what current code requires, including: Malibu, California; Los Angeles County, California; San Jose, California; and Plymouth, Minnesota.

A recent addendum to IES RP-8-18 (previously published as IES RP-20-14), based in part on research by the Virginia Tech Transportation Institute (VTTI), indicates that visibility improvements in parking lots plateau at lower light levels than those recommended in IES RP-8-18 (Bhagavathula and Gibbons 2019). The proposed changes to the lighting power allowances (LPAs) for general hardscape applications would realign the code language with IES RP-8-18 Chapter 17 Addendum 1.

The multifamily outdoor LPAs submeasure develops several new code sections that would be placed in the multifamily chapter of code being proposed for the Multifamily Chapter Restructuring Final CASE Report.[1] This new chapter is intended only for the multifamily building type and carves this section of coverage away from the current nonresidential chapters of Title 24, Part 6. This measure addresses outdoor lighting needs of multifamily housing and creates limits for outdoor lighting that are more appropriate for residential conditions that are associated with multifamily housing.

Proposed Code Change

All submeasures proposed in this report are intended to be applied through the prescriptive approach to compliance and apply to new construction in California. The nonresidential submeasures also apply to alterations, and additions in California. It should be noted that the determination of lighting zones is found in Section 10-114. However, lighting zones determine which LPAs are applicable, so the Statewide CASE Team still considers this as affecting prescriptive requirements. Both the nonresidential lighting zone reclassification and LPAs for general hardscape submeasures apply to nonresidential buildings only. The multifamily outdoor LPAs submeasure applies to multifamily properties, including those with mixed-use spaces contained within.

The Statewide CASE Team is proposing a lighting zone reclassification that aligns the Statewide default location definitions with the IES/IDA Model Lighting Ordinance land-use based lighting zone classifications. This submeasure continues to use the 2010 U.S. Census population density mapping for the lighting zone determination with a

[1] More information on the Multifamily Chapter Restructuring Final CASE Report can be found here: https://title24stakeholders.com/measures/cycle-2022/multifamily-chapter-restructuring/

revision that would update rural classifications as lighting zone 1 and add urban clusters as the default classification for lighting zone 2.

The general hardscape LPAs are proposed to be revised to align with the IES RP-8-18 Chapter 17 addendum 1. The concrete and asphalt surface distinction would be removed and these LPAs would be reduced to align with the lighting levels IES now recommends for parking lots and general hardscape applications. A new allowance for security cameras is proposed to address stakeholders' concerns for general hardscape areas with security needs.

The multifamily outdoor LPA submeasure develops several new code sections that would be placed in the proposed multifamily chapter of code. This measure addresses outdoor lighting needs of multifamily housing and creates limits for outdoor lighting that are more appropriate for residential conditions that are associated with multifamily housing.

Scope of Code Change Proposal

Table 1 summarizes the scope of the proposed changes and which sections of Standards, Reference Appendices, Alternative Calculation Method (ACM) Reference Manual, and compliance documents that would be modified as a result of the proposed changes.

Table 1: Scope of Code Change Proposal

Measure Name	Type of Requirement	Modified Section(s) of Title 24, Part 6	Modified Title 24, Part 6 Appendices	Would Compliance Software Be Modified	Modified Compliance Document(s)
Nonresidential Lighting Zone Reclassification	Administrative	10-114	N/A	No	N/A
Nonresidential Lighting Power Allowances for General Hardscapes	Prescriptive	100.1, 140.7	N/A	No	NRCC-LTO-E
Multifamily Outdoor Lighting Power Allowances	Mandatory and Prescriptive	130.2, 140.7 (revised and renumbered to be unique for multifamily)	N/A	No	NRCC-LTO-E (revised and renumbered to be unique for multifamily)

Market Analysis and Regulatory Assessment

The proposed code changes in this document are based on an analysis of LED luminaires currently available on the market. The Statewide CASE Team studied 119 different LED products from 58 different manufacturers to develop the LPA adjustments for general hardscape and multifamily. LED lighting technology has significantly advanced within the last decade and is expected to have a 99 percent adoption by 2023 (Goebes 2018).

Due to stakeholder comments about security concerns in general hardscape applications, an additional allowance has been added for security cameras. This adder would allow higher lighting levels for general hardscape applications than those recommended in IES RP-8-18 Addendum 1 and the tenth edition of the IES Handbook. This allowance for higher lighting levels is intended to increase the sense of safety within the space while ensuring that cameras installed in the 2022 code cycle will have sufficient light to identify colors during nighttime hours.

The statewide lighting zone default locations would be updated in Title 24, Part 6 Section 10-114 to align with the IES and IDA lighting zone definitions listed in the Model lighting Ordinance (MLO). In addition, Title 24, Part 6 Section 140.7 would also include LPAs for multifamily dwellings.

Cost Effectiveness

The proposed code changes in this document were found to be cost effective for all climate zones where they are expected to be required. The benefit-to-cost (B/C) ratio compares the benefits or cost savings to the costs over the 15-year period of analysis. Proposed code changes that have a B/C ratio of 1.0 or greater are cost effective. The larger the B/C ratio, the faster the measure pays for itself from energy cost savings.

Lighting zone reclassification: The B/C ratio for this measure is 1.0 since reclassifying the lighting zones to lower lighting zones results in energy savings. See Section 5 for the methodology, assumptions, and results of the cost-effectiveness analysis.

General hardscape LPAs: The B/C ratio for this measure is 1.0 since less lighting equipment is necessary to meet IES RP-8-18 Addendum 1. See Section 5 for the methodology, assumptions, and results of the cost-effectiveness analysis.

Multifamily LPAs: The B/C ratio for this measure is 1.0. See Section 5 for the methodology, assumptions, and results of the cost-effectiveness analysis.

Statewide Energy Impacts: Energy, Water, and Greenhouse Gas (GHG) Emissions Impacts

Table 2 presents the estimated energy and demand impacts of the proposed code change that would be realized statewide during the first 12 months that the 2022 Title 24, Part 6 requirements are in effect. First-year statewide energy impacts are represented by the following metrics: electricity savings in gigawatt-hours per year (GWh/yr), peak electrical demand reduction in megawatts (MW), natural gas savings in million therms per year (MMTherms/yr), and time dependent valuation (TDV) energy savings in kilo British thermal units per year (TDV kBtu/yr). See Section b for more details on the first-year statewide impacts calculated by the Statewide CASE Team. Section 4 contains details on the per-unit energy savings calculated by the Statewide CASE Team.

Table 2: First-Year Statewide Energy and Impacts

Measure	Electricity Savings (GWh/yr)	Peak Electrical Demand Reduction (MW)	Natural Gas Savings (MMTherms/yr)	TDV Energy Savings (TDV kBtu/yr)
LZ Reclassification (Total)	**2.82**	**0.45**	**N/A**	**85,398,407**
New Construction	0.69	0.11	N/A	20,907,735
Additions and Alterations	2.13	0.34	N/A	64,490,672
General Hardscape LPAs (Total)	**24.30**	**3.11**	**N/A**	**725,628,010**
New Construction	5.91	0.76	N/A	176,358,096
Additions and Alterations	18.40	2.35	N/A	549,269,914
Multifamily (Total)	**11.75**	**2.29**	**N/A**	**373,237,000**
New Construction	2.28	0.45	N/A	72,514,000
Additions and Alterations	9.47	1.85	N/A	300,722,000

Table 3 presents the estimated avoided greenhouse gas (GHG) emissions associated with the proposed code change for the first year the standards are in effect. Avoided GHG emissions are measured in metric tons of carbon dioxide equivalent (metric tons CO2e). Assumptions used in developing the GHG savings are provided in Section 6.2 and Appendix C of this report. The monetary value of avoided GHG emissions is included in TDV cost factors and is thus included in the cost-effectiveness analysis.

Table 3: First-Year Statewide GHG Emissions Impacts

Measure	Avoided GHG Emissions (Metric Tons CO2e/yr)	Monetary Value of Avoided GHG Emissions ($2023)
Lighting Zone Reclassification	676.9	71,751
General Hardscape LPAs	5,841.5	619,199
Multifamily	2,812.7	298,146
Total	**9,331.1**	**989,097**

Water and Water Quality Impacts

The proposed measure is not expected to have any impacts on water use or water quality, excluding impacts that occur at power plants.

Compliance and Enforcement

Overview of Compliance Process

The Statewide CASE Team worked with stakeholders to develop a recommended compliance and enforcement process and to identify the impacts this process would have on various market actors. The compliance process is described in Section 2.5. Impacts that the proposed measure would have on market actors is described in Section 3 and Appendix E. Access to measure updates education and information pertaining to updated lighting zones would be needed for successful compliance and enforcement.

Field Verification and Acceptance Testing

No new field verification or acceptance tests beyond those that currently exist would be required, and there are no new system or technology requirements proposed.

1. Introduction

This document presents recommended code changes that the California Energy Commission will be considering for adoption in 2021. If you have comments or suggestions prior to the adoption, please email info@title24stakeholders.com*. Comments will not be released for public review or will be anonymized if shared.*

The Codes and Standards Enhancement (CASE) initiative presents recommendations to support the California Energy Commission's (Energy Commission) efforts to update the California Energy Code (Title 24, Part 6) to include new requirements or to upgrade existing requirements for various technologies. Three California Investor Owned Utilities (IOUs) – Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison – and two Publicly Owned Utilities – Los Angeles Department of Water and Power and Sacramento Municipal Utility District (herein referred to as the Statewide CASE Team when including the CASE Author) – sponsored this effort. The program goal is to prepare and submit proposals that will result in cost-effective enhancements to improve energy efficiency and energy performance in California buildings. This report and the code change proposal presented herein are a part of the effort to develop technical and cost-effectiveness information for proposed requirements on building energy-efficient design practices and technologies.

The Statewide CASE Team submits code change proposals to the Energy Commission, the state agency that has authority to adopt revisions to Title 24, Part 6. The Energy Commission will evaluate proposals submitted by the Statewide CASE Team and other stakeholders. The Energy Commission may revise or reject proposals. See the Energy Commission's 2022 Title 24 website for information about the rulemaking schedule and how to participate in the process: https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2022-building-energy-efficiency.

The overall goal of this CASE Report is to present a code change proposal for nonresidential outdoor lighting sources. The report contains pertinent information supporting the code change.

When developing the code change proposal and associated technical information presented in this report, the Statewide CASE Team worked with a number of industry stakeholders including city planners/officials, building officials, manufacturers, lighting industry associations, lighting designers, energy code analysts, builders, utility incentive program managers, and others involved in the code compliance process. The proposal incorporates feedback received during a public stakeholder workshop that the Statewide CASE Team held on September 5, 2019, and March 3, 2020.

The following is a brief summary of the contents of this report:

- Section 2 – Measure Description of this CASE Report provides information on the proposal. This section also presents a detailed description of how this code change is accomplished in the various sections and documents that make up the Title 24, Part 6 Standards.
- Section 3 – In addition to the Market Analysis, this section includes a review of the current market structure. Section 3.2 describes the feasibility issues associated with the code change, including whether the proposed measure overlaps or conflicts with other portions of the building standards, such as fire, seismic, and other safety standards, and whether technical, compliance, or enforceability challenges exist.
- Section 4 – Energy Savings presents the per-unit energy, demand reduction, and energy cost savings associated with the proposed code change. This section also describes the methodology that the Statewide CASE Team used to estimate per-unit energy, demand reduction, and energy cost savings.
- Section 5 – This section includes a discussion and presents analysis of the materials and labor required to implement the measure and a quantification of the incremental cost. It also includes estimates of incremental maintenance costs, i.e., equipment lifetime and various periodic costs associated with replacement and maintenance during the period of analysis.
- Section 6 – First-Year Statewide Impacts presents the statewide energy savings and environmental impacts of the proposed code change for the first year after the 2022 code takes effect. This includes the amount of energy that would be saved by California building owners and tenants and impacts (increases or reductions) on material. Statewide water consumption impacts are also reported in this section.
- Section 7 – Proposed Revisions to Code Language concludes the report with specific recommendations with ~~strikeout~~ (deletions) and underlined (additions) language for the Standards, Reference Appendices, Alternative Calculation Manual (ACM) Reference Manual, Compliance Manual, and compliance documents.
- Section 8 – Bibliography presents the resources that the Statewide CASE Team used when developing this report.
- Appendix A: Statewide Savings Methodology presents the methodology and assumptions used to calculate statewide energy impacts.
- Appendix B: Embedded Electricity in Water Methodology presents the methodology and assumptions used to calculate the electricity embedded in water use (e.g., electricity used to draw, move, or treat water) and the energy savings resulting from reduced water use.
- Appendix C: Environmental Impacts Methodology presents the assumptions used to calculate impacts on GHG emissions and water use and quality.

- Appendix D: California Building Energy Code Compliance (CBECC) Software Specification presents relevant proposed changes to the compliance software (if any).
- Appendix E: Impacts of Compliance Process on Market Actors presents how the recommended compliance process could impact identified market actors.
- Appendix F: Summary of Stakeholder Engagement documents the efforts made to collaborate with market actors and experts.
- Appendix G: Multifamily Light and Health Topics documents how the proposed submeasure would reduce the impact that light at night has on occupant health.
- Appendix H: Multifamily Prototype Characterization documents how the multifamily outdoor lighting savings calculations are made to translate the NR code to MF-specific limits and also to project the savings state-wide.
- Appendix I: Multifamily Calculation Approach documents the methodology and results for calculations in the multifamily general hardscape lighting power allowance submeasure.
- Appendix J: Lighting Zone Calculations documents the calculations for the lighting zone reclassification submeasure.
- Appendix K: General Hardscape Lighting Power Allowance Calculations documents the calculations for the general hardscape LPA submeasure.
- Appendix L: Mapping of IES Criteria documents the special application LPAs to the recommended IES lighting levels.
- Appendix M: Nonresidential Use Schedules lists the nonresidential lighting scheduled used to develop the nominal and PV TDV values.
- Appendix N: Nominal Cost Savings Tables are included in this section until the 2022 TDV values are released by the Energy Commission.
- Appendix O: Security Camera Technology documents how the proposed security camera additional allowance was developed and the lighting requirements for the products studied.
- Appendix P: Ornamental Hardscape LED Conversion documents the analysis to develop the proposed equivalent LED wattage for the hardscape ornamental lighting wattage limit.

2. Measure Description

2.1 Measure Overview

2.1.1 Nonresidential Lighting Zone Reclassification

The outdoor lighting zone reclassification measure is proposed to align the California lighting zones with current industry standards employed across North America. Currently, lighting zones in California are classified with a United States (U.S.) Census-based approach which dictates lighting zones using the population-based classification of an area as "rural" or "urban". This has resulted in over lighting many areas throughout the state. There are five lighting zones:

- Lighting Zone 0 (LZ0): Includes undeveloped areas with essentially no artificial lighting.
- Lighting Zone 1 (LZ1): Includes developed portions of government designated parks, recreation areas, and wildlife preserves.
- Lighting Zone 2 (LZ2): Is defined as “rural” areas.
- Lighting Zone 3 (LZ3): Is defined as “urban” areas.
- Lighting Zone 4 (LZ4): Includes areas with maximum artificial lighting such as Times Square in New York City. Currently, no areas within California fall under LZ4.

This proposal revisits the current population-based approach and aims to provide more discretized lighting zone applications based on the U.S Census classifications; this would reduce energy use throughout California while minimizing sky glow[2] and light trespass.[3] Specifically, this proposal updates the lighting zone definitions to more closely match the Illuminating Engineering Society’s (IES) lighting zone definitions. The updated definitions would still rely on population density, but would specifically shift “rural” areas from LZ2 to LZ1:

- LZ0: This is unchanged.
- LZ1: Would still include developed portions of government designated parks, recreation areas, and wildlife preserves, but “rural” areas previously part of LZ2

[2] Sky glow is additional brightness in the night sky as a result of light from upward facing electric light sources or reflections off airborne particulates. https://www.lrc.rpi.edu/programs/nlpip/lightinganswers/lightpollution/skyglow.asp

[3] Light trespass is the light from electric sources that is cast where it is unwanted, often due to improper luminaire placement or shielding. https://www.lrc.rpi.edu/programs/nlpip/lightinganswers/lightpollution/lightTrespass.asp

would now be included here, along with residential and agricultural areas. “Rural” is defined as less than 2,500 people per square mile.

- Lighting Zone 2 (LZ2): Was previously “rural” areas but is now “urban cluster” areas as well as mixed use residential, light commercial, and industrial areas. “Urban clusters” are defined as areas with between 2,500 and 50,000 people per square mile.
- Lighting Zone 3 (LZ3): is still defined as “urban” areas, but now specifically includes high intensity commercial, entertainment centers, and heavy industrial and manufacturing. “Urban” areas are defined as greater than 50,000 people per square mile.
- Lighting Zone 4 (LZ4): This is unchanged.

No change to the lighting power allowances (LPAs) associated with the current lighting zones have been proposed; this submeasure simply seeks to reclassify existing areas into more appropriate lighting zones.[4] This proposed change, which would modify Section 10-114, would impact new construction and alterations and additions in California.

A new section would be added to the nonresidential lighting compliance manual to document that luminaires installed on the project meet the backlight, uplight, and glare (BUG) rating requirements listed in Title 24, Part 11 (CALGreen). Luminaires installed within two mounting heights from the property line would be documented to confirm that they meet the CALGreen backlight and glare ratings based on their orientation towards the property lines. This would not result in additional field verification or acceptance tests beyond those that currently exist.

2.1.2 Nonresidential Lighting Power Allowances for General Hardscape

The LPAs for the general hardscape submeasure would update the existing prescriptive requirements for outdoor lighting and would impact new construction, alterations, and additions across California. This submeasure would update the general hardscape LPAs for areas affected by the light level recommendations in the latest version of the IES Recommended Practice (RP) 8-18 Addendum 1 to Chapter 17 (Illuminating Engineering Society 2020). This submeasure incorporates recent research that suggests task visibility plateaus at lower lighting levels than previously recommended,

[4] Compliance with Title 24, Part 6 includes mandatory, prescriptive, and performance pathways; certain sections in Title 24, Part 6 are mandatory to achieve compliance. For non-mandatory sections, users can choose to follow the performance or prescriptive pathway. Specifically, the prescriptive pathway has some flexibility, but essentially prescribes minimum performance and conditions that a building system must meet in order to comply. The performance pathway allows greater flexibility because users simply need to design a building that meets a certain energy budget. However, the performance pathway is not applicable to outdoor lighting.

which prompted IES to revise the parking lot lighting levels to align with those recommended by IES prior to the IES RP-20-14 publication (republished as ANSI/IES RP-8-18 Chapter 17),[5] which increased the recommended lighting levels. The Statewide CASE Team is proposing to reduce the prescriptive exterior lighting LPAs to reflect the revised parking lot lighting level recommendations.

This submeasure also reassesses the need to distinguish between asphalt and concrete surfaces, which currently have different LPA specifications in Title 24, Part 6. The pavement distinction is proposed to be removed from Table 140.7-A to simplify this code measure. The general hardscape LPAs would be updated to reflect luminaires available on the market at the time of analysis. No new field verification or acceptance tests beyond those that currently exist would be required, and the proposal would not result in new system or technology requirements.

This submeasure includes a new lighting allowance for general hardscape applications with security cameras; this would allow for lighting levels in general hardscape applications to be increased to improve the sense of safety within the area. The allowance would also ensure that the minimum illumination requirements of a security camera with color detection capabilities can be achieved during non-occupied times when the lighting levels have been reduced per Title 24, Part 6, Section 130.2. Security camera technology, available in 2019 at the time of this analysis, is capable of functioning in low nighttime lighting conditions to identify people, animals, and objects of concern within the general hardscape area. The Statewide CASE Team's analysis found that the average cameras with color detection capabilities require an average of 0.33 lux at 50 IRE F1.6, to properly identify colors during nighttime lighting levels. Cameras with black and white detection capabilities require less ambient lighting, while cameras with infrared detection do not require any additional lighting. Refer to Appendix O for more information on current security camera technology.

The Statewide CASE Team is also proposing to update the legacy hardscape ornamental lighting 100-watt limit to 50 watts to align with the current LED baseline.

The Statewide CASE Team is also proposing to replace the term "cutoff" with "shielding" in Section 130.2(b). This is not a substantive update, but it is beneficial as it aligns code language with industry terminology.

[5] Parking lot lighting levels previously appeared in the IES RP-20 document and they were increased in RP-20-14. However, a recently published study concluded that those increased lighting levels were not beneficial which prompted IES to revise the parking lot lighting levels and reduce them to light levels that appeared in RP-20 documents prior to RP-20-14. Additionally, IES has compiled many of their recommended practices into one document, including the parking lot lighting levels. This new document is RP-8-18 and the Chapter 17 Addendum 1 includes the new, lower lighting levels for parking lots.

The ornamental hardscape special application listed in Table 140.7-B is proposed to be amended to reflect the 50-watt luminaire qualification incorporated in the 2019 Title 24, Part 6, Section 100.1 definition.

2.1.3 Multifamily Outdoor Lighting Power Allowances

The Energy Commission is considering consolidation of low-rise and high-rise multifamily requirements under a new multifamily section in 2022 Title 24, Part 6. The multifamily outdoor LPAs submeasure proposes new LPAs for several new code sections that would be placed in the multifamily chapter of code being proposed for the Multifamily Chapter Restructuring Final CASE Report. This submeasure creates limits for outdoor lighting that are more appropriate for circumstances and conditions associated with the residential nature of multifamily buildings.

This proposal was developed using a similar method to previous nonresidential outdoor lighting code updates. The current nonresidential LPA requirements are used as a base case for the analyses. The 2019 nonresidential outdoor lighting power allowance CASE Study, which describes the methodology for the 2019 code cycle, is available on the Title24stakeholders.com website (Statewide CASE Team 2017).

The proposed technology level used to establish the 2022 multifamily LPA values is based on luminaires that are cost effective at the time of the analysis. Costs are expected to continue to decline before the effective date of the standards. The efficacies of the products used to develop the 2019 LPAs have been updated for the applications that fall under the scope of Table 140.7-A and Table 140.7-B.

Target illumination levels are based upon current IES RP documents recommended lighting levels that set light level guidelines for outdoor spaces and other industry standards for all target illuminance levels. The same recommend practice documents are employed for both the nonresidential and the multifamily general hardscape allowance calculations. Certain allowances that are currently included in Table 140.7-B are not included in the proposed multifamily allowance tables as the use of these additional allowances are incompatible with multifamily residential environments.

This submeasure also makes a change to the setback requirements for outdoor lighting controls in Section 130.2 to match the IES recommendations for late-night setback design criteria. The current code was established with a 50 percent reduction, but the IES recommendations include a 60 percent reduction from the main criteria levels. This measure incorporates this 60 percent reduction.

The submeasure also simplifies the LPA calculation approach by moving from a three-factor method (area wattage allowance, perimeter wattage allowance, and initial wattage allowance) to a two-factor approach (area wattage allowance and initial wattage allowance). The removal of the perimeter wattage allowance reduces the documentation for the design and code compliance steps and would make the

calculation of the LPA easier and faster to complete. This modification would result in a substantial change in the allowance values included in the LPA table for general hardscape in Table 140.7-A, but would have no impact to the allowance values in the additional allowances Table 140.7-B.

2.2 Measure History

2.2.1 Nonresidential Lighting Zone Reclassification

In 2011, the International Dark-Sky Association (IDA) and IES jointly published a Model Lighting Ordinance (MLO) (Illuminating Engineering Society and International Dark-Sky Association 2011). The Statewide CASE Team aims to align Title 24, Part 6 with this current industry standard for determining appropriate lighting levels for each outdoor application. This proposed submeasure aims to protect the environment through reduction in over lighting outdoor spaces, and reducing electricity used on outdoor lighting.

The definitions of the current lighting zones and the associated LPAs were added to Title 24, Part 6 in the 2005 code cycle using a population-based approach for identifying lighting zones. At that time, four lighting zones (LZ1 through LZ4) were defined using the definitions of rural and urban areas in U.S. Census. An additional zone, LZ0, was added in the 2016 code cycle for nonlighted areas using the same population-based approach for identifying lighting zones. Lighting zone LPAs are based on the recommended lighting levels established in the IES 10th edition handbook (Illuminating Engineering Society 2011). These lighting levels are based on the ambient illumination of surrounding areas; higher lighting zones allow for more installed wattage with the intent that they fall within areas of brighter surroundings. For example, LZ0 has the lowest wattage allowance because it is intended to encompass areas with little to no artificial light, such as national parks. Likewise, LZ4 has the highest wattage allowance and is intended for areas with maximum artificial lighting, such as Times Square in New York City. Currently, no areas in California are classified as LZ4.

Since the current definitions of lighting zones does not match the MLO, many spaces within California are in higher lighting zones than needed. These spaces tend to experience over lighting because the LPAs allow for higher light levels than needed for the specific spaces. For the 2022 code cycle, the Statewide CASE Team was interested in moving towards a land-use approach for the lighting zones due to benefits of reducing over lighting and electricity use. A land-use approach means the lighting zones would be chosen based on the specific activities that would occur in the area. For example, a residential neighborhood in a rural area has low light level needs versus a heavy commercial area or downtown area that requires high light levels to illuminate late night venues. The proposed approach is a more granular population-based approach that captures some of the benefits of a land-use approach, but ultimately is an

intermediate step. The Statewide CASE Team has chosen to continue with the population-based approach because a suitable approach for moving to a land-use approach has not been found for the 2022 code cycle. Specifically, the Statewide CASE Team explored developing a map that compiled municipal zoning requirements and using those zoning requirements as reference points for assigning areas to lighting zones. However, the Statewide CASE Team ran into several issues locating:

- Comprehensive data that could effectively be used to connect lighting zones to land use characteristics.
- Reliable and accurate data that would be easily accessible and understandable by local code officials.
- A data source that would not require significant Energy Commission staff resources to maintain.

The Statewide CASE Team still plans to pursue updating the lighting zones to be based on land-use for a future code cycle. Please see Section 2.5.1 for additional details on compliance and enforcement issues.

The Statewide CASE Team decided to continue with the proposal to better align with the MLO and use a more granular population-based approach since this approach still provides significant energy savings and other non-energy benefits. While the shifts between lighting zones are expected to occur from LZ2 to LZ1, this still represents a significant decrease in over lighting, which helps mitigate sky glow. Similarly, there is a growing body of literature that points to blue-rich light at night disturbing circadian function in people in addition to animals. Even though the shift from LZ2 to LZ1 represents a small portion of buildings (and therefore, people) in California, it is still a large step towards reducing exposure to blue-rich light at night.[6] See Section 6.5 for additional information on non-energy benefits.

2.2.2 Nonresidential Lighting Power Allowances for General Hardscape

During the 2019 code cycle, the Statewide CASE Team proposed lowered LPAs based on increased efficiency in solid state technology, which was ultimately adopted in full by the Energy Commission (Statewide CASE Team 2018). During the 2019 code cycle the

[6] There are multiple strategies for reducing exposure to blue-rich light at night: moving towards light sources that have lower concentrations of blue light; examining the spectral power distribution of selected light sources to ensure lower blue light content at desired correlated color temperature (CCT) (related to first strategy); reducing time spent exposed to artificial light at night; and reducing the total amount of artificial light at night. Lowering lighting zones aligns with the last strategy since the shift to a lower lighting zone represents lower wattage and lower lumen output luminaires that align with IES's lighting level recommendations for spaces with low ambient lighting levels, and therefore would reduce the overall lighting levels that people could be exposed to.

Statewide CASE Team also accounted for IES's increased parking lot lighting recommendations and distinction between surface material. Since the 2019 code was adopted, IES RP-8-18 (previously published as IES RP-20-14) was updated to include research by the Virginia Tech Transportation Institute (VTTI) which found that visibility improvements in parking lots plateau at lower light levels than those recommended in IES RP-8-18 (Bhagavathula and Gibbons 2019). Due to this research, IES published an addendum to IES RP-8-18 Chapter 17 which decreased the recommended lighting levels by 60 percent for asphalt surfaces and 80 percent for concrete surfaces. These lower lighting level recommendations align with the legacy IES RP-20-98 lighting level recommendations. VTTI's research also indicated that the difference in the light level requirements between asphalt and concrete surfaces in parking lots are insignificant. Therefore, this submeasure proposes to remove the distinction between pavement surfaces. This proposal would realign the code language with the 2013 Title 24, Part 6 requirements by removing the distinction between concrete and asphalt. This change would also result in less complex code language – something the Statewide CASE Team is aiming to accomplish across all proposed code changes for the 2022 code cycle to address stakeholders' requests to simplify.

The proposed general hardscape LPAs for the 2022 code cycle would reduce the general hardscape LPAs by approximately 20 percent. This reduction incorporates the 60 percent to 80 percent parking lot lighting level reduction recommended by IES. The Statewide CASE Team is not proposing to reduce the additional allowances in Title 24, Part 6, Table 140.7-B which were developed with less efficacious, 3000K CCT LED light sources readily available in 2016. The proposed general hardscape LPAs would improve energy savings in California since less energy would be required to provide the illumination service recommended for parking lots.

This submeasure also proposes including a new lighting allowance for general hardscape applications with security cameras. While the IES recommended parking lot lighting levels are conservative – a minimum illumination requirement was established throughout the entire parking lot instead of the average illumination level published by VTTI – these minimum illuminance recommendations do not account for security lighting levels. Security cameras in use in 2019 require higher lighting levels than those recommended by IES RP-8-18 Addendum 1 to identify people, animals, and objects of concern within the general hardscape area. Including an additional allowance for security cameras would ensure that current security camera technology can be applied in general hardscape areas with security concerns.

During the 2019 code cycle the hardscape ornamental lighting definition was changed from a 100-watt limit to a 30-watt limit to align with the LED baseline. While this change was incorporated into 2019 Title 24, Part 6, Section 100.1, the change was not incorporated in the lighting allowances for Table 140.7-B. To resolve this discrepancy,

the Statewide CASE Team is proposing to update the wattage limit in Title 24, Part 6, Section 140.7 to the equivalent wattage of a LED luminaire. The Statewide CASE Team has expanded on the 2019 analysis to consider 35 different LED products that have equivalent initial luminaire lumen output of several 100-watt legacy light sources. These legacy light sources include pulse start metal halide, ceramic metal halide, and incandescent lamps. The proposed 50-watt limit for the LED baseline would be updated in both the hardscape ornamental definition in Section 100.1 and the lighting power allowances listed in Section 140.7. The analysis for the proposed 50 watts can be found in Appendix P.

In addition to updating the LPA requirements, the Statewide CASE Team is recommending a language cleanup to replace the term “cutoff” with “shielding” in Section 130.2(b). The purpose of this update is to align language with industry since IES has deprecated the use of “cutoff” over 10 years ago. Additionally, the term “shielding” accounts for the backlight, uplight, and glare produced by a luminaire, whereas, “cutoff” only accounts for uplight. Therefore, using the term “shielding” makes more sense for Section 130.2(b) because this section deals with Backlight, Uplight, and Glare (BUG) requirements. The Statewide CASE Team proposed to update this term during the 45-Day Language review of the 2019 code cycle, but language update came too late in the code cycle to be adopted.

2.2.3 Multifamily Outdoor Lighting Power Allowances

The multifamily outdoor LPA submeasure develops several new code sections that would be placed in the currently unnumbered multifamily chapter of code being proposed for the Multifamily Chapter Restructuring Final CASE Report. This new chapter is intended only for the multifamily building type and carves this section of coverage away from the current nonresidential chapters of Part 6. This submeasure addresses outdoor lighting needs of multifamily housing and creates limits for outdoor lighting that are more appropriate for circumstances and conditions that are associated with the residential nature of multifamily housing.

For the circumstance of multi-use properties, the project would be required to meet the multifamily outdoor lighting code sections even if there are specifically nonresidential interior spaces in the building (that would be employing the nonresidential interior code sections for those spaces). There is no mixed-use circumstance where the nonresidential version of the outdoor lighting code section would apply within a single permitted project. For this reason, the multifamily outdoor lighting code section is identical in structure to the existing nonresidential code section and the primary changes are the elimination or modifications for certain allowances in Table 140.7-B that are incompatible with residential occupancy as they are currently included in the nonresidential section. An additional substantive change is the simplification of the

lighting allowance calculations to eliminate the Linear Wattage Allowance from the calculation process.

The multifamily outdoor LPA submeasure has been part of the nonresidential outdoor lighting section until this code revision (unless the project was very small, in which case it may have been considered residential construction instead).

2.3 Summary of Proposed Changes to Code Documents

2.3.1 Summary of Changes to the Standards

2.3.1.1 Summary of Changes to the Standards – Nonresidential Lighting Zone Reclassification

Section 10-114 – Determination of Outdoor Lighting Zones and Administrative Rules for Use:

The purpose of these changes is to amend Table 10-114-A statewide default locations to align with the MLO land-use classification. The current U.S. census urban classifications have been updated to provide more discrete lighting zones than those defined in the current 'rural' classification for lighting zone 2 by reclassifying 'rural' locations as lighting zone 1 and including a new classification for 'urban clusters' to provide further distinction for the lighting zone 2 default locations. These changes are necessary to align the statewide default locations with current lighting standards to minimize confusion for users, while reducing over lighting in rural areas which can have adverse impacts on the local environment and uses more electricity than necessary.

2.3.1.2 Summary of Changes to the Standards – Nonresidential Lighting Power Allowances for General Hardscape

Section 100.1(b) – Definitions

The purpose of these changes is to align the definitions with current industry standards and practices. The hardscape ornamental definition would be updated to a 50-watt limit to align with the wattage proposed for an LED baseline in Section 140.7. The wattage limit in these two sections was not aligned during the last code cycle which could cause confusion for users. The publication date for the referenced IES documentation will be removed to align with those published in the IES Online Library; this would clarify the definition of three IES documents (the Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products, the American National Standard Practice for Design and Maintenance of Roadway and Parking Facility Lighting, and the Luminaire Classification Systems for Outdoor Luminaires). A new definition for "security camera" is proposed for the new allowance in Section 140.7. These changes are

necessary to provide defensible definitions for the allowances listed in Section 130.2 and Section 140.7.

Section 130.2 – Outdoor Lighting Controls and Equipment

The purpose of this change is to amend Section 130.2(b) to use the term "shielding" instead of "cutoff" to match industry language; "shielding" accounts for the backlight, uplight, and glare produced by the luminaire whereas, "cutoff" only accounts for uplight. This change is necessary to align the code language with the luminaire requirements for backlight, uplight, and glare listed within this section.

Section 140.7 – Prescriptive Requirements for Outdoor Lighting

The purpose of these changes is to amend Table 140.7-A to remove the asphalt/concrete surface distinction and lower LPAs according to the ANSI/IES RP-8-18 Chapter 17 Addendum 1. Table 140.7-B would be amended to reflect the 50-watt hardscape ornamental luminaire qualification defined in Section 100.1 that aligns this section with the new LED baseline implemented during the 2019 code cycle. A new special application allowance for security cameras is proposed for Table 140.7-B to ensure that the lower general hardscape LPAs in Table 140.7-A would not limit the operation of security cameras during nighttime hours. These changes are necessary to align the code with current industry design standards; the changes would also simplify the code for users by consolidating the LPA requirement for various surfaces and aligning this section with the definitions in Section 100.1.

2.3.1.3 Summary of Changes to the Standards – Multifamily Outdoor Lighting Power Allowances

The Energy Commission is considering consolidation of low-rise and high-rise multifamily requirements under a new multifamily section(s) in 2022 Title 24, Part 6. Restructuring the standards for multifamily building may also result in revisions to Reference Appendices, ACM Reference Manuals, compliance manuals, and compliance documents. Location and section numbering of the 2022 standards and supporting documents for multifamily buildings depend on the Energy Commission's approach to and acceptance of a unified multifamily section. For clarity and ease of review, the changes proposed in this CASE Report are demonstrated in terms of the 2019 structure and language.

Section 130.2 – Outdoor Lighting Controls and Equipment

The purpose of these changes is to create a new version of existing nonresidential section in a currently unnumbered section dedicated to the multifamily building type. Additionally, this submeasure would change the

minimum light level setback requirements in Section 130.2(c)3A from 50 percent to 60 percent to match the late night low-activity values as established in the IES design recommendations handbook by the reduction in design criteria for late night parking lots, which is 60 percent for both horizontal illuminance and vertical illuminance.

These changes are necessary to create a new multifamily outdoor lighting controls section that can be suitably tailored to the needs of multifamily housing moving int the future. The intent is to start with the current nonresidential code as the basis and only change those portions that are specifically needed to make it apply better for multifamily housing properties.

Section 140.7 – Prescriptive Requirements for Outdoor Lighting

The purpose of these changes is to create a multifamily housing outdoor lighting section and to simplify the code specifically for multifamily housing projects so that the implementation is easier to achieve. The proposed requirements would create a new version of the existing nonresidential outdoor lighting section with edits dedicated to the multifamily building type. This submeasure would simplify the General Hardscape calculation procedure for multifamily building types and revise the allowances based on multifamily building type conditions by using a two-prong calculation method rather than the current three-prong approach in the current code. This is accomplished by eliminating the perimeter allowance from the calculation and revising the area and initial allowance values to accommodate the changes.

Table 140.7-A requirements would be amended to remove the asphalt/concrete distinction and lower LPAs according to the ANSI/IES RP-8-18 Chapter 17 Addendum 1. LPA values would also be modified based on the improvement of light source efficacy of LED sources. The proposed requirements would amend Table 140.7-B Hardscape Ornamental Lighting definition to reflect the new 50-watt LED baseline and remove some of the “Additional Power Allowances” in Table 140.7-B that permit very high light levels for select retail lighting applications.

These changes are necessary because there are allowances in the nonresidential outdoor lighting section that are inappropriate for use in multifamily housing projects but there is no infrastructure in place to consider the suitability of these allowances in the existing code sections. The changes eliminate these allowances while still permitting all the applications that have been permitted, but with a possible difference in the total allowance for the site under certain circumstances based on the removed allowances in the tables. The creation of a multifamily section in the code permits this introduction of a different outdoor

lighting section that is specifically targeted to multifamily housing needs and conditions.

2.3.2 Summary of Changes to the Reference Appendices

The proposed code change would not modify the structure of Reference Appendices, but the thresholds for lighting setback must be updated in NA 7.8.8 to show the correct level for MF housing.

2.3.3 Summary of Changes to Nonresidential ACM Reference Manual

The proposed code change would not modify the ACM Reference Manual.

2.3.4 Summary of Changes to the Nonresidential Compliance Manual

The proposed code change would modify the following section of the Nonresidential Compliance Manual:

- **Section 1.6 – Mandatory Measures and Compliance Approaches** – The proposed multifamily outdoor LPA measure requires revisions to the existing section, or the creation of a new section for a Multifamily Compliance Manual, based on Section 1.6. If the proposal is accepted, the values in the examples and tables representing General Hardscape LPAs and Specific Application LPAs would be updated to reflect the different allowances associated with the multifamily building type
- **Section 6.3 – Outdoor Lighting Zones** – This section would be updated to reflect the updated lighting zone definitions as well as default lighting zones. Luminaire BUG ratings would be added to the Compliance Manual for engineers and designers to document that the luminaires meet the CALGreen BUG ratings for luminaires installed within two mounting heights of the adjacent property lines.
- **Section 6.4 – Mandatory Requirements** – This section would be updated to switch luminaire “cutoff” requirements to luminaire “shielding” requirements per the updated language that aims to align with industry.
- **Section 6.5 – Prescriptive Measures** – This section would be updated with the LPAs developed for General Hardscape. Likewise, the new security camera LPA would need to be inserted. This would likely be inserted into Section 6.5.2.

  See Section 7.5 of this report for the detailed proposed revisions to the text of the compliance manuals.

2.3.5 Summary of Changes to Multifamily Compliance Documents

The proposed code changes would modify the compliance documents listed below. Examples of the revised documents are presented in Section 7.6.

- **NRCC-LTO-E – Section G (all measures)** – This section would change the term “cutoff” to “shielded” to align with current industry standards.

- **NRCC-LTO-E – Section G (all measures)** – This section would create a new section (G2 or re-number the sections to accommodate) provide documentation that every fixture type on the property that is less than two mounting heights from the property line must be documented in Backlight and Glare ratings must be verified depending on the orientation. It would also check the conditions of each luminaire type that is nearest to the property line in this section. *(for example: there is a Type A fixture and a Type A2 fixture, which has backlight control, but the Type A is only found in the internal portions of the site (greater than two mounting heights). The Type A does not need to be verified for the property line restrictions, but the Type A2 must be checked with a second verification for the fixture that is the nearest to the property line. If this fixture passes, then it meets the BUG limits.)*
- **NRCC-LTO-01-E** – (**nonresidential lighting zone reclassification submeasure)** – This section would revise this document to account for new lighting zone definitions.
- **NRCC-LTO-03-E** – **(nonresidential lighting power allowances for general hardscape submeasure)** – This section would revise the document to account for updated LPAs for general hardscape and the additional wattage allowance per square foot of specific area for security cameras.
- **NRCC-LTO-E** – **(multifamily outdoor LPA submeasure)** – This section would duplicate and revise this document to include proper references to the new multifamily standards, once numbered and ensure that all the proper values are set for the compliance calculations based on the multifamily code sections.
- **NRCC-LTO-E** – **Section I (multifamily outdoor LPA submeasure)** – This section would revise the new multifamily compliance document to account for updated multifamily LPA values in Table 140.7-A General Hardscape for the change to a two-prong calculation approach and to update the document with correct code section cross-referencing.
- **NRCC-LTO-E** – **Section J, K and L (multifamily outdoor LPA submeasure)** – This section would revise the new multifamily compliance document to account for updated new code sections for multifamily buildings. Eliminate all references to “Additional Allowances” that are not permitted in the multifamily building type category. The existing nonresidential outdoor lighting compliance document (NRCC-LTO-E) would remain, but specific language should be inserted specifying that the document is not appropriate for multifamily building type projects.

2.4 Regulatory Context

2.4.1 Existing Requirements in the California Energy Code

Exterior lighting power is already regulated in Title 24, Part 6. This code change increases stringency of existing exterior LPAs in Title 24, Part 6. Current requirements for lighting zone classification in Title 24, Part 6 exist in Section 10-114, which describes

the lighting zones defined in California and the classification methodology. LPAs for general hardscapes exist in Section 140.7 of Title 24, Part 6. Section 10-114 of Title 24, Part 6 applies to new construction, alterations and additions for both nonresidential and multifamily spaces. Section 140.7 of Title 24, Part 6 apply to new construction, alterations and additions for nonresidential spaces; the new multifamily section would similarly apply to the new construction, alterations and additions for multifamily spaces. These CASE proposal measures do not overlap with other CASE proposals during this code cycle.

2.4.2 Relationship to Requirements in Other Parts of the California Building Code

The California Green Building Standards (CALGreen, or Title 24, Part 11) includes mandatory BUG rating requirements. Products selected for installation must meet the BUG rating requirements for the location when the products are installed as specified in Table 5.106.8 of CALGreen. Title 24, Part 6 refers to the CALGreen requirements to help inform code users that they must adhere to requirements in CALGreen and Title 24, Part 6.

2.4.3 Relationship to Local, State, or Federal Laws

There are existing Title 20 California Appliance Efficiency Regulations and federal standards for outdoor lighting products. This proposal does not set efficiency requirements for individual lighting products. Title 20 lighting measures do not overlap with these proposed measures other than to impact the minimum efficacy of some products that may be selected.

Adjusting lighting zones has gained traction with a few municipalities both inside and outside of California. Specifically, the City of Malibu, California; San Jose, California; Los Angeles County, California; and Plymouth, Minnesota have all switched from higher to lower lighting zones.[7] While this represents a small portion of cities and population, a few other municipalities, such as the City of Santa Cruz, California, are also considering a similar switch in lighting zones.

2.4.4 Relationship to Industry Standards

The proposed lighting zone reclassification more closely aligns the current lighting zone definitions with the recommendations from the IES/IDA MLO along with IES RP-33-14 *Lighting for Exterior Environments.*

The proposed nonresidential parking lot LPA values were developed using IES RP-8-18 Chapter 17 Addendum 1 recommended light levels as the basis of design. Refer to

[7] More information can be found on each city's respective website.

Appendix L for the mapping of IES design criteria to the LPA allowance tables. The proposed parking lot lighting levels for nonresidential and multifamily measures also consider security camera technology requirements not described in IES RP-8-18 Chapter 17.

2.5 Compliance and Enforcement

When developing this proposal, the Statewide CASE Team considered methods to streamline the compliance and enforcement process and reduce negative impacts on market actors who are involved. This section describes how to comply with the proposed code change and the compliance verification process. Appendix E presents how the proposed changes could impact various market actors.

The activities that need to occur during each phase of the project are described below:

2.5.1 Nonresidential Lighting Zone Reclassification

- **Design Phase:** Designers would still determine the applicable lighting zone based on the population density of the project area as defined by the 2010 U.S. Census, unless the local agency has defined alternative lighting zones classifications, in which case the local agency's lighting zone classifications shall take precedence. Users would be able to refer to the U.S. Census, in the same manner as the current code, to determine the population density of the project address.[8] Changes would be made to the applicable compliance documents, but the same forms would still apply. The main change is areas defined as "rural" would now be LZ1 instead of LZ2. LZ2 is now defined as "urban cluster" areas.
- **Permit Application Phase:** Plans examiners would still verify the lighting zone was correctly determined and wattage allowances comply with the revised requirements.
- **Construction Phase:** Contractors would still verify that the installed lighting equipment complies with the lighting zone requirements in the same manner as the current code.

[8] The compliance manual outlines the process for determining lighting zones. A user simply needs to use the link provided in the compliance manual which directs them to U.S. Census data where they can input their address. Once the address has been inputted, the database tells the user whether they fall under a "rural" or "urban" area which is their indicator of their specific lighting zone. The only substantive change being proposed by the Statewide CASE Team is the distinction that "urban cluster" is for LZ2. The Statewide CASE Team does plan to update language in the compliance manual to note this as well as make the process easier to understand. The following is the link provided by the compliance manual to the U.S. Census database: https://ww2.energy.ca.gov/2018publications/CEC-400-2018-018/chapters/06_OutdoorLighting.pdf

- **Inspection Phase:** Inspectors would still verify that the installed lighting equipment complies with the lighting zone requirements in the same manner as the current code.

2.5.2 Nonresidential Lighting Power Allowances for General Hardscape

- **Design Phase:** Lighting designers and energy consultants would use the appropriate lighting zone (determined from the population density of the project address) to calculate the applicable wattage allowance to design and document the outdoor lighting design as being compliant to code. There would no longer be different LPAs depending on whether the surface is asphalt or concrete, which reduces complexity and improves compliance by making it easier to select the appropriate LPA. Designers and consultants must verify if they are allotted the additional allowance for security cameras.
- **Permit Application Phase:** Plans examiners would still verify the wattage allowances are complying with the revised requirements.
- **Construction Phase:** Contractors would still verify that the installed lighting equipment complies with the LPA requirements in the same manner as the current code.
- **Inspection Phase**: Inspectors would still verify that the installed lighting equipment complies with the LPA requirements in the same manner as the current code. The proposed code change would require a security camera allowance to be included in the existing compliance documentation for the security camera LPA. The method of compliance verification and enforcement for this special category would not require changes.

2.5.3 Multifamily Outdoor Lighting Power Allowances

- **Design Phase:** Lighting designers and energy consultants would use the appropriate lighting zone as determined from the revised lighting zone classifications and the tables in Section 140.7 (to be renumbered for the new multifamily sections) to calculate the wattage allowance to design and document outdoor lighting design as being compliant to code. Similarly, the designers/energy consultants would consult Section 130.2 to design the outdoor lighting controls for the project.
- **Permit Application Phase:** Plans examiners would still verify the wattage allowances comply with the new multifamily outdoor LPA requirements in the same manner as the current code.
- **Construction Phase:** Contractors would still verify that the installed lighting equipment complies with the new multifamily outdoor LPA requirements in the same manner as the current code.
- **Inspection Phase:** Inspectors would still verify that the installed lighting equipment complies with the lighting zone requirements in the same manner as the current code.

Appendix E presents a description of how the proposed code changes could impact various market actors.

3. Market Analysis

3.1 Market Structure

The Statewide CASE Team performed a market analysis with the goals of identifying current technology availability, current product availability, and market trends. It then considered how the proposed standard may impact the market in general as well as individual market actors. Information was gathered about the incremental cost of complying with the proposed measure. Estimates of market size and measure applicability were identified through research and outreach with stakeholders including utility program staff, Energy Commission staff, and a wide range of industry actors. In addition to conducting personalized outreach, the Statewide CASE Team discussed the current market structure and potential market barriers during public stakeholder meetings that the Statewide CASE Team held on September 5, 2019, and March 3, 2020.

3.2 Technical Feasibility, Market Availability, and Current Practices

3.2.1 Nonresidential Lighting Zone Reclassification

The Statewide CASE Team faced a number of challenges while trying to develop a methodology for using a land-use approach for the lighting zone update, including finding a comprehensive data source that is: reliable, easily accessible, and can effectively be used to connect lighting zones to land use characteristics. The original intent of the proposal was to fully connect lighting zones to land use, but the Statewide CASE Team pivoted to continue with a population-based approach due to these issues. Despite continuing with a population-based approach, the updated lighting zone definitions align with the MLO and easily allow for Title 24, Part 6 to be updated again for a land-use approach in a later code cycle. The Statewide CASE Team will continue researching for a way to implement a land-use approach. Please see more details in Section 2.2.1.

The current lighting zone classifications defaults all “rural” areas as LZ2 and all “urban” areas as LZ3. The proposed update switches these defaults to more closely align with the IES/IDA MLO so “rural” would be LZ1, “urban clusters” would be LZ2, and “urban” would be LZ3. Per Section 110-14, local jurisdictions can designate areas to a lower lighting zone without any size limit to align with the current MLO land-use definitions, but this requires a public process and detailed information needs to be submitted to the Energy Commission. This proposal automatically shifts some of the current LZ2 areas to LZ1 as well as updates the lighting zone definitions to align with the MLO land-use definitions. Local jurisdictions can also designate areas to a higher lighting zone, which requires the same public process for moving to a lower lighting zone.

The Statewide CASE Team expects there to be no technical feasibility challenges for lighting zone reclassification. Products from 58 different manufacturers were studied to ensure that products are currently available on the market and could meet the wattage requirements and other lighting needs for all lighting zones. Additionally, moving from higher to lower lighting zones represents a reduction in LPAs for areas encompassed within the lighting zone. Tables 140.7-A and 140.7-B in Title 24, Part 6 both split the LPAs for general hardscape and specific applications by lighting zone, with the lower lighting zones having lower LPAs and the higher lighting zones having higher LPAs.

3.2.2 Lighting Power Allowances for General Hardscape

Recent outdoor lighting market trends are showing that lower (warmer) correlated color temperatures (CCTs) are being installed in outdoor environments. These lower CCTs encompass 2700K CCT and 3000K CCT light sources, which are slightly less efficacious than their higher “cooler” counterparts (4000K CCT or greater). When completing the outdoor lighting analysis, the Statewide CASE Team only considered LED luminaires with either 3000K or 2700K CCT to ensure that the proposed LPA reductions can be met with less efficacious LED products. Most manufacturers provide lower CCTs with LED products by increasing the yellow phosphor coating over the blue LED pump, to convert the blue light source to a board band spectrum light source. As more phosphor is layered over a blue LED chip, the LED efficacy decreases. The Statewide CASE Team studied 49 different LED area lights that could be installed in a general hardscape area to ensure that the proposed LPAs could be met with products currently available. This code does not establish the use of specific color temperatures.

The market continues to make incremental improvements in LED efficacy, LED board technology, optical design, driver capabilities, and cost reductions. This has led to LEDs quickly becoming the standard for many applications, with nearly full LED adoption (99 percent) expected by 2023, and a very high 98 percent or greater of the market by 2020 (Goebes 2018).

Stakeholders have brought up concerns that the reduction of lighting levels for general hardscape applications could cause increased security concerns. An additional LPA has been proposed to ensure that increased lighting levels can be applied for areas with security concerns. Security cameras are being installed in many of these areas to monitor activity within the space. Current camera technology requires an average of 0.33 lux at 50 IRE F1.6, within the camera’s field of view for color identification, which is less light than minimum lighting level recommendations in IES RP-8-18. When the lighting level falls below those required for color detection, the cameras will capture images in black and white. Current camera technology is commonly equipped with infrared imaging which allows the camera to detect people, animals, and objects in the absence of exterior lighting. This additional LPA is for a specific application and therefore, has been added to Table 140.7-B. Stakeholders also noted that the general

hardscape LPA should be updated to account for general hardscape both with and without parking lots. The Statewide CASE Team agrees, however, this feedback was received shortly before the release of the Final CASE Report, so the Statewide CASE Team is considering this update for a proposal in a future code cycle.

3.2.3 Multifamily Outdoor Lighting Power Allowances

The lighting equipment used for multifamily outdoor lighting is identical to that used for nonresidential outdoor lighting in general, although there is typically a lower limit to normally specified wattage, pole heights, and other similar design aspects because the properties are commonly smaller and less commercial in function.

Because there is a not a significant difference in the light source technology, the same conditions described above for the lighting power allowances for general hardscape (Section 3.2.2) applies for this submeasure as well.

3.3 Market Impacts and Economic Assessments

3.3.1 Impact on Builders

Builders of residential and commercial structures are directly impacted by many of the measures proposed by the Statewide CASE Team for the 2022 code cycle. It is within the normal practices of these businesses to adjust their building practices to changes in building codes. When necessary, builders engage in continuing education and training in order to remain compliant with changes to design practices and building codes.

California's construction industry is comprised of about 80,000 business establishments and 860,000 employees (see Table 4).[9] In 2018, total payroll was $80 billion. Nearly 60,000 of these business establishments and 420,000 employees are engaged in the residential building sector, while another 17,000 establishments and 344,000 employees focus on the commercial sector. The remainder of establishments and employees work in industrial, utilities, infrastructure, and other heavy construction (industrial sector).

[9] Average total monthly employment in California in 2018 was 18.6 million; the construction industry represented 4.5 percent of 2018 employment.

Table 4: California Construction Industry, Establishments, Employment, and Payroll

Construction Sectors	Establishments	Employment	Annual Payroll (billions $)
Commercial	**17,273**	**343,513**	**$27.8**
Commercial Building Construction	4,508	75,558	$6.9
Foundation, Structure, & Building Exterior	2,153	53,531	$3.7
Building Equipment Contractors	6,015	128,812	$10.9
Building Finishing Contractors	4,597	85,612	$6.2

Source: (State of California, Employment Development Department n.d.)

Table 5: Specific Subsectors of the California Commercial Building Industry Impacted by Proposed Change to Code/Standard

Construction Subsector	Establishments	Employment	Annual Payroll (billions $)
Commercial Building Construction	4,508	75,558	$7.0
Nonresidential poured foundation contractors	504	14,917	$1.1
Nonresidential Masonry Contractors	254	5,121	$0.3
Other Nonresidential exterior contractors	277	2,879	$0.2
Nonresidential Electrical Contractors	3,115	66,951	$5.6
Nonresidential plumbing and HVAC contractors	2,394	52,977	$4.5
Other Nonresidential equipment contractors	506	8,884	$0.9
Nonresidential site preparation contractors	1,157	17,059	$1.3
All other Nonresidential trade contractors	988	17,960	$1.4

Source: (State of California, Employment Development Department n.d.)

The lighting zone reclassification submeasure would require that builders familiarize themselves with the updated population density-based lighting zone classification specific to the area that the building is located within to ensure compliance with the mandatory backlight, uplight, and glare (BUG) ratings listed in California's mandatory green building standards, Title 24, Part 11 (otherwise known as CALGreen) Table 5.106.8, for luminaires with 6,200 initial luminaire lumens or greater.[10]

[10] Table 5.106.8 in CALGreen can be found here: https://codes.iccsafe.org/content/CGBC2019P3/chapter-5-nonresidential-mandatory-measures

The general hardscape LPA submeasure would require builders to apply the new LPA and consider the potential security camera adder for the general hardscape areas. The proposal includes a simplification in the LPAs by removing the surface material distinction for the general hardscape LPAs.

The multifamily outdoor LPA submeasure would require multifamily builders to apply the new standards instead of the previously applied nonresidential outdoor LPA rules. The new multifamily standards are adapted from the existing nonresidential standards. The proposal includes a simplification in the calculation procedures, and the changes are expected to result in minimal negative impacts on builders.

3.3.2 Impact on Building Designers and Energy Consultants

Adjusting design practices to comply with changing building codes practices is within the normal practices of building designers. Building codes (including Title 24, Part 6) are typically updated on a three-year revision cycle and building designers and energy consultants engage in continuing education and training in order to remain compliant with changes to design practices and building codes.

The lighting zone reclassification would require building designers to familiarize themselves with the updated population density-based lighting zone classification specific to the area that the building is located. Designers would be required to ensure luminaires with 6,200 initial luminaire lumens or greater comply with the BUG rating requirements for lower lighting zones that listed in CALGreen Table 5.106.8.

The removal of asphalt and concrete pavement classifications within Table 140.7-A would simplify the code compliance documentation. Designers and energy consultants must ensure that each design meets the reduced LPAs in Table 140.7-A.

The multifamily outdoor LPA submeasure would similarly remove the asphalt and concrete pavement classifications within the 2022 version of Table 140.7-A (currently unnumbered as it would be in the new section) to simplify the calculation and documentation of the allowance. Additionally, this measure would move to a two-factor LPA allowance calculation approach for General Hardscape, which would further lower the complexity of the calculations.

There is not a North American Industry Classification System (NAICS)[11] code specific for energy consultants. Instead, businesses that focus on consulting related to building

[11] NAICS is the standard used by federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy. NAICS was development jointly by the U.S. Economic Classification Policy Committee (ECPC), Statistics Canada, and Mexico's Instituto Nacional de Estadistica y Geografia, to allow for a high level of

energy efficiency are contained in the Building Inspection Services sector (NAICS 541350), which is comprised of firms primarily engaged in the physical inspection of residential and nonresidential buildings.[12] It is not possible to determine which business establishments within the Building Inspection Services sector are focused on energy efficiency consulting. The information shown in Table 6 provides an upper bound indication of the size of this sector in California.

Table 6: California Building Designer and Energy Consultant Sectors

Sector	Establishments	Employment	Annual Payroll (billions $)
Architectural Services [a]	3,704	29,611	$2.9
Building Inspection Services [b]	824	3,145	$0.2

Source: (State of California, Employment Development Department n.d.)

a. Architectural Services (NAICS 541310) comprises private-sector establishments primarily engaged in planning and designing residential, institutional, leisure, commercial, and industrial buildings and structures;
b. Building Inspection Services (NAICS 541350) comprises private-sector establishments primarily engaged in providing building (residential & nonresidential) inspection services encompassing all aspects of the building structure and component systems, including energy efficiency inspection services.

3.3.3 Impact on Occupational Safety and Health

The recommended parking lot lighting level reduction established in IES RP-8-18 Chapter 17 Addendum 1 is not intended for parking lots with a need for higher security lighting levels. To ensure that parking lots with security concerns – such as hospitals, law enforcement facilities, or other facilities with additional security concerns that require camera technology capable of facial identification within the hardscape area – can install lighting to meet a horizontal average of 3 fc throughout the parking lot.

comparability in business statistics among the North American countries. NAICS replaced the Standard Industrial Classification (SIC) system in 1997.

[12] Establishments in this sector include businesses primarily engaged in evaluating a building's structure and component systems and includes energy efficiency inspection services and home inspection services. This sector does not include establishments primarily engaged in providing inspections for pests, hazardous wastes or other environmental contaminates, nor does it include state and local government entities that focus on building or energy code compliance/enforcement of building codes and regulations.

The selected luminaires are still required to comply with the BUG ratings listed in CALGreen Table 5.106.8 for luminaires with 6,200 initial luminaire lumens or greater. The reclassification of ‘rural’ areas into both ‘rural’ areas and ‘urban clusters’ would align the lighting requirements with more appropriate quantities of lighting in the nighttime environment within these areas. Reducing the quantity of unnecessary light at night would provide positive impacts to the human circadian rhythm, reduce air pollution, and protect local flora and fauna. Refer to Section 6.5 for more information.

3.3.4 Impact on Building Owners and Occupants (Including Homeowners and Potential First-Time Homeowners)

Commercial Buildings

The commercial building sector includes a wide array of building types, including offices, restaurants and lodging, retail, and mixed-use establishments, and warehouses (including refrigerated) (Kenney 2019). Energy use by occupants of commercial buildings also varies considerably with electricity used primarily for lighting, space cooling and conditioning, and refrigeration. Natural gas consumed primarily for heating water and for space heating. According to information published in the 2019 California Energy Efficiency Action Plan, there is more than 7.5 billion square feet of commercial floor space in California and consumes 19 percent of California’s total annual energy use (Kenney 2019). The diversity of building and business types within this sector creates a challenge for disseminating information on energy and water efficiency solutions, as does the variability in sophistication of building owners and the relationships between building owners and occupants.

Residential Buildings

According to data from the U.S. Census, American Community Survey (ACS), there were nearly 14.3 million housing units in California in 2018 and nearly 13.1 million were occupied (see Table 7). Most housing units (nearly 9.2 million were single-family homes (either detached or attached), while about 2 million homes were in building containing two to nine units and 2.5 million were in multi-family building containing 10 or more units. The U.S. Census reported that 59,200 single-family and 50,700 multifamily homes were constructed in 2019.

Table 7: California Housing Characteristics

Housing Measure	Estimate
Total housing units	14,277,867
Occupied housing units	13,072,122
Vacant housing units	1,205,745
Homeowner vacancy rate	1.2%
Rental vacancy rate	4.0%
Units in Structure	**Estimate**
1-unit, detached	8,177,141
1-unit, attached	1,014,941
2 units	358,619
3 or 4 units	783,963
5 to 9 units	874,649
10 to 19 units	742,139
20 or more units	1,787,812
Mobile home, RV, etc.	538,603

Source: (2018 American Community Survey n.d.)

Table 8 shows the distribution of California homes by vintage. About 15 percent of California homes were built in 2000 or later and another 11 percent built between 1990 and 1999. The majority of California's existing housing stock (8.5 million homes – 59 percent of the total) were built between 1950 and 1989, a period of rapid population and economic growth in California. Finally, about 2.1 million homes in California were built before 1950. According to Kenney et al, 2019, more than half of California's existing multifamily buildings (those with five or more units) were constructed before 1978 when there no building energy efficiency standards (Kenney 2019).

Table 8: Distribution of California Housing by Vintage

Home Vintage	Units	Percent	Cumulative Percent
Built 2014 or later	343,448	2.4%	2.4%
Built 2010 to 2013	248,659	1.7%	4.1%
Built 2000 to 2009	1,553,769	10.9%	15.0%
Built 1990 to 1999	1,561,579	10.9%	26.0%
Built 1980 to 1989	2,118,545	14.8%	40.8%
Built 1970 to 1979	2,512,178	17.6%	58.4%
Built 1960 to 1969	1,925,945	13.5%	71.9%
Built 1950 to 1959	1,896,629	13.3%	85.2%
Built 1940 to 1949	817,270	5.7%	90.9%
Built 1939 or earlier	1,299,845	9.1%	100.0%
Total housing units	**14,277,867**	**100%**	

Source: (2018 American Community Survey n.d.)

Table 9 shows the distribution of owner- and renter-occupied housing by household income. Overall, about 55 percent of California housing is owner-occupied and the rate of owner-occupancy generally increases with household income. The owner-occupancy rate for households with income below $50,000 is only 37 percent, whereas the owner occupancy rate is 72 percent for households earning $100,000 or more.

Table 9: Owner- and Renter-Occupied Housing Units in California by Income

Household Income	Total	Owner Occupied	Renter Occupied
Less than $5,000	391,235	129,078	262,157
$5,000 to $9,999	279,442	86,334	193,108
$10,000 to $14,999	515,804	143,001	372,803
$15,000 to $19,999	456,076	156,790	299,286
$20,000 to $24,999	520,133	187,578	332,555
$25,000 to $34,999	943,783	370,939	572,844
$35,000 to $49,999	1,362,459	590,325	772,134
$50,000 to $74,999	2,044,663	1,018,107	1,026,556
$75,000 to $99,999	1,601,641	922,609	679,032
$100,000 to $149,999	2,176,125	1,429,227	746,898
$150,000 or more	2,780,761	2,131,676	649,085
Total Housing Units	**13,072,122**	**7,165,664**	**5,906,458**
Median household income	**$75,277**	**$99,245**	**$52,348**

Source: (2018 American Community Survey n.d.)

Understanding the distribution of California residents by home type, home vintage, and household income is critical for developing meaningful estimates of the economic impacts associated with proposed code changes affecting residents. Many proposed code changes specifically target single-family or multi-family residences and so the

counts of housing units by building type shown in Table 7 provides the information necessary to quantify the magnitude of potential impacts. Likewise, impacts may differ for owners and renters, by home vintage, and by household income, information provided in Table 8 and Table 9.

Estimating Impacts

All three submeasures discussed in this report may indirectly impact tenants or owners in a positive way. The elimination of certain retail lighting allowances for multifamily, lowering of outdoor lighting levels in parking lots, and the reclassification of lighting zones could result in lower outdoor light levels on some properties (but still meeting the accepted guidelines for safety and security). The lower light levels and potentially lower light source wattage would likely result in reductions in the amount of light trespass that is experienced by the tenants, especially on lower floors of multifamily buildings and in adjacent properties. This change is an improvement in the overall lighting quality and visual environment experienced by building tenants and owners.

3.3.5 Impact on Building Component Retailers (Including Manufacturers and Distributors)

The lighting zone reclassification would prevent lighting manufacturers and distributors from selling products with high BUG ratings that do not meet the mandatory rating requirements listed in CALGreen Table 5.106.8 for luminaires with 6,200 initial luminaire lumens or greater. This is anticipated to have a minor impact within the industry. Over 75 percent of the 364 luminaires studied have less than 6,200 initial luminaire lumens and are not required to be compliant with the CALGreen Table 5.106.8 BUG ratings. Of the 364 products studied, 347 had BUG ratings that meet the LZ3 BUG rating allowances for a luminaire mounted more than two mounting heights away from a property line.

The updated LPA requirements align with current lighting products available on the market offered by all the 58 different manufacturers studied. The updated LPAs are anticipated to have no impact on the current LED luminaire offers provided by lighting manufactures.

3.3.6 Impact on Building Inspectors

Table 10 shows employment and payroll information for state and local government agencies in which many inspectors of residential and commercial buildings are employed. Building inspectors participate in continuing training to stay current on all aspects of building regulations, including energy efficiency. The Statewide CASE Team, therefore, anticipates the proposed change would have no impact on employment of building inspectors or the scope of their role conducting energy efficiency inspections.

Table 10: Employment in California State and Government Agencies with Building Inspectors

Sector	Govt.	Establishments	Employment	Annual Payroll (millions $)
Administration of Housing Programs[a]	State	17	283	$29.0
	Local	36	2,882	$205.7
Urban and Rural Development Admin[b]	State	35	552	$48.2
	Local	52	2,446	$186.6

Source: (State of California, Employment Development Department n.d.)

a. Administration of Housing Programs (NAICS 925110) comprises government establishments primarily engaged in the administration and planning of housing programs, including building codes and standards, housing authorities, and housing programs, planning, and development.
b. Urban and Rural Development Administration (NAICS 925120) comprises government establishments primarily engaged in the administration and planning of the development of urban and rural areas. Included in this industry are government zoning boards and commissions.

The lighting zone reclassification would require that building inspectors familiarize themselves with the updated lighting zones to ensure that the lighting power density is appropriate for the project location.

The removal of asphalt and concrete pavement classifications within Table 140.7-A would simplify building inspections. Inspectors would no longer be required to confirm that the site meets the appropriate LPAs for each pavement type.

If the security camera specific application additional LPA is used, building inspectors would be responsible for confirming that the space meets the total outdoor LPA.

3.3.7 Impact on Statewide Employment

As described in Sections 3.3.1 through 3.3.6, the Statewide CASE Team does not anticipate significant employment or financial impacts to any particular sector of the California economy. This is not to say that the proposed change would not have modest impacts on employment in California. In Section 3.4, the Statewide CASE Team estimated how the proposed change in the lighting zone reclassification and LPAs for general hardscape would affect statewide employment and economic output directly and indirectly through its impact on builders, designers and energy consultants, and building inspectors. In addition, the Statewide CASE Team estimated how energy savings associated with the proposed change in the lighting zone reclassification and LPAs for general hardscape would lead to modest ongoing financial savings for California residents, which would then be available for other economic activities.

3.4 Economic Impacts

Adoption of this code change proposal would result in relatively modest economic impacts through the reduction in direct spending by those in the commercial building industry, architects, energy consultants, and building inspectors. The Statewide CASE Team does not anticipate that money saved by commercial building owners or other organizations affected by the proposed 2022 code cycle regulations would result in additional spending by those businesses.

Economic impact estimates for nonresidential lighting and multifamily measures are estimated from material and labor cost savings from equipment not installed due to LPA reductions. LPA reductions result in the need of fewer poles and luminaires, resulting in a negative incremental cost for this measure. The luminaire and pole reductions were calculated by evaluating 12 site layouts for each designated lot size, large, medium, and small, resulting in the analysis of 36 layouts. Pole and luminaire count for the base case and proposed case were compared to determine equipment reductions for each lot size. For assumptions and analysis on luminaire and pole reduction, see Section 6.4, Statewide Material Impacts. Note, multifamily projects are assumed to only have small and medium lot sizes, at 50 percent weighting for each lot size. The installation of each pole is estimated to require 4.73 hours of general contractor labor and 10 hours of electrician labor. The installation of each luminaire is estimated to require 0.5 hours of electrician labor.

Note, typically economic impacts are estimated based on an Evergreen Economics analysis of IMPLAN V3.1 modeling software. Due to negative incremental costs, which are not supported in the software, economic impacts are instead calculated based on a direct reduction of labor hours, results found in Table 11. Labor rates are the fully loaded costs present in the IMPLAN software: Construction Laborers (SOC[13]: 472061): $72/hour, Electricians (472111): $107/hour.

[13] SOC code: Standard Occupational Classification code -- see http://www.bls.gov/soc/home.htm

Table 11: Estimated Impact that the Adoption of the Proposed Measures Would Have On The California Commercial Construction Sector

Measure	Job Type	Per Unit Labor Hours Reduction (labor hours / sf)	Statewide Labor Reduction (hours)	Full Time Equivalent (2000 hours)	Labor Rate ($/hour)	Statewide Labor Cost Reduction (millions $)
Non-Res. Outdoor LPA General Hardscape	General Contractor	2.02×10^{-3}	253,883	126.94	$72	$18.3
	Electrician	4.49×10^{-3}	562,858	281.43	$107	$60.2
	Total	**NA**	**816,741**	**408.37**	**NA**	**$78.5**
Multifamily	General Contractor	2.3×10^{-3}	53,458	26.73	$72	$3.9
	Electrician	4.9×10^{-3}	116,932	58.47	$107	$12.5
	Total	**NA**	**170,391**	**85.20**	**NA**	**$16.4**
All Measures	General Contractor	NA	307,341	143.66	$72	$22.1
	Electrician	NA	679,790	228.86	$107	$72.7
	Total	**NA**	**987,132**	**372.52**	**NA**	**$94.9**

The multifamily measure is not anticipated to have impacts on building designers, energy consultants, or inspectors. All building designer impacts are estimated to be a result of the lighting zone reclassification measure, and the security camera adder, as part of the specific applications of the non-residential outdoor LPA reduction measure.

Table 12: Estimated Impact that Adoption of the Proposed Measure Would Have On The California Building Designers and Energy Consultants Sectors

Type of Economic Impact	Employment (jobs)	Labor Income (millions $)	Total Value Added (millions $)	Output (millions $)
Direct Effects (Additional spending by Building Designers & Energy Consultants)	13.6	$1.4	$1.4	$2.5
Indirect Effect (Additional spending by firms supporting Bldg. Designers & Energy Consult.)	8.6	$0.6	$0.8	$1.2
Induced Effect (Spending by employees of firms experiencing “direct” or “indirect” effects)	10.6	$0.6	$1.1	$1.7
Total Economic Impacts	**32.8**	**$2.57**	**$3.23**	**$5.44**

Source: Analysis by Evergreen Economics of data from the IMPLAN V3.1 modeling software.

The nonresidential outdoor LPA reduction and lighting zone reclassification measures are anticipated to have minor impacts on building inspectors, due to the need to verify the project lighting zone, and verify the location of security cameras if the security camera LPA is used.

Table 13: Estimated Impact that Adoption of the Proposed Measure Would Have On California Building Inspectors

Type of Economic Impact	Employment (jobs)	Labor Income (millions $)	Total Value Added (millions $)	Output (millions $)
Direct Effects (Additional spending by Building Inspectors)	1.0	$0.10	$0.12	$0.15
Indirect Effect (Additional spending by firms supporting Building Inspectors)	0.1	$0.01	$0.01	$0.02
Induced Effect (Spending by employees of Building Inspection Bureaus and Departments)	0.6	$0.03	$0.06	$0.10
Total Economic Impacts	**1.7**	**$0.15**	**$0.20**	**$0.27**

Source: Analysis by Evergreen Economics of data from the IMPLAN V3.1 modeling software.

3.4.1 Creation or Elimination of Jobs.

The Statewide CASE Team does not anticipate that proposed measures would lead to the creation of new *types* of jobs or the elimination of *existing* types of jobs. In other words, the proposed change would not result in economic disruption to any sector of the California economy. Rather, the estimates of economic impacts discussed in Section 3.3 would lead to modest changes in employment of existing jobs.

3.4.2 Creation or Elimination of Businesses in California

As stated in Section 3.4.1, the proposed change would not result in economic disruption to any sector of the California economy. The proposed change represents a modest change to outdoor lighting source allowances, which would not excessively burden or competitively disadvantage California businesses – nor would it necessarily lead to a competitive advantage for California businesses. Therefore, the Statewide CASE Team does not foresee any new businesses being created, nor does the Statewide CASE Team think any existing businesses would be eliminated due to the proposed code changes to Title 24, Part 6.

3.4.3 Competitive Advantages or Disadvantages for Businesses in California

The proposed code changes would apply to all businesses operating in California, regardless of whether the business is incorporated inside or outside of the state.[14] Therefore, the Statewide CASE Team does not anticipate that the proposed measures would have an adverse effect on the competitiveness of California businesses. Likewise, the Statewide CASE Team does not anticipate businesses located outside of California would be advantaged or disadvantaged.

3.4.4 Increase or Decrease of Investments in the State of California

The Statewide CASE Team does not anticipate that the economic impacts associated with the proposed measure would lead to significant change (increase or decrease) in investment in any directly or indirectly affected sectors of California's economy.

3.4.5 Effects on the State General Fund, State Special Funds, and Local Governments

The Statewide CASE Team does not expect the proposed code changes to have a measurable impact on the California's General Fund, any state special funds, or local government funds.

3.4.6 Impacts on Specific Persons

While the objective of any of the Statewide CASE Team's proposal is to promote energy efficiency, the Statewide CASE Team recognizes that there is the potential that a proposed code change may result in unintended consequences.

[14] Gov. Code, § 11346.3(c)(1)(C), 11346.3(a)(2); 1 CCR § 2003(a)(3) Competitive advantages or disadvantages for California businesses currently doing business in the state.

4. Energy Savings

4.1 Key Assumptions for Energy Savings Analysis

The energy and cost analysis presented in this report used the TDV factors that are consistent with the TDV factors presented during the Energy Commission's March 27, 2020 workshop on compliance metrics (California Energy Commission 2020). The electricity TDV factors include the 15 percent retail adder and the natural gas TDV factors include the impact of methane leakage on the building site. The electricity TDV factors used in the energy savings analyses were obtained from Energy and Environmental Economics, Inc. (E3), the contractor that is developing the 2022 TDV factors for the Energy Commission, in a spreadsheet titled "Electric TDVs 2022 - 15 pct Retail Adj Scaled by Avoided Costs.xlsx". The natural gas TDV factors used in the energy savings analyses were obtained from E3 in a spreadsheet titled "2022_TDV_Policy_Compliant_CH4Leak_FlatRtlAdd_20191210.xlsx". The electricity demand factors used in the energy savings analysis were obtained from E3 in a spreadsheet titled "2022 TDV Demand Factors.xlsx". The Energy Commission notified the Statewide CASE Team on April 21, 2020 that they were investigating further refinements to TDV factors using 20-year global warming potential (GWP) values instead of the 100-year GWP values that were used to derive the current TDV factors. It is anticipated that the 20-year GWP values would increase the TDV factors slightly. As a result, the TDV energy savings presented in this report are lower than the values that are expected if the final TDV use 20-year GWP values, and the proposed code changes will be more cost effective using the revised TDV. Energy savings presented in kWh and therms are not affected by TDV or demand factors.

4.1.1 Assumptions for Lighting Zone Reclassification

The Statewide CASE Team calculated per-unit impacts and statewide impacts associated with both new construction and alterations by examining energy use of outdoor LPAs in the different lighting zones that are minimally compliant with the 2019 Title 24, Part 6 Standards. The Statewide CASE Team specifically used the 2019 Title 24, Part 6 LPAs because the LPAs are not being updating in this submeasure, and therefore, all energy savings results only from a change in lighting zone. Changes to the lighting zone classifications result in a larger portion of the state being classified as LZ1 instead of LZ2. The per-unit difference for general hardscape areas and the specific applications[15] were calculated by comparing the differences in the 2019 LZ2 LPAs to

[15] Specific applications are listed in Table 140.7-B and are extra layers of wattage that can be used in addition to the general hardscape LPAs found in Table 140.7-A. Examples of specific applications include Outdoor Sales Frontage, Building Entrances and Exits, and Outdoor Sales Lots.

the 2019 LZ1 LPAs. Energy savings are realized because the LPAs for LZ1 are lower than those for LZ2. Therefore, overall less total wattage can be installed in a LZ1 project versus a LZ2 project.

The Statewide CASE Team studied various LED luminaires commonly available today to ensure that the LPAs for each lighting zone could be met. The Statewide CASE Team studied lower “warm” CCT luminaires (either 3000K CCT or 2700K CCT) that are widely available today to ensure that less efficacious luminaires used in current industry standard practices could be installed in each lighting zone. The LED luminaires were selected from a breadth of products that represent a reasonable cross-section of designs likely to be installed in the 2022 code cycle. The products were then analyzed for each specific application to ensure that the products were available to meet both the lighting level requirements and CALGreen BUG ratings listed in Section 5.108.6 for the updated lighting zone classifications.

The Statewide CASE Team used the same hours of operation in this code cycle as those assumed for the 2019 code cycle to calculate per-unit annual electricity use for each application in both LZ1 and LZ2 as shown in Table 14. More information on the hours of operation schedules can be found in Appendix M. The per-unit electricity savings were determined for each application by comparing the per-unit savings of reducing each application LPA from a LZ2 to an LZ1 classification. The electricity savings for specific applications are classified as per occurrence (e.g. per fuel pump), per linear foot, or per square foot, depending on the application.

Table 14: Nonresidential Outdoor Lighting Hours of Operation per Application

Application	Schedule	Type	Annual Full Load Hours
General Hardscape	General Hardscape with controls (poles heights less than 24 feet)	Dusk-30min to Dawn+30min with bi-level motion sensors	2768
General Hardscape	General Hardscape without controls (pole heights greater than 24 feet)	Dusk-30min to Dawn+30min	4690
Building Entrances and Exits	A	with bi-level motion sensor	4690
Primary Entrances	A	Dusk-30min to Dawn+30min	4690
Drive-Up Windows	Retail	Dusk-30min to Dawn+30min	3193
Uncovered Fuel Dispenser	A	Dusk-30min to Dawn+30min	4690
ATM	ATM	with Partial Off	3311
Outdoor Sales Frontage	C	Dusk-30min to Dawn+30min	1932
Hardscape Ornamental Lighting	A	Dusk-30min to Dawn+30min	4690
Building Facades	D	Dusk-30min to Dawn+30min	3193
Outdoor Sales Lots	Outdoor Sales Lots	Dusk-30min to Dawn+30min	3000
Vehicle Service Station Hardscape	Service Station Hardscape	Dusk-30min to Dawn+30min	3651
Vehicle Service Station Canopies	Service Station Canopies	with Partial Off	3651
Sales Canopies	Retail	Dusk-30min to Dawn+30min	3193
Non-sales Canopies and Pedestrian Tunnels	A	with Partial Off	4690
Guard Stations	A	Dusk-30min to Dawn+30min	4690
Student Pick-up/Drop-off Zones	B	Dusk-30min to Dawn+30min	1567
Outdoor Dining	Outdoor Dining	Dusk-30min to Dawn+30min	1932
Special Security Lighting for Retail Parking and Pedestrian Hardscape	A	with Partial Off	4690
Security Camera	A	Dusk-30min to Dawn+30min	4690

4.1.2 Assumptions for Lighting Power Allowance for General Hardscape

The general hardscape LPAs were developed using a similar approach that was used in both the 2016 and 2019 code cycle. The 10 representative general hardscape layouts are a reasonable approximation of anticipated installations during the 2022 code cycle and are the basis of the new 2022 general hardscape LPAs. These layouts are specific to outdoor lighting and are described in Table 15 and illustrated in Figure 1.

Each general hardscape LPA (for each lighting zone) is also known as the effective area wattage allowance (eAWA), and is a combination of three allowances:

- Initial wattage allowance (IWA): flat wattage allowance for a site. It is expressed in watts.
- Area wattage allowance (AWA): wattage allowance for the area of a site. It is expressed in watts per square foot.
- Linear wattage allowance (LWA): wattage allowance for the perimeter of a site. It is expressed in watts per linear foot.

These three allowances are combined into a single metric, the general hardscape LPA or eAWA, based on the size, shape, and location of the general hardscape area in question. Each of the 10 general hardscape layouts had the new IES recommended lighting levels applied to them and were modeled with “warm” CCT luminaires that are less efficacious than higher CCT luminaires to ensure that these less efficacious luminaires could be used with the new LPAs. New eAWAs were then developed for each of the 10 layouts based on the lower lighting levels and luminaires. The layouts are shown in Figure 1, except for layout k which is a perfect square lot and not shown in the Figure 1. The maximum eAWA for each layout was then used to develop the new proposed general hardscape LPAs. This was completed separately for each lighting zone because each lighting zone has a different lighting level requirement, and therefore, has a different LPA.

The 2022 eAWA values were further adjusted to account for the security camera allowance, expected to apply to a portion of statewide general hardscape area. A camera allowance adjusted eAWA was calculated by computing a weighted average over camera and non-camera equipped regions, between the original 2022 eAWA for non-camera area, and the eAWA plus security camera allowance for camera equipped areas. This calculation results in a single adjusted eAWA per lighting zone that can be used for per-unit and statewide calculations and compared directly with the 2019 base case eAWA.

The per-unit energy savings, including energy cost savings, were developed by comparing the 2019 general hardscape LPA, or 2019 eAWA, with the proposed 2022 general hardscape LPA with weighted camera allowance. Please see Section 4.2.1 for more details on the per-unit and statewide energy savings methodology.

The Statewide CASE Team wanted to confirm that the newly developed general hardscape LPAs were high enough to allow spaces to be lighted to the recommended light levels, so they were validated by using three real site designs.[16] Using lighting design software, the new LPA values were applied to the three parking lot designs and it was confirmed each could be lighted to IES recommended light levels with currently available products. Area lights with Type III, Type IV, and Type V lumen distributions were mounted on poles ranging in height from 15 feet to 45 feet per typical design standards. Figure 2 illustrates the real parking lot designs.

A comparison of the new eAWAs to the average lighting power density (LPD) of each of the real site designs found that the general hardscape eAWA is 30 percent higher than the averaged LPD of the real site designs for each lighting zone. This shows that the new eAWA includes a buffer to allow designers to install decorative, less efficacious luminaires in general hardscape applications.

Key considerations for the three parking lot sites include the expected lumen maintenance of the outdoor luminaires and the appropriate light loss factors. The Statewide CASE Team applied the maintained lumen output of each luminaire at 60,000 hours since this is the less than the typical end of life (L70) for most area lights. Per the general hardscape schedule, luminaires with a 60,000-hour rated life would not reach the reported end of life during the 15-year period of analysis. A luminaire dirt depreciation factor[17] of 0.85 was applied based on the molded acrylic direct deprecation values reported in IES RES-1-16 “Measure and Report Luminaire Dirt Depreciation (LDD) in LED Luminaires for Street and Roadway Lighting Applications” over 15 years.

[16] Real site designs were used for a small, medium, and large parking lot.

[17] This factor accounts for the fact that luminaires get dirty over time in outdoor environments.

Table 15: Description of General Hardscape Layouts Used for Energy, Demand, Cost, and Environmental Impacts Analysis for General Hardscape

Representative Layout ID	Hardscape Area (ft^2)	Hardscape Perimeter (ft)	Perimeter to Area (%)	Notes
Layout A	501,626	6,794	1.4	Long skinny site, big building
Layout B	471,726	5,131	1.1	Square site, irregular building
Layout C	42,828	3,052	7.1	Irregular site, campus buildings
Layout D	28,500	960	3.4	Long skinny site, small building
Layout E	21,000	760	3.6	Square site, small square building
Layout F	61,798	1,940	3.1	Irregular site, long square building
Layout G	21,797	1,408	6.5	Long skinny site, irregular building
Layout H	11,040	1,042	9.4	Square site, large square building
Layout J	34,735	2,593	7.5	Irregular site, large irregular building
Layout K	250,000	2,000	0.8	Ideal square site

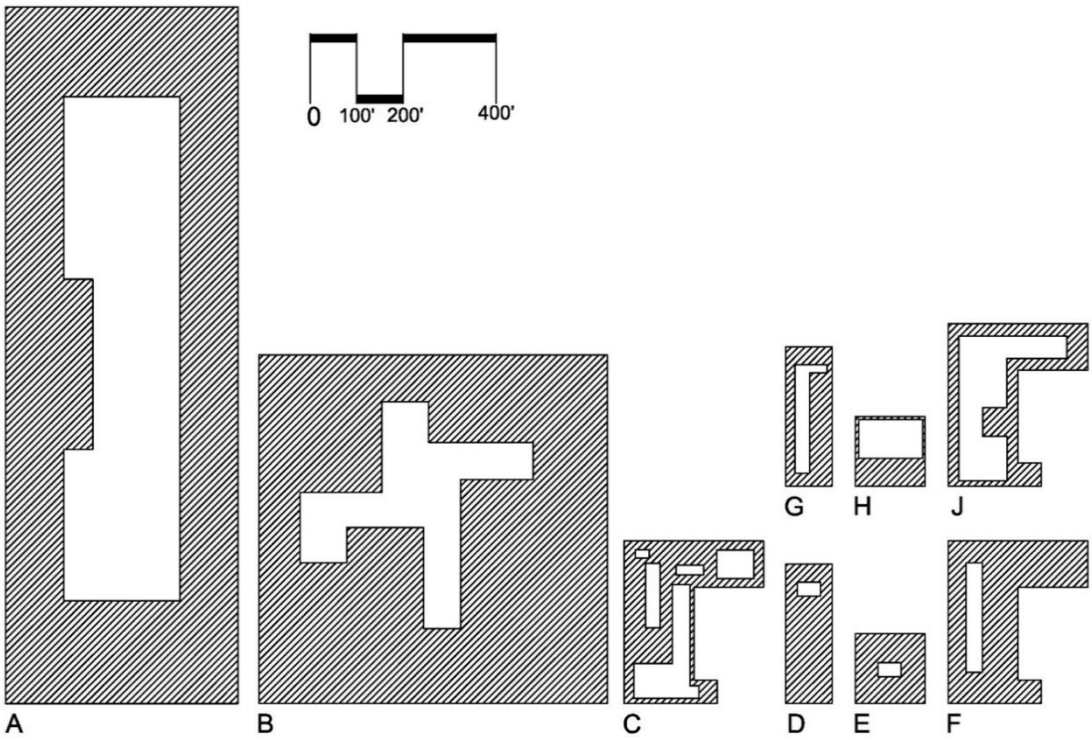

Figure 1: Representation of general hardscape layouts used to determine new lighting power allowances.

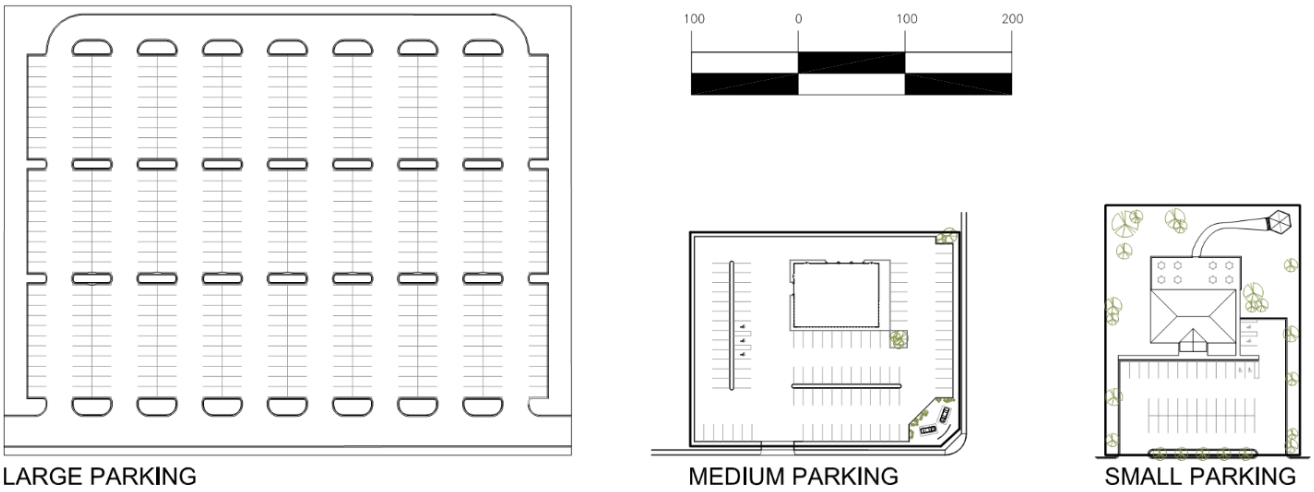

Figure 2: Real parking lot designs used to confirm recommended light levels could be achieved with the proposed lighting power allowances.

4.1.3 Assumptions for Multifamily Lighting Power Allowances

For the multifamily outdoor LPA submeasure, the Statewide CASE Team calculated per-unit impacts and statewide impacts associated with new construction and additions and alterations by comparing energy use of outdoor lighting that is minimally compliant with the 2019 Title 24, Part 6 Standards to the proposed requirements for the 2022 Title 24, Part 6 Standards.

Note that per-unit savings estimates are completed with different units for residential buildings than for nonresidential buildings. The multifamily building category includes the residential models Lowrise Garden, Loaded Corridor, Midrise Mixed, Highrise Mixed.

The analysis for General Hardscapes defines effective area wattage allowances for multifamily ($eAWA_{MF}$) for the 2022 proposal using 3000K LED luminaires that are widely available today and commonly used for multifamily projects. Wattage and pole heights were established for sites that represent a cross-section of what is likely to be installed in multifamily projects in the state during the 2022 code cycle. The Statewide CASE Team used three methods to ensure that the design represents reasonable design practice within the industry: 1.) a survey of lighting practitioners, including designers with multifamily experience, 2.) a review of multifamily projects available for statistical analysis, and 3.) the judgement of lighting experts within the Statewide CASE Team.

The effective area wattage allowance values for multifamily combine the Initial Wattage Allowance and the Area Wattage Allowance into a single value based on the size, shape, and type of the area in question. Note that these all get a “MF” subscript designation to differentiate these formulas from the nonresidential formulas.

The formula for multifamily LPA is as follows:

$$\boldsymbol{eAWA_{MF} = LPA_{MF} = IWA_{MF} + AWA_{MF}}$$

Where:

IWA_{MF} is the Initial Wattage Allowance specifically for multifamily projects (sourced from values in nonresidential outdoor lighting Table 140.7-A).

AWA_{MF} is the Area Wattage Allowance specifically for multifamily projects (sourced from values in the nonresidential outdoor lighting Table 140.7-A).

Note that this formula differs from the formula used in the nonresidential outdoor LPA calculation procedure in that it does not include a Linear Wattage Allowance (LWA) because these values have been absorbed into the new values for AWA_{MF} to simplify the calculation procedure.

4.2 Energy Savings Methodology

4.2.1 Lighting Zone Reclassification

The outdoor lighting applications do not have an interactive effect with HVAC and are not dependent on climate zone. Since savings do not vary by climate zone, the Statewide CASE Team averaged the statewide TDV factors for each climate zone and used that to calculate energy cost impacts.

Each lighting zone has a specific set of general hardscape and specific application LPAs with higher lighting zones having higher LPAs to accommodate higher recommended lighting levels. Updating the lighting zone definitions results in a significant portion of area in LZ2 moving down to LZ1. This results in energy savings due to these areas moving from higher to lower LPAs. The Statewide CASE Team calculated per-unit savings by calculating the total energy usage of one square foot of general hardscape and one unit of each specific application. Each LPA was converted to kWh by applying hours of operation for an entire year to each general hardscape and specific application LPA. These hours of operation assume that the luminaires would be turned on 30 minutes before dawn and turned off 30 minutes after dusk with post occupancy dimming and motion sensor control requirements applied per outdoor lighting control requirements in Section 130.2 of Title 24, Part 6. For luminaires mounted at 24 feet or lower, motion sensors were anticipated to be in use. Luminaires mounted above 24 feet do not require additional motion controls and were assumed to be at full light output until 11:00 PM. The hours of operation are presented in Table 14. This was completed for LZ1 and LZ2 LPAs.

The total per-unit (one square foot of general hardscape and each unit specific application) kWh energy usage for LZ2 was subtracted from the total per-unit kWh

energy usage for LZ1. The resulting kWh is the per-unit savings. The 2019 LPAs for general hardscape and specific applications were used for this analysis.

The per-unit savings were extrapolated to the entire state using estimates of statewide square footage of each type of outdoor hardscape area that would be impacted by the proposed requirements. The total statewide hardscape area was derived by converting the interior building construction forecasts provided by the Energy Commission to exterior construction forecasts. These exterior forecasts applied assumptions about the type and size of hardscaped areas that are associated with typical nonresidential construction of different building types. Refer to Appendix A for information on the percentage of interior construction forecasts applied to each exterior application.

The Statewide CASE Team calculated that statewide savings would occur from approximately five percent of buildings (new construction and alterations) shifting from having a LZ2 designation to LZ1. This is a result of updating the lighting zone definitions to moving “rural” areas to LZ1 and making “urban clusters” now the default LZ2. U.S. Census data shows that approximately five percent of California is designated as “rural” which is why estimated construction activity for LZ1 is increased to five percent. See Table 16 below showing the change in construction activity estimates for each lighting zone.

Table 16: Update to Percent of Construction Activity Per Lighting Zone

Lighting Zone	Percent of Land Mass (Source: 2010 U.S. Census)	Percent of Construction Activity Estimate (base case)	Percent of Construction Activity Estimate (proposed)
LZ0	9%	0.0%	0.0%
LZ1	1%	0.1%	5.0%
LZ2	85%	9.9%	5.0%
LZ3	5%	90.0%	90.0%
LZ4	0%	0.0%	0.0%

4.2.2 Lighting Power Allowance for General Hardscape

The outdoor lighting applications do not have an interactive effect with HVAC and are not dependent on climate zone. Since savings do not vary by climate zone, the Statewide CASE Team averaged the statewide TDV factors for each climate zone and used that to calculate energy cost impacts.

Unlike most 2022 CASE proposals, the outdoor lighting measures do not calculate energy savings associated with prototypical buildings. As described in Section 4.1.2, the Statewide CASE Team used representative layouts for outdoor lighting in general hardscape applications. These layouts include ten site plans that represent a variety of site configurations that account for both the building and hardscape footprint, which vary from an efficient (square) site with a simple building footprint and hardscape layout to a

more complex site with less ideal conditions. These site plans layouts are specific to outdoor lighting and enabled the Statewide CASE Team to compare LPA values in practical lighting layout conditions that represent a reasonable spectrum of conditions that may be encountered in actual site designs.

The LPA estimate average used for savings calculations was adjusted to account for a percentage of general hardscape installations using security cameras. The camera allowance adjusted LPA is calculated as a weighted average of the conventional (no camera) LPA and the conventional LPA plus security camera allowance for installations estimated to have security cameras.

Per-unit savings were developed by calculating the total energy usage of one square foot of general hardscape for each lighting zone. Each lighting zone LPA was converted to kWh by applying hours of operation for an entire year. These hours of operation assume that the luminaires would be turned on 30 minutes before dawn and turned off 30 minutes after dusk with post occupancy dimming and motion sensor control requirements applied per outdoor lighting control requirements in Section 130.2 of Title 24, Part 6. For luminaires mounted at 24 feet or lower, motion sensors were anticipated to be in use. Luminaires mounted above 24 feet do not require additional motion controls and were assumed to be at full light output until 11:00 PM. The hours of operation are presented in Table 14. This was completed for each lighting zone general hardscape LPA.

The Statewide CASE Team then estimated the statewide energy impacts by extrapolating the per-unit impacts to the entire state using estimates of the 2023 construction forecast. The building construction forecasts were developed by converting the interior construction forecasts provided by the Energy Commission to approximate exterior square footage per each space type. Refer to Appendix A for the percentage of interior spaces applied to each outdoor application. The assumptions applied to each of the converted construction forecasts were first developed during the 2016 code cycle. The same assumptions were applied to the 2019 code cycle construction forecasts and further refined. The Statewide CASE Team is applying the same assumptions refined for the 2019 code cycle to the 2023 construction forecasts.

The Statewide CASE Team did not use the updated construction activity estimates in Table 16, but rather the same construction activity estimates as the 2019 code cycle presented in Table 17 below. This was done to prevent double counting of energy savings.

Table 17: Percent of Construction Activity Per Lighting Zone for General Hardscape Lighting Power Allowance

Lighting Zone	Percent of Land Mass (Source: 2010 U.S. Census)	Percent of Construction Activity Estimate
LZ0	9%	0.0%
LZ1	1%	0.1%
LZ2	85%	9.9%
LZ3	5%	90.0%
LZ4	0%	0.0%

4.2.3 Multifamily Outdoor Lighting Power Allowance

For the multifamily outdoor LPA submeasure, the per-unit energy impacts for multifamily buildings are presented in savings per dwelling unit. The Statewide CASE Team developed the savings estimates based on the savings projections for lighting systems modelled to meet the design criteria and projected for the savings by building as discussed in Section 4.2.1 above.

This enabled a projection of statewide savings using construction forecasts to estimate the total energy savings that the state would benefit by adopting this measure. The weighting of the respective prototype models for the multifamily building type and the percentage of the dwelling units impacted by the measure is presented below in Table 19 below.

The Statewide CASE Team developed an understanding of typical hardscape and building conditions by analyzing the site development plans for multifamily projects to establish the ratios of general hardscape compared to square footage of buildings and compared to the number of apartment units within the development projects. These ratios are used to determine the respective statewide impacts of the measure for the respective building category.

Table 18 provides the average characteristics observed through the analysis of approximately 24 different properties to help characterize the multifamily prototypes. Further information on this analysis is provided in Appendix H at the end of the report.

Below that, Table 19 provides the weighting of the four prototype buildings within the overall construction forecasts to calculate the impacts of the proposed code changes. Note that for the analysis of outdoor lighting measures, these prototypes do not include building exterior information, and the Statewide CASE Team developed substitute characteristics based on real-world properties to represent each building prototype using the 24 properties mentioned above.

Table 18: Evaluated Site Characteristics by Prototype

Prototype	Floor Area (ft2)	Unit Count	Building Footprint Area (ft2)	Site Area (ft2)	Hardscape Area (ft2)	Site Perimeter (ft)	Hardscape Perimeter (ft)
High-Rise	143,729	145	43,959	88,801	36,876	1,330	3,255
Mid-Rise	179,832	161	77,048	185,011	74,109	1,742	6,718
Low Rise - Garden	46,150	45	38,584	153,578	66,136	1,608	5,546
Low Rise - Corridor	40,521	70	32,608	92,979	24,087	1,284	2,759

Table 19: Multifamily Building Associated Prototype Weighting

Building Type ID from Statewide Construction Forecast	Building Prototype for Energy Modeling	Weighting Factors of Total Multifamily Dwelling Units	Weighting Factors for Statewide Impacts Analysis
Multifamily	LowRiseGarden	4%	100%
	LoadedCorridor	33%	100%
	MidRiseMixedUse	58%	100%
	HighRiseMixedUse	5%	100%

4.3 Per-Unit Energy Impacts Results

4.3.1 Lighting Zone Reclassification

Energy savings and peak demand reductions per unit are presented in Table 20. There are no anticipated energy impacts for lighting zones 3 and 4 since there are no proposed changes to the weighting factors for these lighting zones. The per-unit energy savings figures do not account for naturally occurring market adoption or compliance rates.

The following per-unit energy impacts were determined by calculating the difference in energy usage and peak demand reduction over one year, for one unit for each specific application.

Table 20: First-Year Energy Impacts Per Unit – Lighting Zone Reclassification

Lighting Application	Per Unit	Electricity Savings (kWh/yr)	Peak Electricity Demand Reductions (kW)	Natural Gas Savings (therms/yr)	TDV Energy Savings (TDV kBtu/yr)
General Hardscape	Per Square Foot	0.003	3.53×10^{-7}	NA	0.09
Building Entrances or Exits	Each	1.380	2.53×10^{-4}	NA	41.18
Primary Entrances	Each	4.601	8.43×10^{-4}	NA	137.28
Drive Up Windows	Each	2.192	3.85×10^{-4}	NA	67.04
Vehicle Service Station Uncovered Fuel Dispenser	Each Pump Face	5.061	9.27×10^{-4}	NA	151.00
ATM Machine Lighting	Each	0.000	0	NA	0.00
Outdoor Sales Frontage	Per Linear Foot	1.042	2.42×10^{-4}	NA	34.01
Hardscape Ornamental Lighting	Per Square Foot	0.002	2.95×10^{-7}	NA	0.05
Building Facades	Per Square Foot	0.016	2.75×10^{-6}	NA	0.48
Outdoor Sales Lots	Per Linear Foot	0.022	4.14×10^{-6}	NA	0.66
Vehicle Service Station Hardscape	Per Square Foot	0.011	2.07×10^{-6}	NA	0.33
Vehicle Service Station Canopies	Per Square Foot	0.038	7.02×10^{-6}	NA	1.13

Sales Canopies	Per Square Foot	0.074	1.29×10^{-5}	NA	2.25
Non-sales Canopies and Tunnels	Per Square Foot	0.018	3.37×10^{-6}	NA	0.55
Guard Stations	Per Square Foot	0.022	4.00×10^{-6}	NA	0.65
Student Pick-up/Drop-off zone	Per Square Foot	0.004	1.04×10^{-6}	NA	0.14
Outdoor Dining	Per Square Foot	0.002	5.72×10^{-7}	NA	0.08
Special Security Lighting for Retail Parking and Pedestrian Hardscape	Per Square Foot	0.000	4.21×10^{-8}	NA	0.01

4.3.2 Light Power Allowances for General Hardscape

The following per-unit energy impacts were determined by calculating the difference in energy usage and peak demand reduction over one year, for one square foot of area of the 2019 General Hardscape LPAs versus the proposed 2022 General Hardscape LPAs.

Table 21: First-Year Energy Impacts Per Unit – General Hardscape Lighting Power Allowance

General Hardscape	Per Unit	Electricity Savings (kWh/yr)	Peak Electricity Demand Reductions (kW)	Natural Gas Savings (therms/yr)	TDV Energy Savings (TDV kBtu/yr)
Lighting Zone 1	Per Square Foot	0.0043	5.24×10^{-7}	N/A	0.128
Lighting Zone 2	Per Square Foot	0.0407	4.98×10^{-6}	N/A	1.214
Lighting Zone 3	Per Square Foot	0.0478	6.15×10^{-6}	N/A	1.428
Lighting Zone 4	Per Square Foot	0.0340	6.23×10^{-6}	N/A	1.015

4.3.3 Multifamily Lighting Power Allowances

Table 22: Weighted Average First-Year Energy Impacts Per Dwelling Unit – Multifamily Outdoor Lighting Power Allowance

Building Prototype	Electricity Savings (kWh/yr)	Peak Electricity Demand Reductions (kW)	Natural Gas Savings (therms/yr)	TDV Energy Savings (TDV kBtu/yr)
Low Rise Garden	140	0.027	NA	1,301
Loaded Corridor	36	0.007	NA	336
Mid-Rise Mixed Use	43	0.008	NA	404
High Rise Mixed Use	24	0.005	NA	231

5. Cost and Cost Effectiveness

5.1 Energy Cost Savings Methodology

The energy cost savings presented in this section were calculated by applying the TDV energy cost factors to the energy savings estimates that were derived using the methodology described in Section 4.2. TDV is a normalized metric to calculate energy cost savings that accounts for the variable cost of electricity and natural gas for each hour of the year, along with how costs are expected to change over the period of analysis (30 years for residential measures and nonresidential envelope measures and 15 years for all other nonresidential measures). In this case, the period of analysis used is 15 years. The TDV cost impacts are presented in 2023 present value dollars and represent the energy cost savings realized over 15 years. TDV cost impacts in nominal dollars are presented in Appendix N.

5.2 Energy Cost Savings Results

Per-unit energy cost savings for newly constructed buildings that are realized over the 15-year period of analysis are presented in 2023 dollars in the following sections. The nominal per-unit impacts are presented in Appendix N and do not vary by new construction or alterations.

5.2.1 Nonresidential Lighting Zone Reclassification

The per-unit savings are averaged across all the lighting zones. The weighting values used to average the lighting zones are presented in Table 23 below. The 2023 present value per-unit impacts do not vary by new construction or alterations and are presented in Table 24.

Table 23: Update to Percent of Construction Activity Per Lighting Zone

Lighting Zone	Percent of Construction Activity Estimate
LZ0	0.0%
LZ1	5.0%
LZ2	5.0%
LZ3	90.0%
LZ4	0.0%

Table 24: Lighting Zone Reclassification: 2023 PV TDV Energy Cost Savings Over 15-Year Period of Analysis – Per Unit – New Construction and Alterations

Lighting Application	Units	15-Year TDV Electricity Cost Savings (2023 PV$)	15-Year TDV Natural Gas Cost Savings (2023 PV$)	Total 15-Year TDV Energy Cost Savings (2023 PV$)
General Hardscape	Per Square Foot	0.008	N/A	0.008
Building Entrances or Exits	Each	3.665	N/A	3.665
Primary Entrances	Each	12.218	N/A	12.218
Drive Up Windows	Each	5.967	N/A	5.967
Vehicle Service Station Uncovered Fuel Dispenser	Each Pump Face	13.440	N/A	13.440
ATM Machine Lighting	Each	0.000	N/A	0.000
Outdoor Sales Frontage	Per Linear Foot	3.027	N/A	3.027
Hardscape Ornamental Lighting	Per Square Foot	0.004	N/A	0.004
Building Facades	Per Square Foot	0.043	N/A	0.043
Outdoor Sales Lots	Per Linear Foot	0.059	N/A	0.059
Vehicle Service Station Hardscape	Per Square Foot	0.030	N/A	0.030
Vehicle Service Station Canopies	Per Square Foot	0.101	N/A	0.101
Sales Canopies	Per Square Foot	0.200	N/A	0.200
Non-sales Canopies and Tunnels	Per Square Foot	0.049	N/A	0.049
Guard Stations	Per Square Foot	0.058	N/A	0.058
Student Pick-up/Drop-off zone	Per Square Foot	0.013	N/A	0.013
Outdoor Dining	Per Square Foot	0.007	N/A	0.007
Special Security Lighting for Retail Parking and Pedestrian Hardscape	Per Square Foot	0.001	N/A	0.001

5.2.2 Nonresidential General Hardscape Lighting Power Allowance

The per-unit savings are averaged across all the lighting zones. The weighting used to average the lighting zones are presented in Table 25 below. The 2023 present value per-unit impacts do not vary by new construction or alterations and are presented in Table 26.

Table 25: Percent of Construction Activity Per Lighting Zone

Lighting Zone	Percent of Construction Activity Estimate
LZ0	0.0%
LZ1	0.1%
LZ2	9.9%
LZ3	90.0%
LZ4	0.0%

Table 26: General Hardscape Lighting Power Allowance: 2023 PV TDV Energy Cost Savings Over 15-Year Period of Analysis – Per Square Foot

Lighting Application	Units	15-Year TDV Electricity Cost Savings (2023 PV$)	15-Year TDV Natural Gas Cost Savings (2023 PV$)	Total 15-Year TDV Energy Cost Savings (2023 PV$)
General Hardscape – New Construction	Per Square Foot	$0.13	N/A	$0.13
General Hardscape – Alterations	Per Square Foot	$0.13	N/A	$0.13

5.2.3 Multifamily General Hardscape Lighting Power Allowance

The per-unit savings are averaged across all the lighting zones. The weighting used to average the lighting zones are presented in Table 27 below. The 2023 present value per-unit impacts do not vary by new construction or alterations and are presented in Table 28.

Table 27: Percent of Construction Activity Per Lighting Zone

Lighting Zone	Percent of Construction Activity Estimate
LZ0	0.0%
LZ1	0.1%
LZ2	9.9%
LZ3	90.0%
LZ4	0.0%

Table 28: Multifamily Outdoor Lighting Power Allowance 2023 Present Value TDV Energy Cost Savings Over 15-Year Period of Analysis – Per Dwelling Unit – New Construction and Alterations

Building Prototype	Units	15-Year TDV Electricity Cost Savings (2023 PV$)	15-Year TDV Natural Gas Cost Savings (2023 PV$)	Total 15-Year TDV Energy Cost Savings (2023 PV$)
Low Rise Garden	Dwelling Unit	$115.78	N/A	$115.78
Loaded Corridor	Dwelling Unit	$29.94	N/A	$29.94
Mid-Rise Mixed Use	Dwelling Unit	$35.96	N/A	$35.96
High Rise Mixed Use	Dwelling Unit	$20.59	N/A	$20.59

5.3 Incremental First Cost

Incremental first cost is the initial cost to adopt more efficient equipment or building practices when compared to the cost of an equivalent baseline project. Therefore, it was important that the Statewide CASE Team consider first costs in evaluating overall measure cost effectiveness. Incremental first costs are based on data available today and can change over time as markets evolve and professionals become familiar with new technology and building practices

5.3.1 Lighting Zone Reclassification

The Statewide CASE Team reached out to 58 different manufacturers and referenced distributor pricing to obtain data on the cost of currently available lighting products. The same lighting products were compared in LZ1 and LZ2 applications, which resulted in no incremental costs for the lighting zone reclassification measure.

5.3.2 General Hardscape Lighting Power Allowance

There are no incremental costs associated with the update to the general hardscape LPAs. The same LED technology is used for both the base and proposed case which does not result in any incremental cost. Additionally, the proposed case uses less equipment per square foot to achieve the new recommended light levels, which means costs for the proposed case are lower than the base case. The Statewide CASE Team compared the average system cost per square foot of each prototype building between the 2019 and the 2022 code cycles. Three different general hardscape sites (large, medium, and small parking lots) were used to verify costs as well as determine the typical quantity of luminaires and luminaire spacing necessary to meet IES recommended minimum lighting levels and uniformity while lighting each parking lot at various mounting heights with multiple luminaire distributions. The differences in the quantity of equipment necessary to meet the lighting levels in the 2019 and 2022 codes was used to determine the equipment cost savings between the code cycles. Fewer

luminaires, light poles, foundations, control equipment, wiring, and conduit is required to meet the lower lighting levels throughout the general hardscape areas.

5.3.3 Multifamily Outdoor Lighting Power Allowance

There are no incremental costs associated with the introduction of the multifamily code section for general hardscape LPAs. The same LED technology is used for both the base and proposed case which does not result in any incremental cost. Additionally, the proposed case uses less equipment per square foot to achieve the new recommended light levels as the base case, which means costs for the proposed case is lower than the base case.

The same calculations that determined no additional costs occur in the Nonresidential LPA measure applies for this measure as the lighting equipment is generally the same and the application in the field are comparable. Fewer luminaires, light poles, foundations, control equipment, wiring, and conduit is required to meet the lower lighting levels throughout the general hardscape areas.

5.4 Incremental Maintenance and Replacement Costs

Incremental maintenance cost is the incremental cost of replacing the equipment or parts of the equipment, as well as periodic maintenance required to keep the equipment operating relative to current practices over the 15-year period of analysis.

The nonresidential outdoor lighting for both the 2019 and 2022 code cycles use an LED baseline. The average end of life (L70) for LED technology is greater than the 15-year period of analysis. During this time period, no equipment maintenance is expected for any of the LED lighting since the products would still be within their life expectancy. The cleaning maintenance schedules would remain the same between the 2019 and 2022 code cycles which results in no changes to incremental cleaning costs. Due to this, there are no anticipated maintenance costs for the nonresidential outdoor lighting submeasures.

5.5 Cost Effectiveness

These submeasures propose a prescriptive requirement. As such, a cost analysis is required to demonstrate that the measure is cost effective over the 15-year period of analysis. The Energy Commission establishes the procedures for calculating cost effectiveness. The Statewide CASE Team collaborated with Energy Commission staff to confirm that the methodology in this report is consistent with Energy Commission guidelines, including which costs were included in the analysis. The incremental first cost and incremental maintenance costs over the 15-year period of analysis were included. The TDV energy cost savings from electricity savings were also included in

the evaluation. Design costs were not included nor were the incremental costs of code compliance verification.

According to the Energy Commission's definitions, a measure is cost effective if the benefit-to-cost (B/C) ratio is greater than 1.0. The B/C ratio is calculated by dividing the cost benefits realized over 15 years by the total incremental costs, which includes maintenance costs for 15 years. The B/C ratio was calculated using 2023 PV costs and cost savings.

Results of the per-unit cost-effectiveness analyses are presented in Table 29 and

Table 30 for new construction and alterations, respectively. The B/C ratio for the lighting zone reclassification and general hardscape LPA submeasures are infinite since the submeasures would save energy without any increase to the incremental costs.

Table 29: 15-Year Cost-Effectiveness Summary Per Unit – New Construction

Measure	Units	Benefits TDV Energy Cost Savings + Other PV Savings[a] (2023 PV$)	Costs Total Incremental PV Costs[b] (2023 PV$)	Benefit-to-Cost Ratio
Lighting Zone Reclassification	Per Square Foot	$0.06	$ 0	Infinite
General Hardscape LPA	Per Square Foot	$0.36	$ 0	Infinite
Multifamily LPA	Per Dwelling Unit	$36.40	$ 0	Infinite

a. **Benefits: TDV Energy Cost Savings + Other PV Savings:** Benefits include TDV energy cost savings over the period of analysis (Energy + Environmental Economics 2020). Other savings are discounted at a real (nominal – inflation) three percent rate. Other PV savings include incremental first-cost savings if proposed first cost is less than current first cost. PV maintenance cost savings are included if PV of proposed maintenance costs is less than PV of current maintenance costs.

b. **Costs: Total Incremental Present Valued Costs:** Costs include incremental equipment, replacement, and maintenance costs over the period of analysis. Costs are discounted at a real (inflation-adjusted) three percent rate. Costs include incremental first cost if proposed first cost is greater than current first cost. Costs include PV of maintenance incremental cost if PV of proposed maintenance costs is greater than PV of current maintenance costs. If incremental maintenance cost is negative, it is treated as a positive benefit. If there are no Total Incremental PV Costs, the Benefit-to-Cost ratio is infinite.

Table 30: 15-Year Cost-Effectiveness Summary Per Unit – Alterations

Measure	Units	Benefits TDV Energy Cost Savings + Other PV Savings[a] (2023 PV$)	Costs Total Incremental PV Costs[b] (2023 PV$)	Benefit-to-Cost Ratio
Lighting Zone Reclassification	Per Square Foot	$0.06	$ 0	Infinite
General Hardscape LPA	Per Square Foot	$0.36	$ 0	Infinite
Multifamily LPA	Per Dwelling Unit	$36.40	$ 0	Infinite

a. **Benefits: TDV Energy Cost Savings + Other PV Savings:** Benefits include TDV energy cost savings over the period of analysis (Energy + Environmental Economics 2020). Other savings are discounted at a real (nominal – inflation) three percent rate. Other PV savings include incremental first-cost savings if proposed first cost is less than current first cost. Present value maintenance cost savings are included if PV of proposed maintenance costs is less than PV of current maintenance costs.

b. **Costs: Total Incremental Present Valued Costs:** Costs include incremental equipment, replacement, and maintenance costs over the period of analysis. Costs are discounted at a real (inflation-adjusted) three percent rate. Costs include incremental first cost if proposed first cost is greater than current first cost. Costs include PV of maintenance incremental cost if PV of proposed maintenance costs is greater than PV of current maintenance costs. If incremental maintenance cost is negative, it is treated as a positive benefit. If there are no Total Incremental Present Valued Costs, the Benefit-to-Cost ratio is infinite.

6. First-Year Statewide Impacts

6.1 Statewide Energy and Energy Cost Savings

The Statewide CASE Team calculated the first-year statewide savings for new construction by multiplying the per-unit savings, which are presented in Section 4.3, by assumptions about the percentage of newly constructed buildings that would be impacted by the proposed code. The statewide new construction forecast for 2023 is presented in Appendix A as are the Statewide CASE Team's assumptions about the percentage of new construction that would be impacted by the proposal.

The first-year statewide savings were calculated by applying the per-unit energy savings for each application by the difference in weighting for each occurrence of space type. The difference in GWh between the 2019 code cycle weighting and the 2022 code cycle weighting were used to determine the total GWh energy savings per each application.

The first-year energy impacts represent the first-year annual savings from all buildings that area anticipated to be completed in 2023. The 15-year energy cost savings represent the energy cost savings over the entire 15-year analysis period. The statewide savings estimates do not take naturally occurring market adoption or compliance rates into account.

6.1.1 Lighting Zone Reclassification

Given data regarding the new construction forecast and expected additions and alterations in 2023, the Statewide CASE Team estimates that the proposed lighting zone reclassification code change would reduce annual statewide electricity use by 2.82 GWh with an associated demand reduction of 0.45 MW. No natural gas reductions are expected from this measure. The energy savings for buildings constructed in 2023 are associated with a present valued energy cost savings of approximately $7.6 million in (discounted) energy costs over the 15-year period of analysis.

Table 31: Statewide Energy and Energy Cost Impacts – Lighting Zone Reclassification – New Construction (NC), Alterations and Additions (A)

Lighting Application[b]	Statewide New Construction Impacted by Proposed Change in 2023 (unit[b])	First-Year[a] Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (MMtherms)	15-Year Present Valued Energy Cost Savings (million 2023 PV$)
General Hardscape **(NC)**	125.49 (MM ft2)	0.36	0.04	N/A	0.96
Building Entrances or Exits **(NC)**	33,415 (ea.)	0.05	0.01	N/A	0.12
Primary Entrances **(NC)**	64 (ea.)	0.00	0.00	N/A	0.00
Drive Up Windows **(NC)**	886 (ea.)	0.00	0.00	N/A	0.01
Vehicle Service Station Uncovered Fuel Dispenser **(NC)**	32 (ea.)	0.00	0.00	N/A	0.00
ATM Machine Lighting **(NC)**	128 (ea.)	0.00	0.00	N/A	0.00
Outdoor Sales Frontage **(NC)**	0.1 (MM lin. ft)	0.10	0.02	N/A	0.29
Hardscape Ornamental Lighting **(NC)**	4.84 (MM ft2)	0.01	0.00	N/A	0.02
Building Facades **(NC)**	1.99 (MM ft2)	0.03	0.01	N/A	0.08
Outdoor Sales Lots **(NC)**	0.96 (MM lin. ft)	0.02	0.00	N/A	0.06
Vehicle Service Station Hardscape **(NC)**	3.52 (MM ft2)	0.04	0.01	N/A	0.10
Vehicle Service Station Canopies **(NC)**	0.38 (MM ft2)	0.01	0.00	N/A	0.04
Sales Canopies **(NC)**	0.16 (MM ft2)	0.01	0.00	N/A	0.03
Non-sales Canopies and Tunnels **(NC)**	2.69 (MM ft2)	0.05	0.01	N/A	0.13
Guard Stations **(NC)**	0.04 (MM ft2)	0.00	0.00	N/A	0.00
Student Pick-up/Drop-off zone **(NC)**	0.18 (MM ft2)	0.00	0.00	N/A	0.00
Outdoor Dining **(NC)**	0.62 (MM ft2)	0.00	0.00	N/A	0.00
Special Security Lighting for Retail Parking and Pedestrian Hardscape **(NC)**	0.53 (MM ft2)	0.00	0.00	N/A	0.00
Total – New Construction	N/A	**0.69**	**0.11**	**N/A**	**1.86**
General Hardscape **(A)**	390.83 (MM ft2)	1.13	0.14	N/A	3.00
Building Entrances or Exits **(A)**	103,660 (ea.)	0.14	0.03	N/A	0.38
Primary Entrances **(A)**	192 (ea.)	0.00	0.00	N/A	0.00
Drive Up Windows **(A)**	2,591 (ea.)	0.01	0.00	N/A	0.02
Vehicle Service Station Uncovered Fuel Dispenser **(A)**	96 (ea.)	0.00	0.00	N/A	0.00

ATM Machine Lighting **(A)**	385 (ea.)	0.00	0.00	N/A	0.00
Outdoor Sales Frontage **(A)**	0.29 (MM lin. ft)	0.30	0.07	N/A	0.87
Hardscape Ornamental Lighting **(A)**	14.92 (MM ft2)	0.02	0.00	N/A	0.06
Building Facades **(A)**	6.19 (MM ft2)	0.10	0.02	N/A	0.26
Outdoor Sales Lots **(A)**	2.89 (MM lin. ft)	0.06	0.01	N/A	0.17
Vehicle Service Station Hardscape **(A)**	10.59 (MM ft2)	0.12	0.02	N/A	0.31
Vehicle Service Station Canopies **(A)**	1.16 (MM ft2)	0.04	0.01	N/A	0.12
Sales Canopies **(A)**	0.48 (MM ft2)	0.04	0.01	N/A	0.10
Non-sales Canopies and Tunnels **(A)**	8.39 (MM ft2)	0.15	0.03	N/A	0.41
Guard Stations **(A)**	0.13 (MM ft2)	0.00	0.00	N/A	0.01
Student Pick-up/Drop-off zone **(A)**	0.68 (MM ft2)	0.00	0.00	N/A	0.01
Outdoor Dining **(A)**	1.86 (MM ft2)	0.00	0.00	N/A	0.01
Special Security Lighting for Retail Parking and Pedestrian Hardscape **(A)**	1.63 (MM ft2)	0.00	0.00	N/A	0.00
Total – Alterations	**N/A**	**2.13**	**0.34**	**N/A**	**5.74**
Total – All	**N/A**	**2.82**	**0.45**	**N/A**	**7.60**

a. First-year savings from all buildings completed statewide in 2023.

b. MM ft2: Million Square Feet; ea.: Each; MM lin. ft: Million Linear Feet. NC – New Construction, A – Alterations.

6.1.2 General Hardscape Lighting Power Allowance

Given data regarding the new construction forecast and expected additions and alterations in 2023, the Statewide CASE Team estimates that the proposed general hardscape reclassification code change would reduce annual statewide electricity use by 24.30 GWh with an associated demand reduction of 3.11 MW. No natural gas reductions are expected from this measure. The energy savings for buildings constructed in 2023 are associated with a present valued energy cost savings of approximately $64.58 million in (discounted) energy costs over the 15-year period of analysis.

Table 32: Statewide Energy and Energy Cost Impacts – General Hardscape – New Construction, Alterations, and Additions

Lighting Application	Statewide New Construction Impacted by Proposed Change in 2023 (million square feet)	First-Year[a] Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (MMtherms)	15-Year Present Valued Energy Cost Savings (million 2023 PV$)
General Hardscape – New Construction	125.49	5.91	0.76	N/A	$15.70
General Hardscape - Alterations	390.83	18.40	2.35	N/A	$48.89
Total	**516.32**	**24.30**	**3.11**	**N/A**	**$64.58**

a. First-year savings from all buildings completed statewide in 2023.

6.1.3 Multifamily Outdoor Lighting Power Allowance

Given data regarding the new construction forecast and expected additions and alterations in 2023, the Statewide CASE Team estimates that the proposed multifamily outdoor LPA code introduction would reduce annual statewide electricity use by 2.28 GWh with an associated demand reduction of 0.45 MW. Natural gas use would not be impacted. The statewide energy savings for buildings constructed in 2023 are associated with a present valued energy cost savings of approximately $1.89 million in (discounted) energy costs over the 15-year period of analysis. This information is shown in Table 33 and Table 34 below.

Table 33: Statewide Energy and Energy Cost Impacts Multifamily Outdoor Lighting Power Allowance – New Construction

Building Prototype	Statewide New Construction Impacted by Proposed Change in 2023 Dwelling Units	First-Year[a] Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (MMtherms)	15-Year Present Valued Energy Cost Savings (million 2023 PV$)
Low Rise Garden	2,079	0.29	0.06	NA	$0.24
Loaded Corridor	17,149	0.62	0.12	NA	$0.51
Mid-Rise Mixed Use	30,140	1.31	0.26	NA	$1.08
High Rise Mixed Use	2,598	0.06	0.01	NA	$0.05
TOTAL	**12,992**	**2.28**	**0.45**	**NA**	**$1.89**

a. First-year savings from all buildings completed statewide in 2023.

Table 34: Statewide Energy and Energy Cost Impacts Multifamily Outdoor Lighting Power Allowance – Alterations

Building Prototype	Statewide Alterations Impacted by Proposed Change in 2023 Dwelling Units	First-Year[a] Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (MMtherms)	15-Year Present Valued Energy Cost Savings (million 2023 PV$)
Low Rise Garden	8,620	1.20	0.24	NA	$1.00
Loaded Corridor	71,118	2.57	0.50	NA	$2.13
Mid-Rise Mixed Use	124,993	5.43	1.06	NA	$4.49
High Rise Mixed Use	10,776	0.27	0.05	NA	$0.22
TOTAL	**215,506**	**9.47**	**1.85**	**NA**	**$7.84**

a. First-year savings from all buildings completed statewide in 2023.

6.2 Statewide Greenhouse Gas (GHG) Emissions Reductions

The Statewide CASE Team calculated avoided GHG emissions assuming the emissions factors specified in the United States Environmental Protection Agency (U.S. EPA) Emissions & Generation Resource Integrated Database (eGRID) for the Western Electricity Coordination Council California (WECC CAMX) subregion.[18] Avoided GHG emissions from natural gas savings attributable to sources other than utility-scale electrical power generation are calculated using emissions factors specified in U.S. EPA's Compilation of Air Pollutant Emissions Factors (AP-42). See Appendix C for additional details on the methodology used to calculate GHG emissions. In short, this analysis assumes an average electricity emission factor of 240.4 metric tons CO2e per GWh based on the average emission factors for the CACX EGRID subregion.

Table 35 presents the estimated first-year avoided GHG emissions of the proposed code change. During the first year, GHG emissions of 9,331 metric tons of carbon dioxide equivalents (metric tons CO2e) would be avoided.

Table 35: First-Year Statewide GHG Emissions Impacts

Measure	Electricity Savings[a] (GWh/yr)	Reduced GHG Emissions from Electricity Savings[a] (Metric Tons CO2e)	Natural Gas Savings[a] (MMtherms/ yr)	Reduced GHG Emissions from Natural Gas Savings[a] (Metric Tons CO2e)	Total Reduced CO_2e Emissions[a,b] (Metric Tons CO2e)
Lighting Zone Reclassification	2.82	676.91	N/A	N/A	676.91
General Hardscape LPA	24.30	5,841.46	N/A	N/A	5,841.46
Multifamily Outdoor LPA	11.75	2,812.68	N/A	N/A	2,812.68
TOTAL	**38.87**	**9,331**	**N/A**	**N/A**	**9,331**

a. First-year savings from all buildings completed statewide in 2023.

b. Assumes the following emission factors: 240.4 MTCO2e/GWh and 5, 454.4 MTCO2e/MMTherms.

GHG first year savings from avoided material use are summarized below in Table 36. Overall CO2e reduction for both material types (i.e., concrete, aluminum) results in a

[18] When evaluating the impact of increasing the Renewable Portfolio Standard from 20 percent renewables by 2020 to 33 percent renewables by 2020, the California Air Resources Board (CARB) published data on expected air pollution emissions for various future electricity generation scenarios (CARB 2010). The incremental emissions were calculated by dividing the difference between California emissions in the CARB high and low generation forecasts by the difference between total electricity generated in those two scenarios.

total avoided emissions of 40,342 metric tons CO2e. Note that the GHG impact (in avoided CO2e) for concrete is 180 kg CO2e per m^3 (Lafarge 2010) based on a concrete density of 143 lb per ft^3 (Polebase 2014). Avoided emissions from aluminum is 3.12 kg CO2e per lb aluminum (Building Transparency 2020). Detailed calculations for these material impacts are located in Materials Impacts, Section 6.4.

Table 36: GHG First-Year Reductions from Materials Impacts

Measure	Reduced GHG Emissions from Concrete Material Use Reduction (Metric Tons CO2e)	Reduced GHG Emissions from Aluminum Material Use Reduction (Metric Tons CO2e)	Total Reduced GHG Emissions from Materials Impacts (Metric Tons CO2e)
General Hardscape LPA	5,685	27,563	33,248
Multifamily Outdoor LPA	1,201	5,892	7,093
TOTAL	**6,886**	**33,456**	**40,342**

6.3 Statewide Water Use Impacts

The proposed measure is not expected to have any impacts on water use or water quality, excluding impacts that occur at power plants.

6.4 Statewide Material Impacts

The lighting zone reclassification submeasure is not anticipated to result in a reduction of the equipment quantity installed in nonresidential outdoor applications. The Statewide CASE Team anticipates that the same products, except with lower luminaire lumen outputs, would be installed in project areas that have been reclassified from a LZ2 application to an LZ1 application. This reduction in lumen outputs is not anticipated to result in material savings.

The general hardscape submeasure would reduce the infrastructure required throughout the general hardscape area due to the 2022 Title 24, Part 6 code realignment with IES RP-8-18 Addendum 1. The general hardscape can be illuminated with fewer luminaires, spaced further apart, and still provide a quality lighting design that aligns with IES recommended lighting levels. This greater spacing reduces the quantity of luminaires, poles, foundations, motion sensors, conduit, and wiring installed in each general hardscape area.

The Statewide CASE Team estimated material impacts using the following methodology:

- Estimate material composition of a luminaire;
- Estimate material composition of an outdoor light pole, including wiring;
- Estimate the average reduction of luminaires and poles based on the lower LPAs. This analysis was completed for a small, medium, and large parking lot to account for different general hardscape designs and resulted in per unit, pounds per square foot results.
- Apply the per-unit savings to new construction and alterations estimates to develop statewide savings.

The Statewide CASE Team estimated material composition for luminaires by looking at the manufacturer specifications of an average outdoor, pole mounted luminaire. Unfortunately, the specifications only provided the total weight (31 pounds) of the luminaire and composition of the luminaire housing (aluminum). The Statewide CASE Team estimated that approximately 80 percent of the weight of the luminaire would be from the aluminum housing, recognizing that materials for the lens, screws, fasteners, and other miscellaneous materials would not be accounted for. This estimate also did not provide any information on the LEDs within the luminaire itself, so the Statewide CASE Team used a 2012 study that looked at the potential impacts from metals within different lamp types, including LEDs (Lim, et al. 2013). The study included estimated amounts of different types of metals within an LED luminaire (Lim, et al. 2013). The Statewide CASE Team recognized that this is an older study and material composition may differ in light sources and luminaires produced in 2020 versus those produced nearly 10 years ago. However, the Statewide CASE Team was unable to locate a comprehensive current study. The Statewide CASE Team used this information to estimate the total amount of materials contained within one luminaire (housing and LEDs).

The Statewide CASE Team used a single manufacturer's specifications for a 20-foot light pole. While many light poles would be greater than 20 feet in height (and 20-foot poles would have light controls attached), the Statewide CASE Team assumed poles would be 20 feet with no attached controls to simplify the calculation. The specific manufacturer sells light poles made from various materials, but the Statewide CASE Team decided an aluminum pole was the most common type. This assumption was based on professional lighting design experience and judgement. Based on the specifications, one aluminum light pole contains 140 pounds of aluminum. Based again on professional lighting design experience and judgement, the Statewide CASE Team estimated that each light pole would also require three 20-foot strands of #12 American wire gauge (AWG) copper conductors for internal wiring, and three 70-foot strands of #8

AWG copper conductors to connect to the next nearest light pole. The copper wiring adds up to approximately 7.1 pounds of copper.

The concrete pole foundation for a conventional outdoor luminaire is estimated to be a 7-foot tall (3-foot above grade), 2-foot diameter cylindrical foundation, with 5000 psi at 28 day strength benchmark. The composition of this concrete is Type I or Type III Portland cement in accordance with ASTM C150, fly ash or other pozzolans (e.g. blast furnace slag) in accordance with ACI 318-11-Table 4.4.2, aggregate in accordance with ASTM C33, Size 57, Class 4S, with a water to cementitious material max ratio of 0.40 in accordance with ASTM C143 (Polebase 2014). This concrete mixture has a manufacturer estimated density of 143 lb/ft^3, and an estimated CO2e impact of 180 kg CO2e per m^3 concrete (Lafarge 2010).

The Statewide CASE Team used three parking lot designs to estimate the number of light poles and luminaires that would be reduced as a result of the lower proposed LPAs. Specifically, the Statewide CASE Team used designs for a small, medium, and large parking lots. The Statewide CASE Team assumed different building types were likely to be associated with the different parking lot sizes. Refer to Table 37 below for mapping of building types to parking lot size. Based on the different parking lot size designs, the Statewide CASE Team also estimated the average number of luminaires and light poles that would be reduced for each parking lot size. Please see Table 38 for details on the reduced number of luminaires and light poles for each parking lot size.

Table 37: Mapping Building Types to Associated Parking Lot Size

Building Type	Associated Parking Lot Size	Percent Applied
Small Office	Small Parking Lot	100%
Large Office	Medium Parking Lot	100%
Restaurant	Small Parking Lot	100%
Retail	Large Parking Lot / Small Parking Lot	50% / 50%
Grocery Store	Medium Parking Lot / Small Parking Lot	50% / 50%
Non-Refrigerated Warehouse	Medium Parking Lot / Small Parking Lot	50% / 50%
Refrigerated Warehouse	Medium Parking Lot / Small Parking Lot	50% / 50%
Schools	Medium Parking Lot	100%
Colleges	Large Parking Lot	100%
Hospitals	Large Parking Lot	100%
Hotel/Motels	Medium Parking Lot	100%
Miscellaneous	Large Parking Lot / Medium Parking Lot / Small Parking Lot	33.33% / 33.33% / 33.33%

Table 38: Estimated Reduction in Luminaires and Light Poles per Different Sized Parking Lots, General Hardscape

Parking Lot	Parking Lot Size (ft^2)	Reduced Number of Luminaires	Reduced Number of Light Poles
Large Parking Lot	197,018	34	31
Medium Parking Lot	36,321	13	21
Small Parking Lot	15,536	10	8

Table 39: Estimated Reduction in Luminaires and Light Poles per Different Sized Parking Lots, Multifamily

Parking Lot	Parking Lot Size (ft^2)	Reduced Number of Luminaires	Reduced Number of Light Poles
Medium Parking Lot	36,321	14	16
Small Parking Lot	15,536	10	8

Most of the materials savings result from the reduction of light poles; each of which accounts for 140 pounds of aluminum and over seven pounds of copper saved. This per-pole material savings is converted into pounds of material saved per square foot of hardscape based on the number of poles reduced, versus the parking lot nominal size. The Statewide CASE Team then applied these unit savings to the same new construction estimates used for the energy and energy cost savings estimates. The statewide material impacts results show a significant reduction in aluminum and copper. The results of this analysis are outlined in Table 40 through Table 42, where material savings are tabulated for NR Outdoor LPA measure, Multifamily measure, and total impacts, respectively.

Table 40: First-Year Statewide Impacts on Material Use for General Hardscape Lighting Power Allowance

Material	Impact (I, D, or NC) [a]	Impact on Material Use (pounds/year)	
		Per-Unit Impacts (pounds/ft^2)	First-Year[b] Statewide Impacts
Aluminum	D	0.07	8,834,406.66
Antimony	D	1.83×10^{-8}	2.50
Barium	D	5.39×10^{-8}	7.36
Cerium	D	1.12×10^{-9}	0.15
Chromium	D	1.77×10^{-8}	2.41
Concrete	D	1.28	159,502,587.50
Copper	D	2.98×10^{-3}	382,344.15
Gallium	D	1.60×10^{-8}	2.18
Gold	D	3.45×10^{-10}	0.05
Iron	D	1.82×10^{-6}	248.11
Lead	D	2.50×10^{-9}	0.34
Mercury	D	8.63×10^{-11}	0.01
Nickel	D	2.24×10^{-8}	3.06
Phosphorus	D	1.88×10^{-8}	2.57
Silver	D	2.36×10^{-8}	3.21
Tungsten	D	1.73×10^{-10}	0.02
Yttrium	D	2.59×10^{-10}	0.04
Zinc	D	6.73×10^{-7}	91.82

a. Material Increase (I), Decrease (D), or No Change (NC) compared to base case (lbs/yr).

b. First-year savings from all buildings completed statewide in 2023, including new construction and alterations.

Table 41: First-Year Statewide Impacts on Material Use for Multifamily Hardscape Lighting Power Allowance

Material	Impact (I, D, or NC) [a]	Impact on Material Use (pounds/year)	
		Per-Unit Impacts (pounds/ft^2)	First-Year[b] Statewide Impacts
Aluminum	D	0.08	1,888,538.28
Antimony	D	2.40×10^{-8}	0.57
Barium	D	7.09×10^{-8}	1.68
Cerium	D	1.47×10^{-9}	0.03
Chromium	D	2.33×10^{-8}	0.55
Concrete	D	1.42	33,691,968.58
Copper	D	3.41×10^{-3}	80,773.78
Gallium	D	2.10×10^{-8}	0.50
Gold	D	$4.54x\ 10^{-10}$	0.01
Iron	D	2.39×10^{-6}	56.55
Lead	D	3.29×10^{-9}	0.08
Mercury	D	$1.13x\ 10^{-11}$	0.00
Nickel	D	2.95×10^{-8}	0.70
Phosphorus	D	2.47×10^{-8}	0.59
Silver	D	3.10×10^{-8}	0.73
Tungsten	D	2.27×10^{-10}	0.01
Yttrium	D	3.40×10^{-10}	0.01
Zinc	D	8.85×10^{-7}	20.93

a. Material Increase (I), Decrease (D), or No Change (NC) compared to base case (lbs/yr).

b. First-year savings from all buildings completed statewide in 2023, including new construction and alterations

Table 42: First-Year Statewide Impacts on Material Use for All Measures

Material	Impact (I, D, or NC) [a]	First-Year[b] Statewide Impacts (pounds/year)
Aluminum	D	10,722,944.94
Antimony	D	3.07
Barium	D	9.04
Cerium	D	0.19
Chromium	D	2.96
Concrete	D	193,194,556.08
Copper	D	463,117.93
Gallium	D	2.67
Gold	D	0.06
Iron	D	304.65
Lead	D	0.42
Mercury	D	0.01
Nickel	D	3.76
Phosphorus	D	3.15
Silver	D	3.95
Tungsten	D	0.03
Yttrium	D	0.04
Zinc	D	112.75

a. Material Increase (I), Decrease (D), or No Change (NC) compared to base case (lbs/yr).

b. First-year savings from all buildings completed statewide in 2023, including new construction and alterations

6.5 Other Non-Energy Impacts

Realigning the lighting zone classifications with IES and IDA definitions, along with reducing the amount of light required to meet IES recommended lighting levels in general hardscape applications would positively impact the ecosystem. Light at night has increased by 1.8 to 2.2 percent each year since 2012 (Benes 2018), with 83 percent of the human population living under light polluted skies (Falchi et al. 2016). As Travis Longcore and Catherine Rich stated in Artificial Night Lighting and Protected Lands: Ecological Effects and Management Approaches “The disruption of natural patterns of light and dark, which have been more or less reliable for millions of years, has a range of adverse consequences for wildlife across taxonomic groups and landscape types” (Longcore and Rich 2016).

6.5.1 Air Quality

A study completed by the Cooperative Institute for Research in Environmental Sciences at University of Colorado (CIRES) with the National Oceanic and Atmospheric

Administration (NOAA) in 2010 determined that light at night increased air pollution the next day (Stark, et al. 2011). CIRES measured the light intensity at night along with nitrate radical loss over the City of Los Angeles. In areas of high light pollution (sky glow) the studies showed that the nitrate radical levels were reduced by up to four percent while nitrate oxide levels were increased by up to 3.5 percent. Free nitrate radicals, within the air, break down particles that can result in air pollution such as smog; whereas, nitrate oxide can result in oxidation which can increase the acidity of water particles within the air (Stark, et al. 2011).

6.5.2 Impacts to Fauna

Numerous studies have shown that electric lights at night increase light trespass and light pollution (sky glow), resulting in animal behavioral changes. Gaston, Davies, Nedelec, and Holt published a study titled *Impacts of Artificial Light at Night on Biological Timings* which discusses artificial light at night and its effects on flora and fauna. These researchers point out the strong biological impacts that electric light at night have by disrupting the Earth's natural night-dark light cycles. The increase of light at night changes foraging, reproductive behavior, migration, hibernation, and molting of fauna (Gaston 2017).

The use of electric lighting at night changes the typical behavior to pollinators such as the moth. Moths and other photosensitive insects and are drawn to electric lighting installed at typical heights of ten to fifty feet above pollinating plants. The pollination transport of the moth and other nocturnal insects is disrupted by the moths flying above typical flowering plant heights (Macgregor, Evans, et al. 2016). These lighted areas also draw moths from adjacent communities, which limits the pollen transfer in unlighted areas. These factors have resulted in a decline in the moth population which would have an adverse effect on ecosystem stability as the number of pollinating transporters are reduced (Macgregor, Pocock, et al. 2014).

Furthermore, the presence of electric lighting also changes the foraging and prey-predator behaviors of diurnal and nocturnal animals. The increased lighting levels at dusk and dawn extend the duration of foraging for diurnal animals, while shortening the foraging period for nocturnal animals. These changes to foraging patterns result in an increased predation risk for small mammals and other prey (Longcore and Rich, Ecological light pollution 2004). A study by Minnaar et al. 2015, found that bats in lighted areas ate six times more moths than those in unlighted areas due to the moths photosensitive nature (Minnaar, et al. 2015).

6.5.3 Impacts to Flora

Light at night impacts the flowering and maturation of plants. Scientists at the University of Exeter found that low levels of ambient light, such as sky glow from electric lighting at night, disrupt the plant growth cycle which results in early or late flowering of plants. The

research noted that while vegetation immediately adjacent to a light source displays delayed maturation, sky glow may have an impact on plants hundreds of miles away (Bennie 2018). The increase of light at night impacts bud bursting, fragrance emission, germination and growth patterns of flora (Gaston 2017).

Similarly, soybean growth adjacent to streetlights were studied by the Illinois Department of Transportation (IDOT) and the Virginia Transportation Technical Institute (VTTI) to determine the impact that light at night has on soybean plant development. Seven different locations were analyzed to compare the plant growth, maturity, and yield. The study found that the maturation of soybeans adjacent to streetlights were delayed by up to seven weeks (Palmer, et al. 2017).

6.5.4 Multifamily

For the multifamily outdoor LPA submeasure, there are additional non-energy benefits associated with the removal of allowances that are inconsistent with residential neighborhoods that would result in a reduction in light trespass and excessive light levels. Since this is situationally dependent, some situations may not see a difference, but others may benefit from this measure.

This measure proposes to simplify the compliance process for multifamily buildings by eliminating the three-factor LPA calculation approach and moving to a simpler two-factor approach. This approach would eliminate the Linear Wattage Allowance (LWA) in Table 140.7-A and recalculating the Area Wattage Allowance (AWA) to compensate for the difference, which would be designated as the AWA_{MF} to differentiate this allowance from the AWA in the nonresidential sections. The Initial Wattage Allowance (IWA) would remain, but would have different values from the nonresidential allowance, and thus be designated IWA_{MF}.

7. Proposed Revisions to Code Language

7.1 Guide to Markup Language

The proposed changes to the standards, Reference Appendices, and the ACM Reference Manuals are provided below. Changes to the 2019 documents are marked with red underlining (new language) and ~~strikethroughs~~ (deletions).

7.2 Standards

7.2.1 Standards: Nonresidential Lighting Zone Reclassification

SECTION 10-114 – DETERMINATION OF OUTDOOR LIGHTING ZONES AND ADMINISTRATIVE RULES FOR USE

TABLE 10-114-A LIGHTING ZONE CHARACTERISTICS AND RULES FOR AMENDMENTS BY LOCAL JURISDICTIONS

Zone	Ambient Illumination	Statewide Default Location	Moving Up to Higher Zones	Moving Down to Lower Zones
LZ0	Very Low	Undeveloped areas of government designated parks, recreation areas, and wildlife preserves.	Undeveloped areas of government designated parks, recreation areas, and wildlife preserves can be designated as LZ1 or LZ2 if they are contained within such a zone.	Not applicable
LZ1	Low	Rural areas, as defined by the 2010 U.S. Census. These areas include: single or dual family residential areas, parks, and agricultural zone districts, d~~D~~eveloped portion of government designated parks, recreation areas, and wildlife preserves. Those that are wholly contained within a higher lighting zone may be considered by the	Retail stores, located in a residential neighborhood, and rural town centers, as defined by the 2010 U.S. Census, can be designed as LZ2 if the business operates during hours of darkness. Developed portion of a government designated park, recreation area, or wildlife preserve, can be designated as LZ2 ~~or LZ3~~ if they are	Not applicable.

Zone	Ambient Illumination	Statewide Default Location	Moving Up to Higher Zones	Moving Down to Lower Zones
		local government as part of that lighting zone.	contained within such a zone.	
LZ2	Moderate	Urban clusters ~~Rural areas,~~ as defined by the 2010 U.S. Census. The following building types are likely to occur here: multi-family housing, mixed use residential neighborhoods, religious facilities, schools, and light commercial business districts or industrial zoning districts.	Special districts within a default LZ2 zone may be designated as LZ3 ~~or LZ4~~ by a local jurisdiction. Examples include special commercial districts or areas with special security considerations located within a mixed-use residential area or city center. ~~rural area.~~	Special districts ~~and government designated parks within a default LZ2 zone~~ maybe designated as LZ1 by the local jurisdiction for lower illumination standards, without any size limits.
LZ3	Moderately High	Urban areas as defined by the 2010 U.S. Census. The following building types are likely to occur here: high intensity commercial corridors, entertainment centers, and heavy industrial or manufacturing zone districts.	Special districts within a default LZ3 may be designated as a LZ4 by local jurisdiction for high intensity nighttime use, such as entertainment or commercial districts or areas with special security considerations requiring very high light levels.	Special districts ~~and government designated parks~~ within a default LZ3 zone may be designated as LZ1 or LZ2 by the local jurisdiction, without any size limits.
LZ4	High	None.	Not applicable.	Not applicable.

NOTE: Authority: Sections 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

7.2.2 Standards: Nonresidential Lighting Power Allowances for General Hardscape

SECTION 100.1 - DEFINITIONS AND RULES OF CONSTRUCTION

IES LM-79 ~~08~~ is the Illuminating Engineering Society document titled, "~~IES~~ Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products" ~~(2008)~~.

IES RP-8 is the Illuminating Engineering Society document titled, "American National Standard Practice for Design and Maintenance of Roadway and Parking Facility Lighting".

IES TM-15-11 is the Illuminating Engineering Society document titled, "Luminaire Classification Systems for Outdoor Luminaires" ~~(2011)~~.

Ornamental, Luminaires installed outdoor which are rated for 50 ~~100~~ watts or less that are post-top luminaires, lanterns, pendant luminaires, chandeliers, and marque lighting, not providing general lighting or task lighting

Security cameras are any operational camera used to enhance the safety and security within a general hardscape area.

SECTION 130.2 – OUTDOOR LIGHTING CONTROLS AND EQUIPMENT

(b) Luminaire ~~Cutoff~~ Shielding Requirements: All outdoor luminaires of 6,200 initial luminaire lumens or greater, shall comply with Backlight, Uplight, and Glare (collectively referred to as "BUG" in accordance with IES TM-15-11, Addendum A) requirements as follows

SECTION 140.7 – PRESCRIPTIVE REQUIREMENTS FOR OUTDOOR LIGHTING

TABLE 140.7-A GENERAL HARDSCAPE LIGHTING POWER ALLOWANCE

Type of Power Allowance	Lighting Zone 0[3]	Lighting Zone 1[3]	Lighting Zone 2[3]		Lighting Zone 3[3]		Lighting Zone 4[3]
	~~Asphalt/Concrete~~	~~Asphalt/Concrete~~	~~Asphalt~~	~~Concrete[2]~~	~~Asphalt~~	~~Concrete[2]~~	~~Asphalt/Concrete~~
Area Wattage Allowance (AWA)	No allowance[1]	0.016 ~~0.018~~ W/ft²	0.019 ~~0.023~~ W/ft²	~~0.025 W/ft²~~	0.021 ~~0.025~~ W/ft²	~~0.03 W/ft²~~	0.024 ~~0.03~~ W/ft²
Linear Wattage Allowance (LWA)	No allowance[1]	0.13 ~~0.15~~ W/lf	0.15 ~~0.17~~ W/lf	~~0.4 W/lf~~	0.20 ~~0.25~~ W/lf	~~0.4 W/lf~~	0.29 ~~0.35~~ W/lf
Initial Wattage Allowance (IWA)	No allowance[1]	150 ~~180~~ W	200 ~~250~~ W	~~250 W~~	250 ~~350~~ W	~~350 W~~	320 ~~400~~ W

[1]Continuous lighting is explicitly prohibited in Lighting Zone 0. A single luminaire of 15 Watts or less may be installed at an entrance to a parking area, trail head, fee payment kiosk, outhouse, or toilet facility, as required to provide safe navigation of the site infrastructure. Luminaires installed shall meet the maximum zonal lumen limits as specified in Section 130.2(b).

~~[2]Where greater than 50% of the paved surface of a parking lot is finished with concrete. This does not extend beyond the parking lot, and does not include any other General Hardscape areas.~~

[2]Narrow band spectrum light sources with a dominant peak wavelength greater than 580 nm – as mandated by local, state, or federal agencies to minimize the impact on local, active professional astronomy or nocturnal habitat of specific local fauna – shall be allowed a 2.0 lighting power allowance multiplier.

TABLE 140.7-B ADDITIONAL LIGHTING POWER ALLOWANCE FOR SPECIFIC APPLICATIONS

Lighting Application		Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
	WATTAGE ALLOWANCE PER APPLICATION. Use all that apply as appropriate.					
Building Entrances or Exits. Allowance per door. Luminaires qualifying for this allowance shall be within 20 feet of the door.		Not applicable	9 watts	15 watts	19 watts	21 watts
Primary Entrances to Senior Care Facilities, Police Stations, Healthcare Facilities, Fire Stations, and Emergency Vehicle Facilities. Allowance per primary entrance(s) only. Primary entrances shall provide access for the general public and shall not be used exclusively for staff or service personnel. This allowance shall be in addition to the building entrance or exit allowance above. Luminaires qualifying for this allowance shall be within 100 feet of the primary entrance.		Not applicable	20 watts	40 watts	57 watts	60 watts
Drive Up Windows. Allowance per customer service location. Luminaires qualifying for this allowance shall be within 2 mounting heights of the sill of the window.		Not applicable	16 watts	30 watts	50 watts	75 watts
Vehicle Service Station Uncovered Fuel Dispenser. Allowance per fueling dispenser. Luminaires qualifying for this allowance shall be within 2 mounting heights of the dispenser.		Not applicable	55 watts	77 watts	81 watts	135 watts
ATM Machine Lighting. Allowance per ATM machine. Luminaires qualifying for		Not applicable	100 watts for first ATM machine, 35 watts for each additional ATM machine.			

Lighting Application	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
this allowance shall be within 50 feet of the dispenser.					
WATTAGE ALLOWANCE PER UNIT LENGTH (w/linear ft). May be used for one or two frontage side(s) per site.					
Outdoor Sales Frontage. Allowance for frontage immediately adjacent to the principal viewing location(s) and unobstructed for its viewing length. A corner sales lot may include two adjacent sides provided that a different principal viewing location exists for each side. Luminaires qualifying for this allowance shall be located between the principal viewing location and the frontage outdoor sales area.	Not applicable	No Allowance	11 W/linear ft	19 W/linear ft	25 W/linear ft
WATTAGE ALLOWANCE PER HARDSCAPE AREA (W/ft²). May be used for any illuminated hardscape area on the site.					
Hardscape Ornamental Lighting. Allowance for the total site illuminated hardscape area. Luminaires qualifying for this allowance shall be rated for 50 ~~100~~ watts or less as determined in accordance with Section 130.0(d), and shall be post-top luminaires, lanterns, pendant luminaires, or chandeliers.	Not applicable	No Allowance	0.007 W/ft²	0.013 W/ft²	0.019 W/ft²
WATTAGE ALLOWANCE PER SPECIFIC AREA (W/ft²). Use as appropriate provided that none of the following specific applications shall be used for the same area.					
Building Facades. Only areas of building façade that are illuminated shall qualify for this allowance. Luminaires qualifying for this allowance shall be aimed at the façade and shall be capable of illuminating it	Not applicable	No Allowance	0.100 W/ft²	0.170 W/ft²	0.225 W/ft²

Lighting Application	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
without obstruction or interference by permanent building features or other objects.					
Outdoor Sales Lots. Allowance for uncovered sales lots used exclusively for the display of vehicles or other merchandise for sale. Driveways, parking lots or other non-sales areas shall be considered hardscape areas even if these areas are completely surrounded by sales lot on all sides. Luminaires qualifying for this allowance shall be within 5 mounting heights of the sales lot area.	Not applicable	0.060 W/ft²	0.210 W/ft²	0.280 W/ft²	0.485 W/ft²
Vehicle Service Station Hardscape. Allowance for the total illuminated hardscape area less area of buildings, under canopies, off property, or obstructed by signs or structures. Luminaires qualifying for this allowance shall be illuminating the hardscape area and shall not be within a building, below a canopy, beyond property lines, or obstructed by a sign or other structure.	Not applicable	0.006 W/ft²	0.068 W/ft²	0.138 W/ft²	0.200 W/ft²
Vehicle Service Station Canopies. Allowance for the total area within the drip line of the canopy. Luminaires qualifying for this allowance shall be located under the canopy.	Not applicable	0.220 W/ft²	0.430 W/ft²	0.580 W/ft²	1.010 W/ft²
Sales Canopies. Allowance for the total area within the drip line of the canopy. Luminaires qualifying for this allowance shall be located under the canopy.	Not applicable	No Allowance	0.470 W/ft²	0.622 W/ft²	0.740 W/ft²

Lighting Application	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Non-sales Canopies and Tunnels. Allowance for the total area within the drip line of the canopy or inside the tunnel. Luminaires qualifying for this allowance shall be located under the canopy or tunnel.	Not applicable	0.057 W/ft²	0.137 W/ft²	0.270 W/ft²	0.370 W/ft²
Guard Stations. Allowance up to 1,000 square feet per vehicle lane. Guard stations provide access to secure areas controlled by security personnel who stop and may inspect vehicles and vehicle occupants, including identification, documentation, vehicle license plates, and vehicle contents. Qualifying luminaires shall be within 2 mounting heights of a vehicle lane or the guardhouse.	Not applicable	0.081 W/ft²	0.176 W/ft²	0.325 W/ft²	0.425 W/ft²
Student Pick-up/Drop-off zone. Allowance for the area of the student pick-up/drop-off zone, with or without canopy, for preschool through 12th grade school campuses. A student pick-up/drop off zone is a curbside, controlled traffic area on a school campus where students are picked-up and dropped off from vehicles. The allowed area shall be the smaller of the actual width or 25 feet, times the smaller of the actual length or 250 feet. Qualifying luminaires shall be within 2 mounting heights of the student pick-up/drop-off zone.	Not applicable	No Allowance	0.056 W/ft²	0.200 W/ft²	No Allowance
Outdoor Dining. Allowance for the total illuminated hardscape of outdoor dining. Outdoor dining areas are hardscape areas used to serve and consume food and beverages. Qualifying luminaires shall be	Not applicable	0.004 W/ft²	0.030 W/ft²	0.050 W/ft²	0.075 W/ft²

Lighting Application	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
within 2 mounting heights of the hardscape area of outdoor dining.					
Special Security Lighting for Retail Parking and Pedestrian Hardscape. This additional allowance is for illuminated retail parking and pedestrian hardscape identified as having special security needs. This allowance shall be in addition to the building entrance or exit allowance.	Not applicable	0.004 W/ft²	0.005 W/ft²	0.010 W/ft²	No Allowance
Security Camera. This additional allowance is for the illuminated general hardscape area. This allowance shall apply when a security camera is installed within 2 mounting heights of the general hardscape area and mounted more than 10 feet away from a building.	Not applicable	No Allowance	0.018 W/ft²	0.018 W/ft²	0.018 W/ft²

7.2.3 Standards: Multifamily Outdoor Lighting Power Allowances

Create a new code section in 2022 Title 24, Part 6 that uses Sections 130.2 and 140.7 as the genesis. These changes are specific to multifamily buildings and not indicative of changes that may apply to residential or nonresidential building code sections that would remain.

Note that in the code language listed below, the current nonresidential code section citations are being used in lieu of new proposed code sections since they have not been determined yet.

SECTION 130.2 – OUTDOOR LIGHTING CONTROLS AND EQUIPMENT FOR MULTIFAMILY BUILDING TYPE

[Section numbers will be revised once new section assignment is complete.]

~~Nonresidential, high-rise residential~~ Multifamily ~~and hotel/motel~~ buildings shall comply with the applicable requirements of Sections 130.2(a) through 130.2(c).

Projects that include residential units (apartments, condos, or similar) that meet the general requirements as a multifamily building per the definitions in Section 100.1 are subject to the outdoor lighting requirements provided in this section. Hotels and motels are excluded from the classification. Projects that include nonresidential interior building areas (commonly called "mixed-use buildings") must follow the requirements of this section of the code. Refer to Section

X (section number to be determined) for specific information on the classification of a project as a multifamily building project.

(a)**RESERVED**

(b)**Luminaire ~~Cutoff~~ Shielding Requirements.** All outdoor luminaires of 6,200 initial luminaire lumens or greater, shall comply with Backlight, Uplight, and Glare (collectively referred to as "BUG" in accordance with IES TM-15-11, Addendum A) requirements as follows:

1.Maximum zonal lumens for Backlight, Uplight, and Glare shall be in accordance with Title 24, Part 11, Section 5.106.8.

EXCEPTION 1 to Section 130.2(b): Signs.

EXCEPTION 2 to Section 130.2(b): Lighting for building facades, public monuments, statues, and vertical surfaces of bridges.

EXCEPTION 3 to Section 130.2(b): Lighting not permitted by a health or life safety statute, ordinance, or regulation to be a cutoff luminaire.

EXCEPTION 4 to Section 130.2(b): Temporary outdoor lighting**.**

EXCEPTION 5 to Section 130.2(b): Replacement of existing pole mounted luminaires in hardscape areas meeting all of the following conditions:

A. Where the existing luminaire does not meet the luminaire BUG requirements in Section 130.2(b); and

B. Spacing between existing poles is greater than six times the mounting height of the existing luminaires; and

C. Where no additional poles are being added to the site; and

D. Where new wiring to the luminaires is not being installed; and

E. Provided that the connected lighting power wattage is not increased.

EXCEPTION 6 to Section 130.2(b): Luminaires that illuminate the public right of way ~~on publicly maintained~~ (including all roadways, sidewalks, and bikeways that are owned or maintained by the public municipality or utility).

EXCEPTION 7 to Section 130.2(b): Outdoor lighting attached to a ~~high-rise residential or hotel/motel building and separately controlled from the inside of a dwelling unit or guest room.~~ multifamily building and separately controlled from inside of a dwelling unit.

(c)**Controls for Outdoor Lighting.** Outdoor lighting shall be independently controlled from other electrical loads, and the controls for outdoor lighting shall meet the following functional requirements:

EXCEPTION 1 to Section 130.2(c): Outdoor lighting not permitted by a health or life safety statute, ordinance, or regulation to be turned OFF or reduced.

EXCEPTION 2 to Section 130.2(c): Lighting in tunnels required to be illuminated 24 hours per day and 365 days per year.

1. **Daylight Availability.** All installed outdoor lighting shall be controlled by a photo control, astronomical time-switch control, or other control capable of automatically shutting OFF the outdoor lighting when daylight is available.

2. **Automatic Scheduling Controls.**

   A. Automatic scheduling controls shall be capable of reducing the outdoor lighting power by at least ~~50~~ 60 percent and no more than 90 percent, and separately capable of turning the lighting OFF, during scheduled unoccupied periods.

   B. Automatic scheduling controls shall allow scheduling of a minimum of two nighttime periods with independent lighting levels and may include an override function that turns lighting ON during its scheduled dim or OFF state for no more than two hours when an override is initiated.

   C. Acceptance tests of outdoor lighting controls shall verify the scheduled occupied and unoccupied periods, as specified in Section 130.4(a)6.

   D. Automatic scheduling controls shall be installed for all outdoor lighting and may be installed in combination with motion sensing controls or other outdoor lighting controls.

3. **Motion Sensing Controls.**

   A. Motion sensing controls shall be capable of reducing the outdoor lighting power of each controlled luminaire by at least ~~50~~ 60 percent and no more than 90 percent, and separately capable of turning the luminaire OFF, during unoccupied periods.

   B. Motion sensing controls shall be capable of reducing the lighting to its dim or OFF state no longer than 15 minutes after the area has been vacated, and of returning the lighting to its ON state when the area becomes occupied.

   C. No more than 1,500 watts of lighting power shall be controlled by a single sensor.

   D. Motion sensing controls shall be installed for the following luminaires, and may be installed for other outdoor lighting and in combination with other outdoor lighting controls:

      i. Outdoor luminaires other than Building Façade, Ornamental Hardscape, or Outdoor Dining, ~~or Outdoor Sales Frontage lighting,~~ where the bottom of luminaire is mounted 24 feet or less above grade; and,

      ii. Outdoor wall mounted luminaires installed for Building Façade, Ornamental Hardscape or Outdoor Dining lighting that have a bilaterally symmetric distribution as described in the IES Handbook (typically referred to as “wall packs”) mounted 24 feet above grade or lower.

EXCEPTION 1 to Section 130.2(c)3: Luminaires with a maximum rated wattage of 40 watts each are not required to have motion sensing controls.

EXCEPTION 2 to Section 130.2(c)3: Applications listed as Exceptions to Section 140.7(a) are not required to have motion sensing controls.

EXCEPTION 3 to Section 130.2(c)3: Lighting subject to a health or life safety statute, ordinance, or regulation may have a minimum time-out period longer than 15 minutes or a minimum dimming level above 50 percent when necessary to comply with the applicable law.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

SECTION 140.7 – PRESCRIPTIVE REQUIREMENTS FOR OUTDOOR LIGHTING FOR MULTIFAMILY BUILDING TYPE

[Section numbers will be revised once new section assignment is complete.]

Projects that include residential units (apartments, condos, or similar) that meet the general requirements as a multifamily building per the definitions in Section 100.1 are subject to the outdoor lighting requirements provided in this section. Hotels and motels are excluded from the classification. Projects that include nonresidential interior building areas (commonly called "mixed-use buildings") must follow the requirements of this section of the code. Refer to Section X (section number to be determined) for specific information on the classification of a project as a multifamily building project.

(a) A multifamily outdoor lighting installation complies with this section if it meets the requirements in Subsections (b) and (c), and the actual outdoor lighting power installed is no greater than the allowed outdoor lighting power calculated under Subsection (d). The allowed outdoor lighting shall be calculated according to Outdoor Lighting Zone in Title 24, Part 1, Section 10-114.

EXCEPTIONS to Section 140.7(a): When more than 50 percent of the light from a luminaire falls within one or more of the following applications, the lighting power for that luminaire shall be exempt from Section 140.7:

1. Temporary outdoor lighting.
2. Lighting required and regulated by the Federal Aviation Administration, and the Coast Guard.
3. Lighting for public streets, roadways, highways, and traffic signage lighting, including lighting for driveway entrances occurring in the public right-of-way owned or maintained by the local municipality or utility.
4. Lighting for sports and athletic fields, and children's playgrounds.

5. ~~Lighting for industrial sites, including but not limited to, rail yards, maritime shipyards and docks, piers and marinas, chemical and petroleum processing plants, and aviation facilities.~~

6. Lighting of public monuments.

7. Lighting of signs complying with the requirements of Sections 130.3 and 140.8.

8. Lighting of stairs, wheelchair elevator lifts for American with Disabilities Act (ADA) compliance, and ramps that are other than parking garage ramps.

9. Landscape lighting.

10. ~~In theme parks: outdoor lighting only for themes and special effects.~~

11. Lighting for outdoor theatrical and other outdoor live performances, provided that these lighting systems are additions to area lighting systems and are controlled by a multi-scene or theatrical cross-fade control station accessible only to authorized operators.

12. Outdoor lighting systems for qualified historic buildings, as defined in the California Historic Building Code (Title 24, Part 8), if they consist solely of historic lighting components or replicas of historic lighting components. If lighting systems for qualified historic buildings contain some historic lighting components or replicas of historic components, combined with other lighting components, only those historic or historic replica components are exempt. All other outdoor lighting systems for qualified historic buildings shall comply with Section 140.7.

(b)**Outdoor Lighting Power Trade-offs.** Outdoor lighting power trade-offs shall be determined as follows:

1. Allowed lighting power determined according to Section 140.7(d)1 for general hardscape lighting allowance may be traded to specific applications in Section 140.7(d)2, provided the hardscape area from which the lighting power is traded continues to be illuminated in accordance with Section 140.7(d)1A.

2. Allowed lighting power determined according to Section 140.7(d)2 for additional lighting power allowances for specific applications shall not be traded between specific applications, or to hardscape lighting in Section 140.7(d)1.

3. Trading off lighting power allowances between outdoor and indoor areas shall not be permitted.

(c)**Calculation of Actual Lighting Power.** The wattage of outdoor luminaires shall be determined in accordance with Section 130.0(c).

(d)**Calculation of Allowed Lighting Power.** The allowed lighting power shall be the combined total of the sum of the general hardscape lighting allowance determined in accordance with Section 140.7(d)1, and the sum of the additional lighting power allowance for specific applications determined in accordance with Section 140.7(d)2.

1. **General Hardscape Lighting Allowance.** Determine the general hardscape lighting power allowances as follows:

   A. The general hardscape area of a site shall include parking lot(s), roadway(s), driveway(s), sidewalk(s), walkway(s), bikeway(s), plaza(s), bridge(s), tunnel(s), and other improved area(s) that are illuminated. Roadway(s) that are illuminated by a lighting system owned or operated by the local municipality or utility shall not be included in the area calculations. In plan view of the site, determine the illuminated hardscape area, which is defined as any hardscape area that is within a square pattern around each luminaire or pole that is ten times the luminaire mounting height with the luminaire in the middle of the pattern, less any areas that are within a building, beyond the hardscape area, beyond property lines, or obstructed by a structure. The illuminated hardscape area shall include portions of planters and landscaped areas that are within the lighting application and are less than or equal to 10 feet wide in the short dimensions and are enclosed by hardscape or other improvement on at least three sides. Multiply the illuminated hardscape area by the Area Wattage Allowance (AWA) from Table 140.7-A for the appropriate Lighting Zone.

~~B. Determine the perimeter length of the general hardscape area. The total perimeter shall not include portions of hardscape that is not illuminated according to Section 140.7(d)1A. Multiply the hardscape perimeter by the Linear Wattage Allowance (LWA) for hardscape from Table 140.7-A for the appropriate lighting zone. The perimeter length for hardscape around landscaped areas and permanent planters shall be determined as follows:~~

~~i. Landscaped areas completely enclosed within the hardscape area, and which have a width or length less than 10 feet wide, shall not be added to the hardscape perimeter length.~~

~~ii. Landscaped areas completely enclosed within the hardscape area, and which width or length is a minimum of 10 feet wide, the perimeter of the landscaped areas or permanent planter shall be added to the hardscape perimeter length.~~

~~iii. Landscaped edges that are not abutting the hardscape shall not be added to the hardscape perimeter length.~~

C. Determine the Initial Wattage Allowance (IWA) for general hardscape lighting from Table 140.7-A for the appropriate lighting zone. The hardscape area shall be permitted one IWA per site.

D. The general hardscape lighting allowance shall be the sum of the allowed watts determined from (A), ~~(B)~~ and (C) above.

2. **Additional Lighting Power Allowance for Specific Applications.** Additional lighting power for specific applications shall be the smaller of the additional lighting allowances for specific

applications determined in accordance with TABLE 140.7-B for the appropriate lighting zone, or the actual installed lighting power meeting the requirements for the allowance.

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8, and 25943, Public Resources Code.

TABLE 140.7-A GENERAL HARDSCAPE MULTIFAMILY LIGHTING POWER ALLOWANCE

Type of Power Allowance	Lighting Zone 0[3]	Lighting Zone 1[3]	Lighting Zone 2[3]		Lighting Zone 3[3]		Lighting Zone 4[3]
	~~Asphalt/Concrete~~	~~Asphalt/Concrete~~	~~Asphalt~~	~~Concrete[2]~~	~~Asphalt~~	~~Concrete[2]~~	~~Asphalt/Concrete~~
Area Wattage Allowance (AWA)	No allowance[1]	0.026 ~~0.018~~ W/ft²	0.030 ~~0.023~~ W/ft²	~~0.025 W/ft²~~	0.038 ~~0.025~~ W/ft²	~~0.03 W/ft²~~	0.055 ~~0.03~~ W/ft²
~~Linear Wattage Allowance (LWA)~~		~~0.15 W/lf~~	~~0.17 W/lf~~	~~0.4 W/lf~~	~~0.25 W/lf~~	~~0.4 W/lf~~	~~0.35 W/lf~~
Initial Wattage Allowance (IWA)		300 ~~180~~ W	350 ~~250~~ W	~~250 W~~	400 ~~350~~ W	~~350 W~~	450 ~~400~~ W

[1]Continuous lighting is explicitly prohibited in Lighting Zone 0. A single luminaire of 15 Watts or less may be installed at an entrance to a parking area, trail head, fee payment kiosk, outhouse, or toilet facility, as required to provide safe navigation of the site infrastructure. Luminaires installed shall meet the maximum zonal lumen limits as specified in Section 130.2(b).

~~[2]Where greater than 50% of the paved surface of a parking lot is finished with concrete. This does not extend beyond the parking lot, and does not include any other General Hardscape areas.~~

[2]Narrow band spectrum light sources with a dominant peak wavelength greater than 580 nm – as mandated by local, state, or federal agencies to minimize the impact on local, active professional astronomy or nocturnal habitat of specific local fauna – shall be allowed a 2.0 lighting power allowance multiplier.

TABLE 140.7-B ADDITIONAL MULTIFAMILY LIGHTING POWER ALLOWANCE FOR SPECIFIC APPLICATIONS

All area and distance measurements in plan view unless otherwise noted.

Lighting Application	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
WATTAGE ALLOWANCE PER APPLICATION. Use all that apply as appropriate.					
Building Entrances or Exits. Allowance per door. Luminaires qualifying for this allowance shall be within 20 feet of the door.	Not applicable	9 watts	15 watts	19 watts	21 watts
Primary Entrances to Senior Care Facilities, Police Stations, Healthcare Facilities, Fire Stations, and Emergency Vehicle Facilities. Allowance per primary entrance(s) only. Primary entrances shall provide access for the general public and shall not be used exclusively for staff or service personnel. This allowance shall be in addition to the building entrance or exit allowance above. Luminaires qualifying for this allowance shall be within 100 feet of the primary entrance.	Not applicable	20 watts	40 watts	57 watts	60 watts
~~**Drive Up Windows.** Allowance per customer service location. Luminaires qualifying for this allowance shall be within 2 mounting heights of the sill of the window.~~	~~Not applicable~~	~~16 watts~~	~~30 watts~~	~~50 watts~~	~~75 watts~~
~~**Vehicle Service Station Uncovered Fuel Dispenser.** Allowance per fueling dispenser. Luminaires qualifying for this allowance shall be within 2 mounting heights of the dispenser.~~	~~Not applicable~~	~~55 watts~~	~~77 watts~~	~~81 watts~~	~~135 watts~~
ATM Machine Lighting. Allowance per ATM machine. Luminaires qualifying for this allowance shall be within 50 feet of the dispenser.	Not applicable	100 watts for first ATM machine, 35 watts for each additional ATM machine.			
~~**WATTAGE ALLOWANCE PER UNIT LENGTH (w/linear ft). May be used for one or two frontage side(s) per site.**~~					
~~**Outdoor Sales Frontage.** Allowance for frontage immediately adjacent to the principal viewing location(s) and~~	~~Not applicable~~	~~No Allowance~~	~~11 W/linear ft~~	~~19 W/linear ft~~	~~25 W/linear ft~~

~~unobstructed for its viewing length. A corner sales lot may include two adjacent sides provided that a different principal viewing location exists for each side. Luminaires qualifying for this allowance shall be located between the principal viewing location and the frontage outdoor sales area.~~					
WATTAGE ALLOWANCE PER HARDSCAPE AREA (W/ft²). May be used for any illuminated hardscape area on the site.					
Hardscape Ornamental Lighting. Allowance for the total site illuminated hardscape area. Luminaires qualifying for this allowance shall be rated for ~~100~~ 50 watts or less as determined in accordance with Section 130.0(d), and shall be post-top luminaires, lanterns, pendant luminaires, or chandeliers.	Not applicable	No Allowance	0.007 W/ft²	0.013 W/ft²	0.019 W/ft²
WATTAGE ALLOWANCE PER SPECIFIC AREA (W/ft²). Use as appropriate provided that none of the following specific applications shall be used for the same area.					
Building Facades. Only areas of building façade that are illuminated shall qualify for this allowance. Luminaires qualifying for this allowance shall be aimed at the façade and shall be capable of illuminating it without obstruction or interference by permanent building features or other objects. This allowance calculation shall not include portions of the building facades within 20 feet of residence bedroom windows.	Not applicable	No Allowance	0.100 W/ft²	0.170 W/ft²	0.225 W/ft²
~~**Outdoor Sales Lots.** Allowance for uncovered sales lots used exclusively for the display of vehicles or other merchandise for sale. Driveways, parking lots or other non sales areas shall be considered hardscape areas even if these areas are completely surrounded by sales lot on all sides. Luminaires qualifying for this allowance shall be within 5 mounting heights of the sales lot area.~~	~~Not applicable~~	~~0.060 W/ft²~~	~~0.210 W/ft²~~	~~0.280 W/ft²~~	~~0.485 W/ft²~~
~~**Vehicle Service Station Hardscape.** Allowance for the total illuminated hardscape area less area of~~	~~Not applicable~~	~~0.006 W/ft²~~	~~0.068 W/ft²~~	~~0.138 W/ft²~~	~~0.200 W/ft²~~

~~buildings, under canopies, off property, or obstructed by signs or structures. Luminaires qualifying for this allowance shall be illuminating the hardscape area and shall not be within a building, below a canopy, beyond property lines, or obstructed by a sign or other structure.~~					
~~**Vehicle Service Station Canopies.** Allowance for the total area within the drip line of the canopy. Luminaires qualifying for this allowance shall be located under the canopy.~~	~~Not applicable~~	~~0.220 W/ft²~~	~~0.430 W/ft²~~	~~0.580 W/ft²~~	~~1.010 W/ft²~~
~~**Sales Canopies.** Allowance for the total area within the drip line of the canopy. Luminaires qualifying for this allowance shall be located under the canopy.~~	~~Not applicable~~	~~No Allowance~~	~~0.470 W/ft²~~	~~0.622 W/ft²~~	~~0.740 W/ft²~~
~~**Non-sales**~~ **Canopies and Tunnels.** Allowance for the total area within the drip line of the canopy or inside the tunnel. Luminaires qualifying for this allowance shall be located under the canopy or tunnel.	Not applicable	0.057 W/ft²	0.137 W/ft²	0.270 W/ft²	0.370 W/ft²
~~**Guard Stations.** Allowance up to 1,000 square feet per vehicle lane. Guard stations provide access to secure areas controlled by security personnel who stop and may inspect vehicles and vehicle occupants, including identification, documentation, vehicle license plates, and vehicle contents. Qualifying luminaires shall be within 2 mounting heights of a vehicle lane or the guardhouse.~~	~~Not applicable~~	~~0.081 W/ft²~~	~~0.176 W/ft²~~	~~0.325 W/ft²~~	~~0.425 W/ft²~~

CONTINUED: TABLE 140.7-B ADDITIONAL LIGHTING POWER ALLOWANCE FOR SPECIFIC APPLICATIONS

All area and distance measurements in plan view unless otherwise noted.

Lighting Application	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Student Pick-up/Drop-off zone. Allowance for the area of the student pick-up/drop-off zone, with or without canopy, for preschool through 12th grade school campuses. A student pick-	Not applicable	No Allowance	0.056 W/ft²	0.200 W/ft²	No Allowance

up/drop off zone is a curbside, controlled traffic area on a school campus where students are picked-up and dropped off from vehicles. The allowed area shall be the smaller of the actual width or 25 feet, times the smaller of the actual length or 250 feet. Qualifying luminaires shall be within 2 mounting heights of the student pick-up/drop-off zone.					
Outdoor Dining. Allowance for the total illuminated hardscape of outdoor dining. Outdoor dining areas are hardscape areas used to serve and consume food and beverages. Qualifying luminaires shall be within 2 mounting heights of the hardscape area of outdoor dining.	Not applicable	0.004 W/ft²	0.030 W/ft²	0.050 W/ft²	0.075 W/ft²
Special Security Lighting for Retail Parking and Pedestrian Hardscape. This additional allowance is for illuminated retail parking and pedestrian hardscape identified as having special security needs. This allowance shall be in addition to the building entrance or exit allowance.	Not applicable	0.004 W/ft²	0.005 W/ft²	0.010 W/ft²	No Allowance

7.3 Reference Appendices

There are no proposed changes to the Reference Appendices for the three submeasures.

7.4 ACM Reference Manual

There are no proposed changes to the ACM Reference Manual for the three submeasures.

7.5 Compliance Manuals

The Nonresidential Compliance Manual would need to be revised to account for the lighting zone reclassification and updated general hardscape LPAs.

- Chapter 6.3 – The compliance manual U.S. Census definitions need to be revised to refer users to the U.S. Census for new LZ1 “rural” area and the LZ2 “urban cluster” classifications.

- Chapter 6.7 – The proposed changes would revise the compliance documentation NRCC-LTO-E to include the updated general hardscape LPAs and the additional allowance for security cameras along with including documentation of luminaire BUG ratings for luminaires installed within two mounting heights of a property line.

Chapter 6 of the Nonresidential Compliance Manual would need to be revised to accommodate the multifamily building code sections. Provided below is a list of the proposed revisions:

- All sections – The Manual would need to add references to the new multifamily code sections to alert the reader that there is more than one location in the code that details the appropriate outdoor lighting and controls approaches, depending on the building type.
- Chapter 6.2.1 – The proposed changes would add a second diagram to show the two-prong calculation approach that eliminates the Linear Wattage Allowance (LWA). Add language to describe the two-prong calculation approach.
- Chapter 6.4.2 – A clarification is proposed for the scheduling and motion sensing requirements that the minimum setback level is now 60 percent for multifamily projects, an increase from 50 percent.
- Chapter 6.5.2 – The proposed changes would add language to describe the difference in calculation procedure for multifamily buildings and detail the two-prong calculation approach. This is a simplification of the older three-prong approach, so the mechanics of calculating the LPA would be very similar. Additionally, new tables for the general hardscape calculation allowances for multifamily buildings would be added, including an example question and solution for multifamily buildings.
- Chapter 6.5.3 – Proposed language would be added to describe and explain reasons for the difference in the Additional Lighting Power Allowance tables (Table 140.7-B and the new multifamily version of that table) between the nonresidential and multifamily tables. Additionally, a new table that presents the information in the multifamily building Additional Lighting Power Allowance table (Table 170.7-B in the nonresidential code section but would be renumbered in the new multifamily code sections) would be added.
- Chapter 6.6.5 – The proposed changes would add language to describe the increase in the setback requirement from 50 percent to 60 percent for scheduling and motion sensing controls.
- Chapter 6.7 – The proposed changes would add specific information to detail the new compliance document (currently unnumbered but revised from NRCC-LTO-E as the basis).

7.6 Compliance Documents

Compliance document NRCC-LTO-E would need to be updated to reference the proposed general hardscape LPAs and include the additional allowance for security cameras, along with including documentation of luminaire BUG ratings for luminaires installed within two mounting heights of a property line.

Compliance document NRCC-LTO-E would also need to be revised to accommodate the multifamily measure. Proposed revisions to compliance document NRCC-LTO-E are provided below:

- Create a new document and revise all code section citations to include the relevant new code sections for multifamily buildings (currently unnumbered).
- Revise the compliance document listing and cross-referencing to include the newly created multifamily version of NRCC-LTO-E.
- **Section I -** Remove the three-factor calculation approach used for the General Hardscape calculation and document the two-factor approach as detailed in Table 140.7-A.
- **Sections J, K, and L -** Eliminate references to Additional Lighting Power Allowances that are not included in the multifamily outdoor Table 140.7-B.

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Appendix A: Statewide Savings Methodology

The Energy Commission Building Standards Office provided the nonresidential construction forecast, which is available for public review on the Energy Commission's website: https://www.energy.ca.gov/title24/participation.html.

The construction forecast presents total floorspace of newly constructed buildings in 2023 by building type and climate zone. The building types included in the Energy Commissions' forecast are summarized in Table 43: Estimated New Nonresidential Construction Impacted by Proposed Code Change in 2023, by General Hardscape and Specific Application and Building Type (Million Square Feet). This table also identifies the prototypical buildings that were used to model the energy use of the proposed code changes. This mapping was required because the building types the Energy Commission defined in the construction forecast are not identical to the prototypical building types that the Energy Commission requested that the Statewide CASE Team use to model energy use. This mapping is consistent with the mapping that the Energy Commission used in the Final Impacts Analysis for the 2019 code cycle (California Energy Commission 2018).

The Energy Commission's forecast allocated 19 percent of the total square footage of new construction in 2023 to the miscellaneous building type, which is a category for all space types that do not fit well into another building category. It is likely that the Title 24, Part 6 requirements apply to the miscellaneous building types, and savings would be realized from this floorspace. The new construction forecast does not provide sufficient information to distribute the miscellaneous square footage into the most likely building type, so the Statewide CASE Team redistributed the miscellaneous square footage into the remaining building types so that the percentage of building floorspace in each climate zone, excluding the miscellaneous square footage, will remain constant. See Table 45 for a sample calculation for redistributing the miscellaneous square footage among the other building types.

After the miscellaneous floorspace was redistributed, the Statewide CASE Team made assumptions about the percentage of newly constructed floorspace that would be impacted by the proposed code change. Table 43 presents the assumed percentage of floorspace that would be impacted by the proposed code change by building type. If a proposed code change does not apply to a specific building type, it is assumed that zero percent of the floorspace would be impacted by the proposal. If the assumed percentage is non-zero, but less than 100 percent, it is an indication that no buildings would be impacted by the proposal. Table 47 presents percentage of floorspace assumed to be impacted by the proposed change by climate zone. The proposed code

change is not dependent on climate zone and is applicable to all new construction. The Statewide CASE Team assumed a rate of lighting retrofits to be once in 15 years.[19]

[19] Once in 15 years is 1/15 or roughly seven percent. This aligns with the same rate of lighting retrofits assumptions used for the 2019 Title 24, Part 6 outdoor lighting code change analysis.

Table 43: Estimated New Nonresidential Construction Impacted by Proposed Code Change in 2023, by General Hardscape and Specific Application and Building Type (Million Square Feet)

Application	Small Office	Large Office	Restaurant	Retail	Food	Non-Refrigerated Warehouse	Refrigerated Warehouse	School	College	Hospital	Hotel/ Motel	TOTAL
General Hardscape	8.623	30.330	4.426	18.268	6.899	7.618	0.393	7.145	5.404	7.632	6.373	103.111
Building Entrances or Exits	0.002	0.006	0.001	0.000	0.001	0.005	N/A	0.002	0.001	0.002	0.002	33.415
Primary Entrances	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Drive-up Windows	N/A	N/A	0.001	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.001
Vehicle Service Station Uncovered Fuel Dispenser	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ATM Machine Lighting	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Outdoor Sales Frontage	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.096 from Misc.
Hardscape Ornamental Lighting	0.431	1.516	0.221	1.305	0.172	N/A	N/A	0.255	0.135	0.190	0.455	4.842
Building Facades	0.111	0.391	0.114	0.673	0.089	N/A	N/A	0.132	0.070	0.098	0.235	1.994
Outdoor Sales Lots	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.959 from Misc.
Vehicle Service Station Hardscape	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.516 from Misc.
Vehicle Service Station Canopies	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.384 from Misc.
Sales Canopies	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.160 from Misc.
Non-sales Canopies and Tunnels	0.216	0.758	0.111	0.652	0.172	N/A	N/A	0.255	0.135	N/A	0.228	2.687
Guard Stations	0.004	0.013	N/A	N/A	N/A	0.011	0.001	N/A	0.002	N/A	N/A	0.044
Student Pick-up/ Drop-off Zones	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.177	N/A	N/A	N/A	0.177
Outdoor Dining	N/A	N/A	0.443	0.130	0.035	N/A	N/A	N/A	N/A	0.015	N/A	0.0623

Application	Small Office	Large Office	Restaurant	Retail	Food	Non-Refrigerated Warehouse	Refrigerated Warehouse	School	College	Hospital	Hotel/ Motel	TOTAL
Special Security Lighting for Retail and Pedestrian Tunnels	N/A	N/A	0.004	0.261	0.069	N/A	N/A	N/A	N/A	N/A	N/A	0.534
TOTAL	9.386	33.014	5.361	21.294	7.438	7.634	0.394	7.966	5.748	7.937	7.292	119.161

Table 44: Estimated Existing Nonresidential Floorspace Impacted by Proposed Code Change in 2023 (Alterations), by General Hardscape and Application and Building Type (Million Square Feet)

Application	Small Office	Restaurant	Retail	Food	Non-Refrigerated Warehouse	Refrigerated Warehouse	School	College	Hospital	Hotel/ Motel	Large Office	TOTAL
General Hardscape	25.9	13.0	56.6	21.4	22.8	1.2	27.5	20.6	26.6	17.2	90.6	323.4
Building Entrances or Exits	0.005	0.002	0.016	0.004	0.015	0.0008	0.008	0.004	0.005	0.005	0.018	0.104
Primary Entrances	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.000
Drive-Up Windows	N/A	0.003	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.003
Vehicle Service Station Uncovered Fuel Dispenser	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.000
ATM Machine Lighting	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.000
Outdoor Sales Frontage	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.289 from Misc.
Hardscape Ornamental Lighting	1.295	0.648	4.045	0.535	N/A	N/A	0.984	0.516	0.664	1.228	4.529	14.924
Building Facades	0.334	0.334	2.085	0.276	N/A	N/A	0.507	0.266	0.342	0.633	1.167	6.191
Outdoor Sales Lots	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.888 from Misc.
Vehicle Service Station Hardscape	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.591 from Misc.
Vehicle Service Station Canopies	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.155 from Misc.
Sales Canopies	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.481 from Misc.
Non-sales Canopies and Tunnels	0.647	0.324	2.023	0.535	N/A	N/A	0.984	0.516	N/A	0.614	2.265	8.388
Guard Stations	0.011	N/A	N/A	N/A	0.033	0.002	-	0.009	N/A	N/A	0.039	0.135
Student Pick-up/ Drop-off Zone	N/A	N/A	N/A	N/A	N/A	N/A	0.681	N/A	N/A	N/A	N/A	0.681
Outdoor Dining	N/A	1.295	0.405	0.107	N/A	N/A	N/A	N/A	0.053	N/A	N/A	1.860

Application	Small Office	Restaurant	Retail	Food	Non-Refrigerated Warehouse	Refrigerated Warehouse	School	College	Hospital	Hotel/ Motel	Large Office	TOTAL
Special Security Lighting for Retail and Pedestrian Tunnel	N/A	1.295	0.405	0.107	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.634
TOTAL	28.192	15.687	66.015	23.066	22.861	1.235	30.707	21.955	27.622	19.665	98.596	372.76

Table 45: Example of Redistribution of Miscellaneous Category - 2023 New Construction in Climate Zone 1

Building Type	2020 Forecast (Million Square Feet) [A]	Distribution Excluding Miscellaneous Category [B]	Redistribution of Miscellaneous Category (Million Square Feet) [C] = B × [D = 0.145]	Revised 2020 Forecast (Million Square Feet) [E] = A + C
Small Office	0.036	7%	0.010	0.046
Large Office	0.114	21%	0.031	0.144
Restaurant	0.015	3%	0.004	0.020
Retail	0.107	20%	0.029	0.136
Grocery Store	0.029	5%	0.008	0.036
Non-Refrigerated Warehouse	0.079	15%	0.021	0.101
Refrigerated Warehouse	0.006	1%	0.002	0.008
Schools	0.049	9%	0.013	0.062
Colleges	0.027	5%	0.007	0.034
Hospitals	0.036	7%	0.010	0.046
Hotel/Motels	0.043	8%	0.012	0.055
Miscellaneous **[D]**	0.145	---	---	---
TOTAL	0.686	100%	0.147	0.686

The calculation of the effective area wattage allowances (eAWA) with the security camera allowance also requires assumptions on the prevalence of security cameras. The Statewide CASE Team approached this set of assumptions based on the following rationale:

- Office Small: Would be unlikely to purchase hardscape cameras except in extreme circumstances, such as known high risk areas.
- Office Large: A mixture of secured facilities and low risk facilities would make hardscape cameras applicable to some installations.
- Restaurants: Chain restaurants would be more likely than independent shops for camera usage. Camera usage would be a crime deterrent and insurance benefit.
- Retail: Loss prevention and insurance considerations would make this space type a prime user of cameras, especially for national chains. Smaller shops may not follow this pattern.
- Grocery: Loss prevention and insurance considerations would make this space type a prime user of cameras, for national chains. Note that independent shops may not follow this pattern

- Non-Refrigerated Warehouse: Warehouses are anticipated to have cameras on key locations, such as yard entrances and exits, loading docks, building entrances and exits, but are not anticipated to have hardscape wide camera installation except under extreme circumstances.
- Refrigerated Warehouse: Expected to follow the Non-Refrigerated Warehouse design principles
- Schools: Schools can vary widely in security, from almost no camera usage to ubiquitous usage.
- College: Colleges are anticipated to follow similar design principles as schools.
- Hospital: Some hospitals are anticipated to have higher security, especially if located in known high risk areas. Other hospitals are anticipated to have considerable interior security but limited hardscape camera usage.
- Hotel: Anticipated to be similar to retail, as hardscape camera usage would be expected to have insurance benefits and serve as a deterring to possible vandalism and theft.
- Other: Some high security applications anticipated to be located in the miscellaneous category.

Based on these assumptions, the Statewide CASE Team estimated the following factors, applicable to general hardscape for both new construction and alterations:

Table 46: Estimated Security Camera Prevalence in General Hardscape, by Building Type.

Building Type	Percent using Security Camera
Small Office	10%
Large Office	25%
Restaurant	20%
Retail	33%
Grocery Store	25%
Non-Refrigerated Warehouse	5%
Refrigerated Warehouse	5%
Schools	25%
Colleges	25%
Hospitals	20%
Hotel/Motels	33%
Miscellaneous [D] (Other)	15%

Table 47: Percent of Floorspace Impacted by Proposed Measure, by Climate Zone

Climate Zone	Percent of Square Footage Impacted	
	New Construction	Existing Building Stock (Alterations)[a]
1	100%	7%
2	100%	7%
3	100%	7%
4	100%	7%
5	100%	7%
6	100%	7%
7	100%	7%
8	100%	7%
9	100%	7%
10	100%	7%
11	100%	7%
12	100%	7%
13	100%	7%
14	100%	7%
15	100%	7%
16	100%	7%

a. Percent of existing floorspace that would be altered during the first year the 2022 standards are in effect.

Appendix B: Embedded Electricity in Water Methodology

There are no on-site water savings associated with the proposed code change.

Appendix C: Environmental Impacts Methodology

Greenhouse Gas (GHG) Emissions Factors

As directed by Energy Commission staff, GHG emissions were calculated making use of the average emissions factors specified in the United States Environmental Protection Agency (U.S. EPA) Emissions & Generation Resource Integrated Database (eGRID) for the Western Electricity Coordination Council California (WECC CAMX) subregion (United States Environmental Protection Agency 2018). This ensures consistency between state and federal estimations of potential environmental impacts. The electricity emissions factor calculated from the eGRID data is 240.4 metric tons CO2e per GWh. The Summary Table from eGrid 2016 reports an average emission rate of 529.9 pounds CO2e/MWh for the WECC CAMX subregion. This value was converted to metric tons/GWh.

Avoided GHG emissions from natural gas savings attributable to sources other than utility-scale electrical power generation are calculated using emissions factors specified in Chapter 1.4 of the U.S. EPA's Compilation of Air Pollutant Emissions Factors (AP-42) (United States Environmental Protection Agency 1995). The U.S. EPA's estimates of GHG pollutants that are emitted during combustion of one million standard cubic feet of natural gas are: 120,000 pounds of CO_2 (Carbon Dioxide), 0.64 pounds of N_2O (Nitrous Oxide) and 2.3 pounds of CH_4 (Methane). The emission value for N_2O assumed that low NOx burners are used in accordance with California air pollution control requirements. The carbon equivalent values of N_2O and CH_4 were calculated by multiplying by the global warming potentials (GWP) that the California Air Resources Board used for the 2000-2016 GHG emission inventory, which are consistent with the 100-year GWPs that the Intergovernmental Panel on Climate Change used in the fourth assessment report (AR4). The GWP for N_2O and CH_4 are 298 and 25, respectively. Using a nominal value of 1,000 Btu per standard cubic foot of natural gas, the carbon equivalent emission factor for natural gas consumption is 5,454.4 metric tons per MMTherms.

GHG Emissions Monetization Methodology

The 2022 TDV energy cost factors used in the lifecycle cost-effectiveness analysis include the monetary value of avoided GHG emissions based on a proxy for permit costs (not social costs). To demonstrate the cost savings of avoided GHG emissions, the Statewide CASE Team disaggregated the value of avoided GHG emissions from the other economic impacts. The authors used the same monetary values that are used in the TDV factors – $106.20 per metric ton CO_2e.

Water Use and Water Quality Impacts Methodology

The proposed measure is not expected to have any impacts on water use or water quality, excluding impacts that occur at power plants.

Appendix D: California Building Energy Code Compliance (CBECC) Software Specification

There are no recommended revisions to the compliance software as a result of this code change proposal.

Appendix E: Impacts of Compliance Process on Market Actors

This appendix discusses how the recommended compliance process, which is described in Section 2.5, could impact various market actors. Table 48 identifies the market actors who would play a role in complying with the proposed change, the tasks for which they would be responsible, their objectives in completing the tasks, how the proposed code change could impact their existing work flow, and ways negative impacts could be mitigated. The information contained in Table 48 is a summary of key feedback the Statewide CASE Team received when speaking to market actors about the compliance implications of the proposed code changes. Appendix F summarizes the stakeholder engagement that the Statewide CASE Team conducted when developing and refining the code change proposal, including gathering information on the compliance process.

The Statewide CASE Team expects minimal impact on industry and others impacted by the relevant nonresidential code sections as a result of this proposal. For the nonresidential lighting zone reclassification submeasure, the Statewide CASE Team anticipates minimal adjustment to changes in calculations of the appropriate lighting zone based on population density, a related metric to the population figures currently employed by the technique based on the U.S. Census. No additional tasks to calculate the lighting zones, no new coordination between market actors, and no additional documentation is expected. In order for this submeasure to be a success, the Statewide CASE Team must ensure that proper education in the new technique comes to fruition. Education might be facilitated by cooperation with relevant professional organizations (such as the IES) and/or through collaboration with the Energy Commission.

For the nonresidential LPA for parking lots submeasure, the Statewide CASE Team has suggested changes to the general hardscape allowances for each lighting zone as well as the addition of an adder for security camera equipment to offset lowered light levels where warranted. The Statewide CASE team does not anticipate changes to the calculation of the allowed wattage but do expect that the allowed adders for certain situations would be altered to avoid the unnecessary over lighting of some areas. No additional tasks to calculate the allowed wattage in general areas (without allowed adders), no new coordination between market actors, and no additional documentation is expected. The Statewide CASE Team has based the additional security camera allowance on the specified recommended illuminance levels of existing security equipment to avoid over lighting while providing sufficient illumination and anticipates working with various professional organizations to limit allowable adders for some spaces while preserving the ability to implement proper outdoor lighting design practices.

For the multifamily LPA for general hardscape submeasure, the Statewide CASE Team has suggested changes to the general hardscape allowances for each lighting zone. The lighting allowance tables for outdoor lighting for multifamily buildings also has a proposed reduced list of retail lighting additional allowances which would reduce some lighting allowance wattage under some potential circumstances, but the Statewide CASE Team does not anticipate that most of these allowances were used much, if at all in typical multifamily housing projects. The Statewide CASE Team also proposed a simplification to the calculation method of the allowed wattage for outdoor lighting. The Statewide CASE team does not anticipate that this change would result in any confusion about how the calculation process would occur as it is a simplification of the existing process.

Other than identifying that a project is a multifamily project, there are no additional tasks required to calculate the allowed wattage in general hardscape areas and no new coordination between market actors and no additional documentation is expected.

Table 48: Roles of Market Actors in the Proposed Compliance Process

Market Actor	Task(s) In Compliance Process	Objective(s) in Completing Compliance Tasks	How Proposed Code Change Could Impact Workflow	Opportunities to Minimize Negative Impacts of Compliance Requirement
Lighting Designer	• Understand wattage and control requirements so that design can meet code (there is no option to "trade" outdoor lighting with other building features hence little flexibility if design exceeds wattage requirements) • Be aware of the lighting zone applicable to the project and how that would determine wattage allowance.	• Be able to design outdoor lighting to meet the code requirements. • Maintain photometric design parameters within the wattage allowances of the Energy Code.	• Security cameras could be an issue because lighting levels may be too low for camera use. • Impacts on alterations vs. new construction: existing poles may remain in place. • Most of LZ3 would drop to LZ2 by redefining LZ. This may be an issue for alterations. • Standardizing LZ across state (this could be positive). • Multifamily – apply a different code section for outdoor lighting and outdoor controls.	• Consider a threshold value on the rezoning criteria for alterations. Be aware of current triggers for LTO alts. & maybe align this with an existing trigger. • Coordinate with some cities who have rezoned to see how it's impacting alterations, and any unforeseen issues with rezoning. • Rely on existing wattage adders when possible • Multifamily – keep the code sections as similar as possible to ensure the same basic approach and structure for both.

Owner	Provide guidance to designer on desired photometric requirements and be aware of how wattage allowance may impact that request.	Work with professional organizations to ensure proper education and proper allocation of adders.	• Large retail might have issues showing compliance to LTO lighting allowance due to liability concerns. • Some cities have minimum illumination requirements for safety, must ensure measure doesn't conflict with health and safety concerns. • Multifamily – Owners would need to consider the suitability of certain retail applications in the MF context.	• Early outreach to security camera designers, retailers, and realtors. • Multifamily – education of design team and owners to the limits of additional retail lighting allowances in the MF context.
Energy Consultants	Work with designer to document compliance to the Energy Code.	• Clearly communicate to designer wattage allowances based on lighting zone and other factors such as concrete/ non-concrete surfaces and "specific allowances." • Coordinate control requirements with designer so that compliance documentation accurately represents control design.	• Ensure projects are being developed with the LPA from proper LZ. • Multifamily – Ensure energy consults are applying the MF code sections for the calculations.	• Clear documentation of project lighting zone. • Multifamily – ensure the industry has suitable documentation of the proposed MF code sections.
Contractor	May be acting as the "designer", really	• They are responsible for following what is in the design – if they do	Ensure luminaires meet the BUG rating requirements.	• Clear documentation of Title 24, Part 6 compliant products.

	replacing the existing luminaires.	not, the system can end up being out of compliance. They complete installation compliance documents. • Coordinate with lighting designer in case issues with installation arise. • They purchase/install products specified by design. It is helpful for them to know what products meet compliance in case they need to substitute products.		• Clear documentation illustrating difference between old standards and new one. • Clear documentation explaining who they can speak with for help on code compliance. • Examples showing systems that are Title 24 compliant. • Examples showing systems that are not Title 24 compliant with explanations of why they are not.

Electrician	• Need to understand the code as they might be responsible for designing lighting systems. • They might play a similar role to contractor/builder and follow lighting design/install lighting equipment.	• If designing the system, they are responsible for ensuring it follows the code. They would also be responsible for filling out design compliance documents. • If building the system, they are responsible for following what is in the design – if they do not, the system can end up out of compliance. They would complete installation compliance documents. • Coordinate with lighting designer in case issues with installation arise. • Purchase/install products specified by design that are compliant.	Ensure projects are being developed with the proper LPA per the project LZ.	• Clear documentation of Title 24, Part 6 compliant products. • Clear documentation illustrating difference between old standards and new one. • Clear documentation explaining who they can speak with for help on code compliance. • Examples showing systems that are Title 24 compliant. • Examples showing systems that are not Title 24 compliant with explanations of why they are not. • Ensure responsible designers know about the distinction and introduction of the MF building sections of code.

Title 24 Consultant	• Experts on Title 24, Part 6 and compliance / compliance documents / compliance steps. • They are hired by designers/building owners to help interpret the code/ensure compliance / fill out paperwork.	• Coordinate with designers, installers, building owners, and compliance agencies. • They generate compliance documentation as well as assist in code interpretation.	• Direct designers, installers, and building owners to the proper LPA per the project LZ. • Direct designers, installers, and building owners to the maximum BUG ratings allowed per the project LZ.	• Document explaining Title 24 process and where documents go/who needs to sign what. • Modeling software would need to be updated to include proposed values. Software training updates. • Clear code requirements that apply to the project. • Designation on products about whether or not they meet code requirements. How to/direction on how to specify the products that meet the code (lighting designer is not purchasing the lighting fixtures, the contractor purchases). • Examples showing systems that are Title 24 compliant. • Examples showing systems that are not Title 24 compliant with explanations of why they are not. • Documents explaining who they can speak with for help on code compliance.
Plans Examiner	• Identify relevant requirements. • Confirm data on documents is compliant. • Confirm plans/ specifications match data on documents. • Provide correction comments if necessary.	• Quickly and easily determine requirements based on scope. • Quickly and easily determine if data in documents meets requirements. • Quickly and easily determine if plans/ specs match documents.	• Would need to verify calculations are compliant with new standards. • Would need to verify existing conditions baseline.	• Clear code language that is easily understandable. Clear instructions on where to find everything in the plans. • Clear documentation of what paperwork they need to receive and/or other tasks they need to perform. • Clear documentation of how the new code differs from the old. • Compliance document could auto-verify data is compliant with the standards.

		• Quickly and easily provide correction comments that would resolve issue. • Coordinate with building owners/designers/inspectors.		• Existing conditions documented via as-builts or photos or ATT. Do not require additional field visit by Authority Having Jurisdiction. • Document compliance on documents in a way easily compared to plans. • Examples of plans that comply. • Examples of plans that are not in compliance and reasons why they are not.
Building Inspector	• Identify relevant requirements. • Confirm installed equipment matches documents/plans. • Provide correction comments if necessary.	• Quickly and easily determine requirements based on scope. • Quickly and easily determine if installation meets requirements and matches documents/plans. • Quickly and easily provide correction comments that would resolve issue. • Coordinate with building owners/designers/plan checkers.	• Would need to verify installations are compliant with new standards.	• Clear documentation of code requirements, although they probably rely more on the plan checker to make sure everything in the plan is up to code. • Clear documentation of how the new code differs from the old. • Clear documentation of the different types of technologies that might be used/installed and equivalences – if something installed is different from the plans, then the inspector needs to know whether or not it is still in code compliance. • Clear documentation of what paperwork they need to receive and/or other tasks they need to perform.

Appendix F: Summary of Stakeholder Engagement

Collaborating with stakeholders that might be impacted by proposed changes is a critical aspect of the Statewide CASE Team's efforts. The Statewide CASE Team aims to work with interested parties to identify and address issues associated with the proposed code changes so that the proposals presented to the Energy Commission in this Final CASE Report are generally supported. Public stakeholders provided valuable feedback on draft analyses and help identify and address challenges to adoption including cost effectiveness, market barriers, technical barriers, compliance and enforcement challenges, and potential impacts on human health or the environment. Some stakeholders also provided data that the Statewide CASE Team used to support analyses.

This appendix summarizes the stakeholder engagement that the Statewide CASE Team conducted when developing and refining the recommendations presented in this report.

Utility-Sponsored Stakeholder Meetings

Utility-sponsored stakeholder meetings provide an opportunity to learn about the Statewide CASE Team's role in the advocacy effort and to hear about specific code change proposals that the Statewide CASE Team is pursuing for the 2022 code cycle. The goal of stakeholder meetings is to solicit input on proposals from stakeholders early enough to ensure the proposals and the supporting analyses are vetted and have as few outstanding issues as possible. To provide transparency in what the Statewide CASE Team is considering for code change proposals, during these meetings the Statewide CASE Team asks for feedback on:

a. Proposed code changes
b. Draft code language
c. Draft assumptions and results for analyses
d. Data to support assumptions
e. Compliance and enforcement, and
f. Technical and market feasibility

The Statewide CASE Team hosted two stakeholder meetings for nonresidential and multifamily outdoor lighting sources via webinar. Please see below for dates and links to event pages on Title24Stakeholders.com. Materials from each meeting. Such as slide presentations, proposal summaries with code language, and meeting notes, are included in the bibliography section of this report.

Meeting Name	Meeting Date	Event Page from Title24stakeholders.com
First Round of Nonresidential and Multifamily Outdoor Lighting Sources and Daylighting Utility-Sponsored Stakeholder Meeting	Thursday, September 5, 2019	https://title24stakeholders.com/event/lighting-utility-sponsored-stakeholder-meeting/
Second Round of Nonresidential and Multifamily Outdoor Lighting Sources and Daylighting Utility-Sponsored Stakeholder Meeting	Thursday, March 3, 2020	https://title24stakeholders.com/event/lighting-utility-sponsored-stakeholder-meeting-2/

The first round of utility-sponsored stakeholder meetings occurred from August to November 2019 and were important for providing transparency and an early forum for stakeholders to offer feedback on measures being pursued by the Statewide CASE Team. The objectives of the first round of stakeholder meetings were to solicit input on the scope of the 2022 code cycle proposals; request data and feedback on the specific approaches, assumptions, and methodologies for the energy impacts and cost-effectiveness analyses; and to understand potential technical and market barriers. The Statewide CASE Team also presented initial draft code language for stakeholders to review.

The second round of utility-sponsored stakeholder meetings occurred from March to May 2020 and provided updated details on proposed code changes. The second round of meetings introduced early results of energy, cost effectiveness, and incremental cost analyses, and solicited feedback on refined draft code language.

Utility-sponsored stakeholder meetings were open to the public. For each stakeholder meeting, two promotional emails were distributed from info@title24stakeholders.com. One email was sent to the entire Title 24 Stakeholders listserv, totaling over 1,900 individuals, and a second email was sent to a targeted list of individuals on the listserv depending on their subscription preferences. The Title 24 Stakeholders' website listserv is an opt-in service and includes individuals from a wide variety of industries and trades, including manufacturers, advocacy groups, local government, and building and energy professionals. Each meeting was posted on the Title 24 Stakeholders' LinkedIn page[20] (and cross-promoted on the Energy Commission LinkedIn page) two weeks before each meeting to reach out to individuals and larger organizations and channels outside of the listserv. The Statewide CASE Team conducted extensive personal outreach to stakeholders identified in initial work plans who had not yet opted into the listserv. Exported webinar meeting data captured attendance numbers and individual comments,

[20] Title 24 Stakeholders' LinkedIn page can be found here: https://www.linkedin.com/showcase/title-24-stakeholders/

and recorded outcomes of live attendee polls to evaluate stakeholder participation and support.

Statewide CASE Team Communications

The Statewide CASE Team held personal communications over email and phone with numerous stakeholders when developing this report. The Statewide CASE Team was able to engage in conversation with representatives from several townships and cities in California and nationwide including Plymouth, Minnesota; San Diego, California; Los Angeles County, California; Bakersfield, California; and Walnut Creek, California. The Statewide CASE Team also contacted IDA and lighting designers to obtain feedback on the feasibility of the lighting zone reclassification measure.

The Statewide CASE Team also contacted 58 different manufacturers to select products that meet both the lighting zone reclassification submeasure and general hardscape LPA submeasure to ensure that the proposed changes could be met with products currently available on the market from multiple manufacturers. The product manufacturers include, but are not limited to: Acuity, Signify ALW, Architectural Area Light, Axis Lighting, Beacon, Cooper Lighting, Ecosense, Finelite, Cyclone, ERCO, GE Lighting, Hess, Hubbell Lighting, Lucifier Lighting, Lumenwerx, Luminii, Nova Flex, Pinnacle, PMC, Selux, RAB, Sistemalux, Spectrum, TCP, Tech Lighting, Tivoli, Visionaire, WAC, and WE-EF. These products were employed for both the nonresidential LPA submeasure and the multifamily submeasure based on the suitability of the product for both applications.

The Statewide CASE Team contacted retail management agencies and security camera system engineers to understand current security camera limitations in low lighting levels along with how these systems are typically deployed in general hardscape applications. The minimum illumination requirements of various security cameras were compared to determine an appropriate allowance to enable the detection of people, animals, and objects of concern during low light conditions.

In addition to these resources, the Statewide CASE Team also met with IES and the International Association of Lighting Designers (IALD) to explain the 2022 CASE Report outline and garner feedback.

Lighting Survey

The Statewide CASE Team (via subcontractor Evergreen Economics) conducted a stakeholder survey from November 2019 to January 2020. This survey aimed to gather feedback from industry experts regarding the 2019 code cycle, both for the Codes and Standards Enhancement (CASE) process and the California Energy Commission Rulemaking process, to inform changes in 2022.

Survey Results

Surveyed Stakeholder Background

Survey respondents were asked their experience with various lighting types and their lighting role.

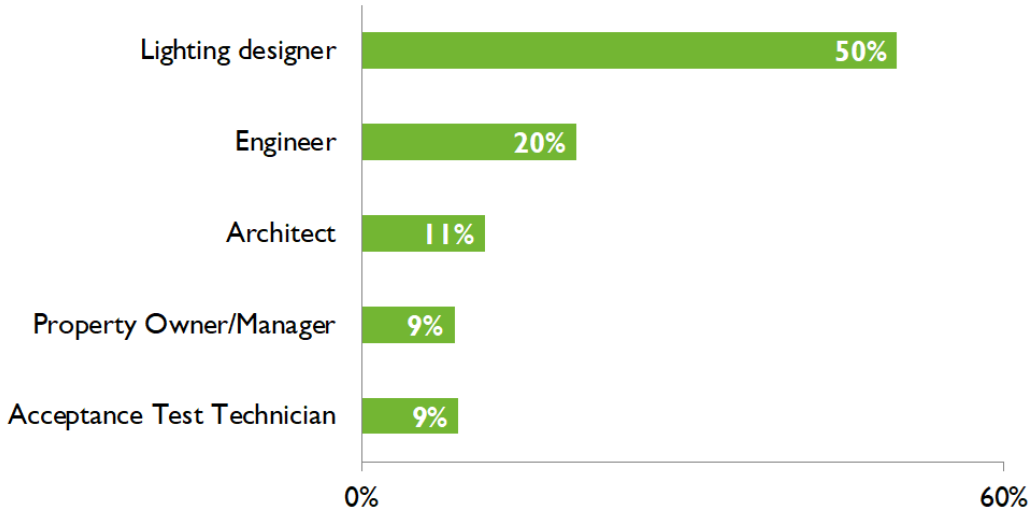

Figure 3: Top five respondent roles (n=54).

Figure 4: Percent of respondents with experience with various lighting types (n=62).

Outdoor Lighting

Survey respondents who indicated they were familiar with outdoor lighting were asked a series of questions in regard to outdoor lighting allowances for general hardscapes and lighting zone reclassification.

General Hardscape

Nearly all outdoor lighting respondents (87 percent) said they were at least somewhat familiar with the Illuminating Engineering Society (IES) and the specific standards that it sets.

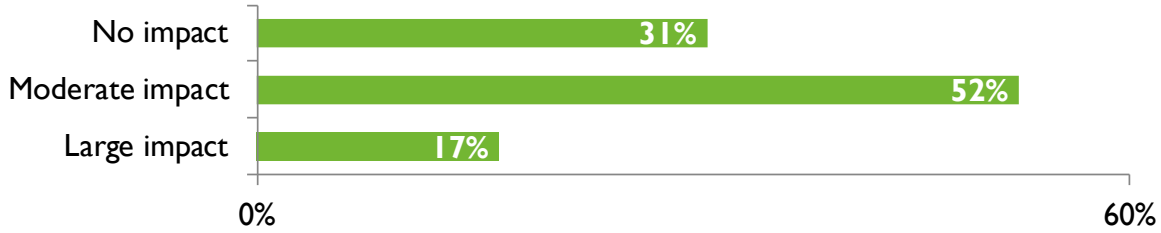

Figure 5: Impact on designed lighting levels if IES decreased lighting level recommendations (n=42).

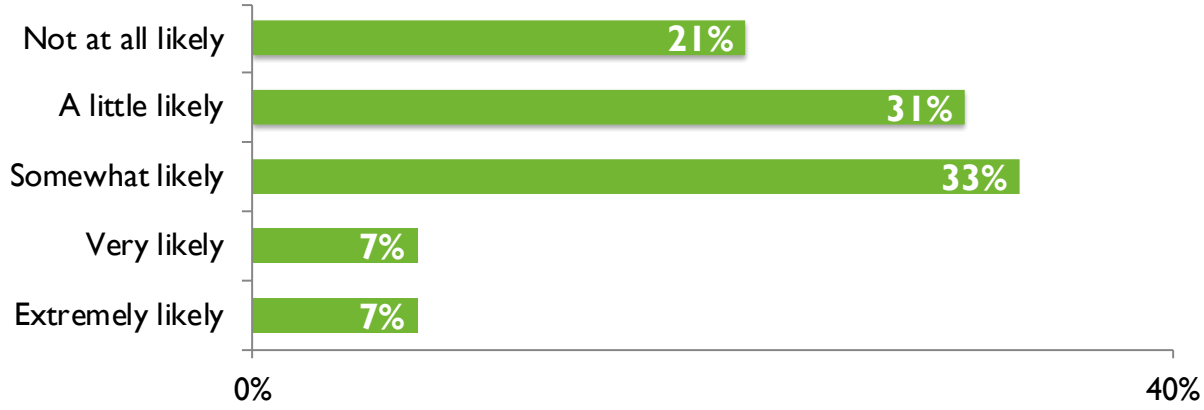

Figure 6: Likelihood of security issues from applying IES recommendations for projects in non-secure environments (n=42).

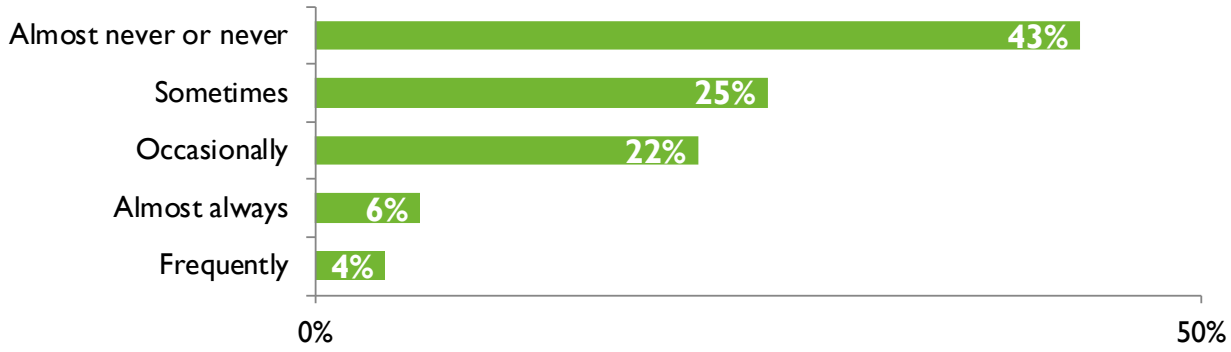

Figure 7: How often respondents think IES-recommended lighting levels would negatively affect their lighting projects (n=51).

Respondents who reported that the IES-recommended lighting levels would negatively affect their projects at least sometimes, frequently, or almost always noted that:

- Recommended levels that are higher than necessary for safety and functionality can increase payback time and make projects harder to sell.
- For areas that operate 24 hours, the IES-recommended levels are insufficient and pose a safety hazard, especially when in an industrial or commercial setting.
- In urban areas, security will override any energy savings in terms of importance.

Lighting Zone Reclassification

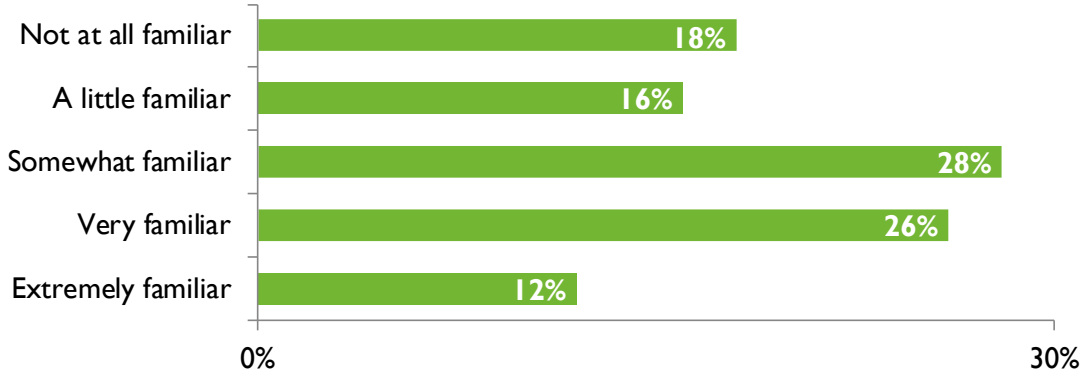

Figure 8: Familiarity with Dark-Sky Association (IDA) and the Illuminating Engineering Society Model Lighting Ordinance (MLO) (n=50).

A follow-up question to Figure 8 indicated that 72 percent of respondents reported that they are at least somewhat familiar with the IES RP-33-14 Lighting for Exterior Environments lighting zone definitions.

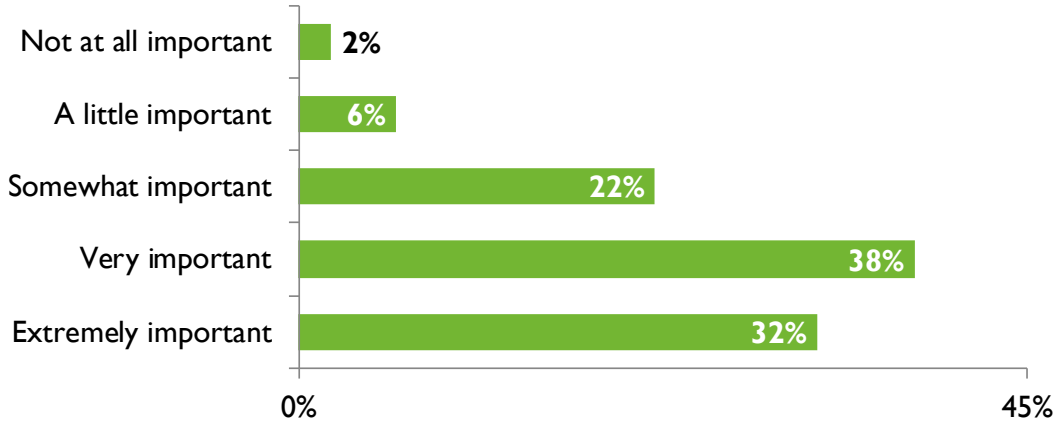

Figure 9: Overall importance of considering light pollution or light trespass for outdoor lighting design (n=50).

A follow-up question to Figure 9 asked respondents which specific steps they took to minimize light pollution and / or light trespass. Respondents who reported that considering light pollution or light trespass was somewhat, very, or extremely important were then asked what specific steps they take to minimize light pollution or light trespass in their own projects. Specific steps respondents reported included the following:

- Change the mounting height, and the house shield.
- Have minimum light levels, careful locations of luminaires, fully shielded luminaires with optional add-on shields.
- Use fixtures and mounting techniques that aim the light down and design to the lower end of the IESNA standards.
- Avoid lights with poor backlight, uplight, and glare (BUG) ratings, choose optically efficient fixtures to better control where light goes, reduce light levels where possible, and use low level integrated lights if possible.

Additionally, respondents were asked whether or not there are any published standards or guidelines that they use to help minimize light pollution or light trespass. Seventeen of the 30 respondents indicated that yes, they do utilize published standards or guidelines to help minimize light pollution or light trespass, including: California Title 24, the Illuminating Engineering Society handbook, IES-RP-33-14 Lighting for Exterior Environments, International Dark-Sky Association, CALGreen, LEED, and manufacturer data.

Respondents were also given the opportunity to provide their preferences for how lighting zones are established. Of the 32 respondents, 41 percent preferred establishment of lighting zones to be project specific and to be selected by the designer based on the MLO/IES-RP-33-14 lighting definitions. Thirty-eight percent of respondents said they preferred they be established by the local jurisdictions. Additionally, the 13 percent of respondents who reported "other" noted they would prefer:

- Using U.S. Census data (n=2)
- Lighting zones to be established by use type. When designing a shopping center in a rural city, you do not want to be limited. Likewise, a city park in a busy city should not be different than a rural park (n=1)
- Using a combination of IES-RP-33-14 lighting definitions with local jurisdiction in tandem would be good in some instances. (n=1)

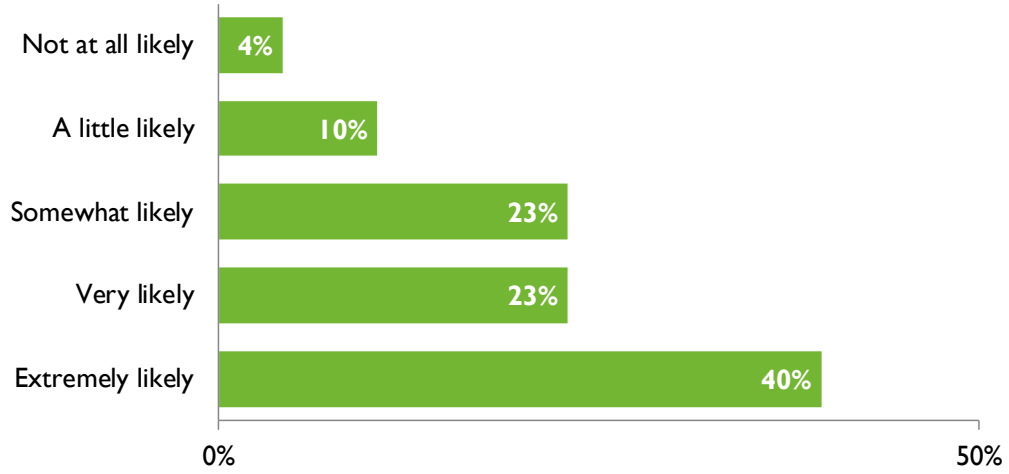

Figure 10: Likelihood of installing luminaires with appropriate lumen outputs, distribution, and shielding instead of installing additional equipment (n=48).

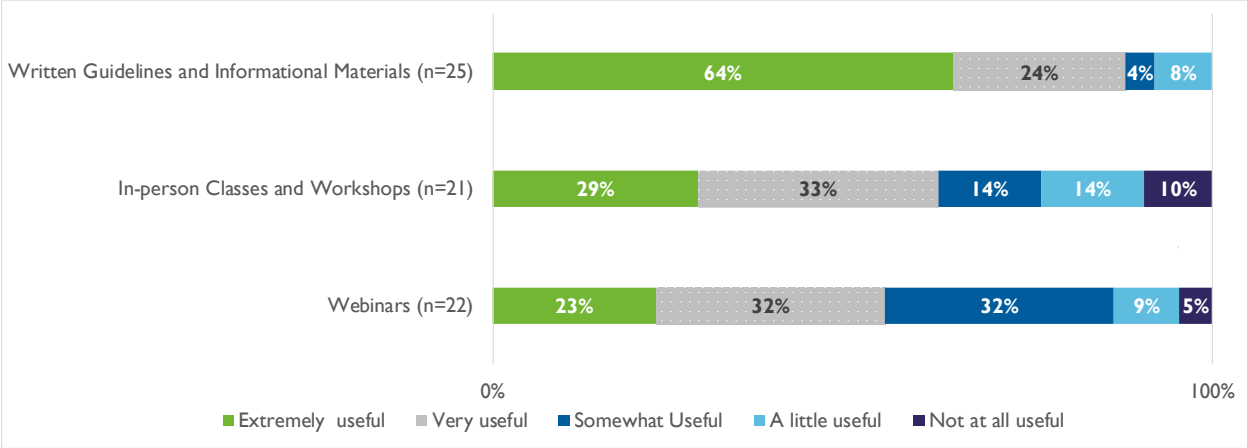

Figure 11: Desired assistance in determining lighting zones.

Multifamily Typical Lighting Design Practice

Survey respondents who indicated working with outdoor lighting in multifamily applications were asked a set of questions related to their experiences within the last six years.

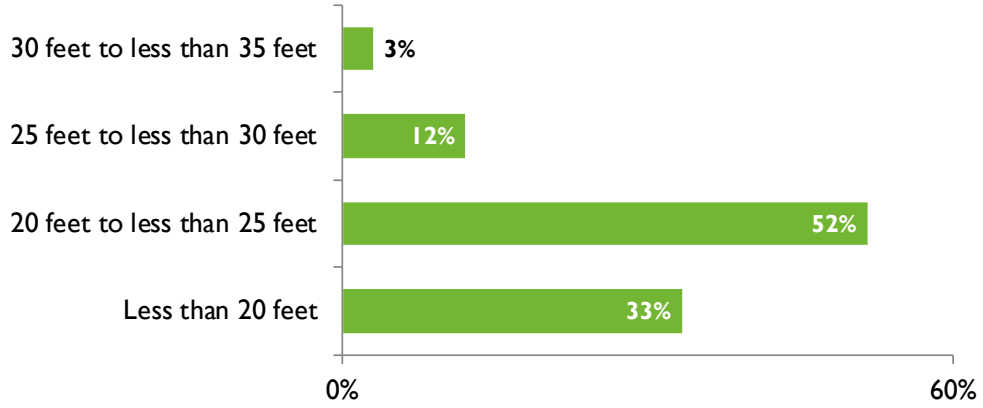

Figure 12: Typical mounting height for parking poles (n=33).

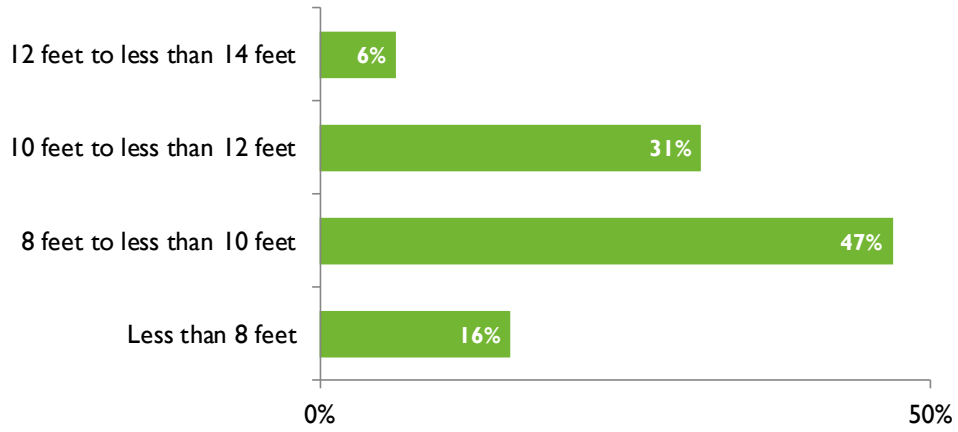

Figure 13: Typical mounting height for building entrances (n=32).

There was much more consensus regarding the mounting height for pedestrian poles, with 84 percent of the 25 respondents reporting the mounting height to be between 10 and 15 feet.

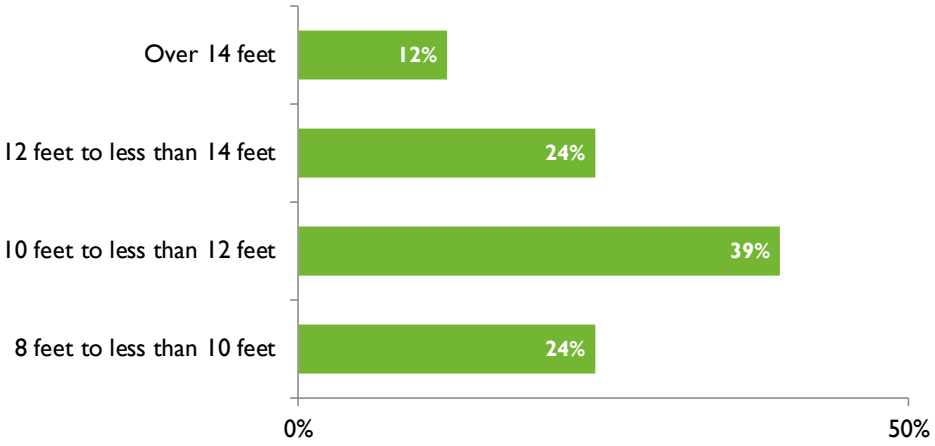

Figure 14: Typical mounting height for building mounted area lights (n=33).

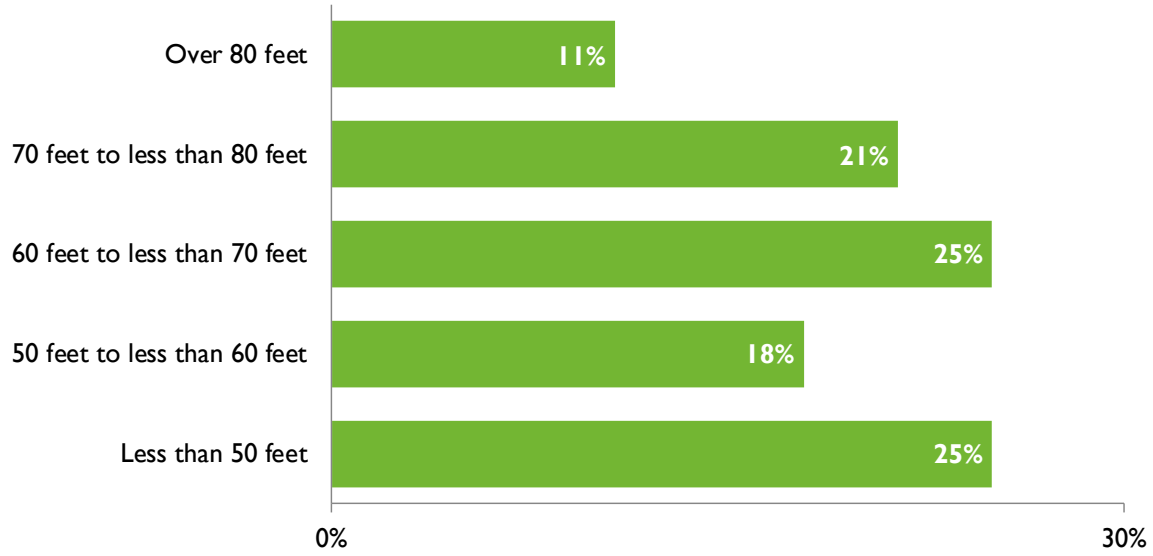

Figure 15: Typical pole-to-pole spacing for parking poles (n=28).

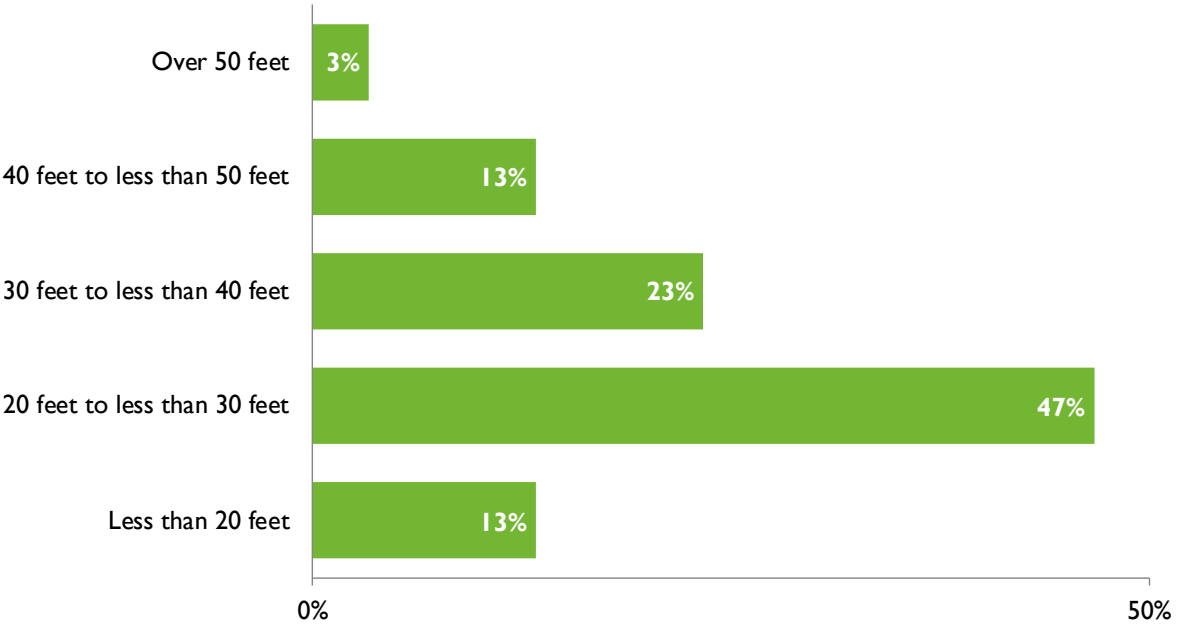

Figure 16: Typical pole to pole spacing for pedestrian poles (n=30).

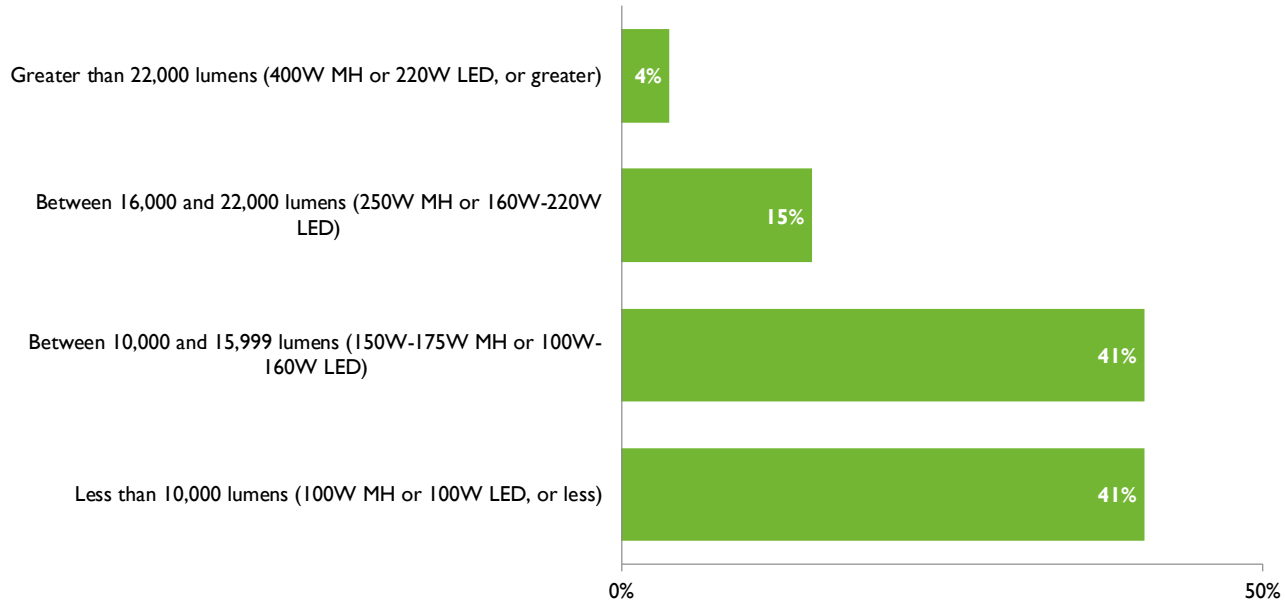

Figure 17: Typical lighting output for parking poles for projects completed in past six months (n=27).

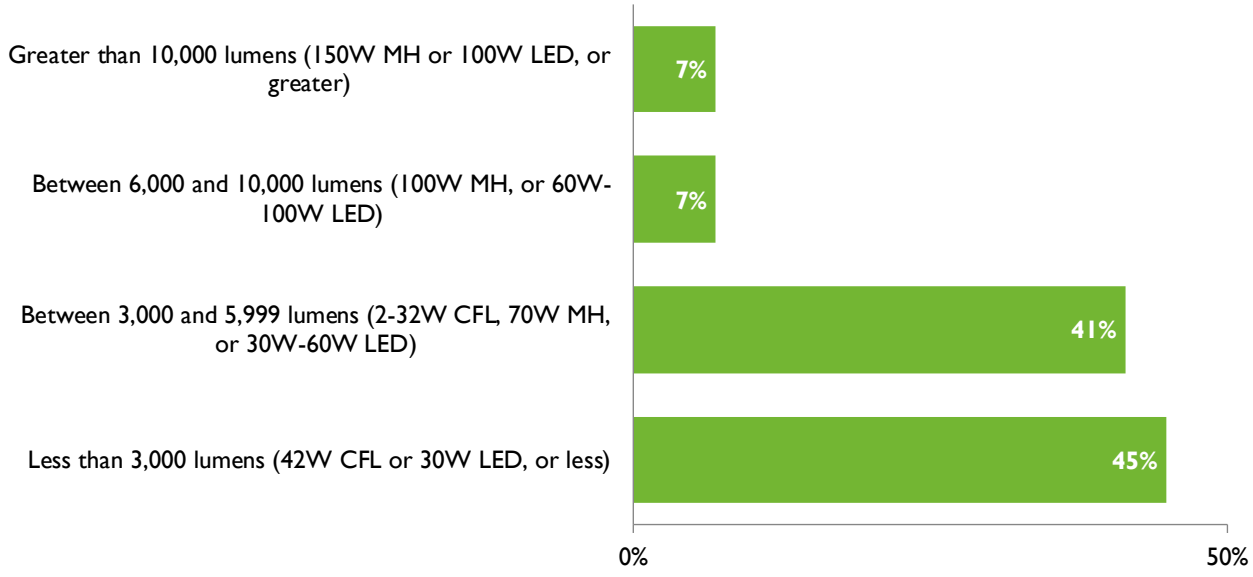

Figure 18: Typical lighting output for building entrances for projects completed in past six months (n=29).

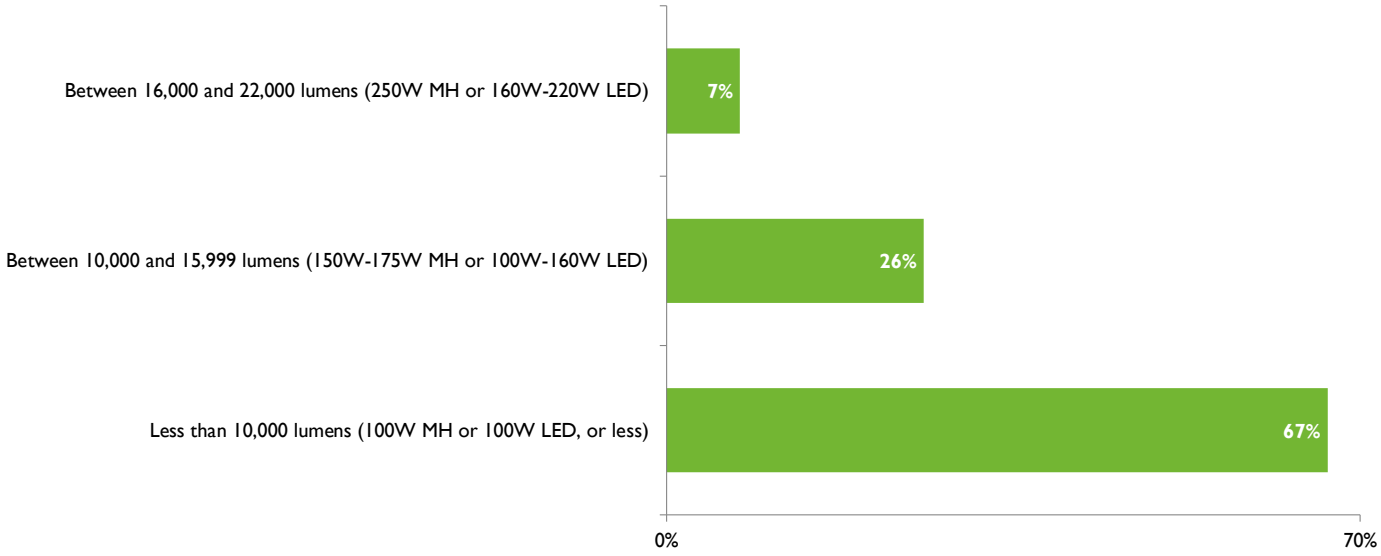

Figure 19: Typical lighting output for pedestrian poles for projects completed in past six months (n=24).

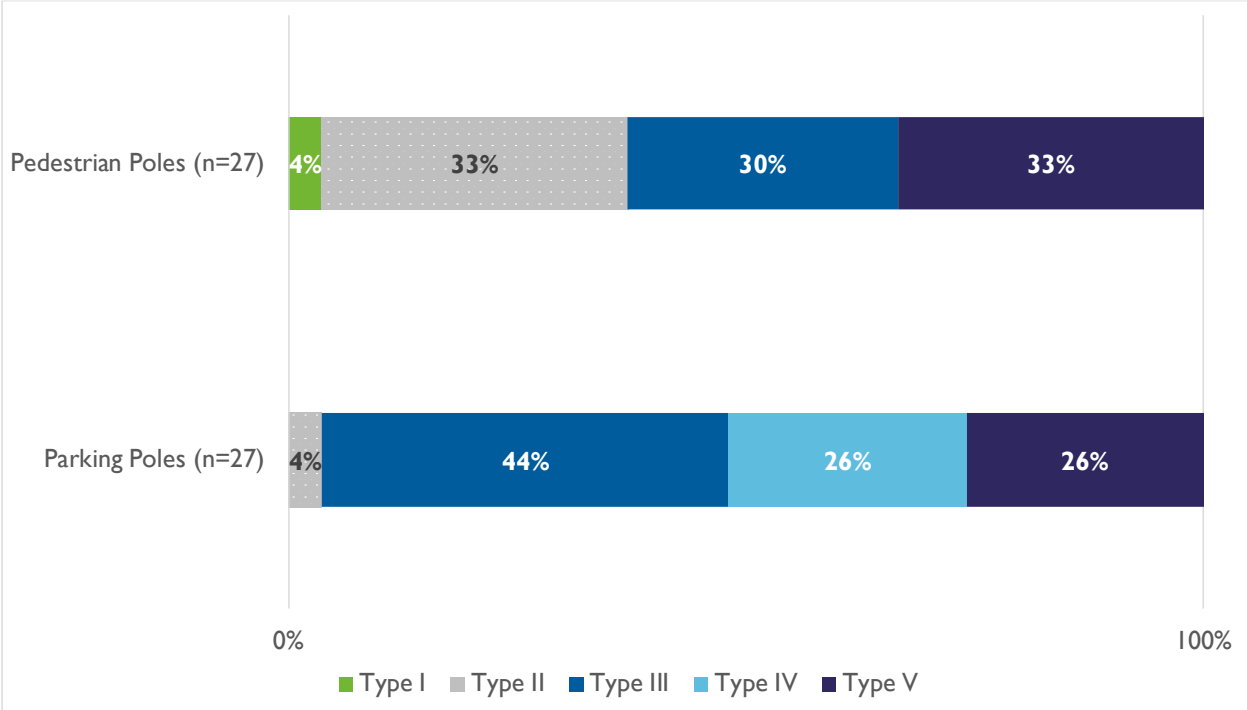

Figure 20: Typical light distribution for pedestrian and parking poles for projects completed in past six months.

Multifamily Human Health

In addition to multifamily outdoor design practices, survey respondents who indicated working on multifamily outdoor lighting projects were also asked questions regarding outdoor lighting and the impacts that it may have on human health.

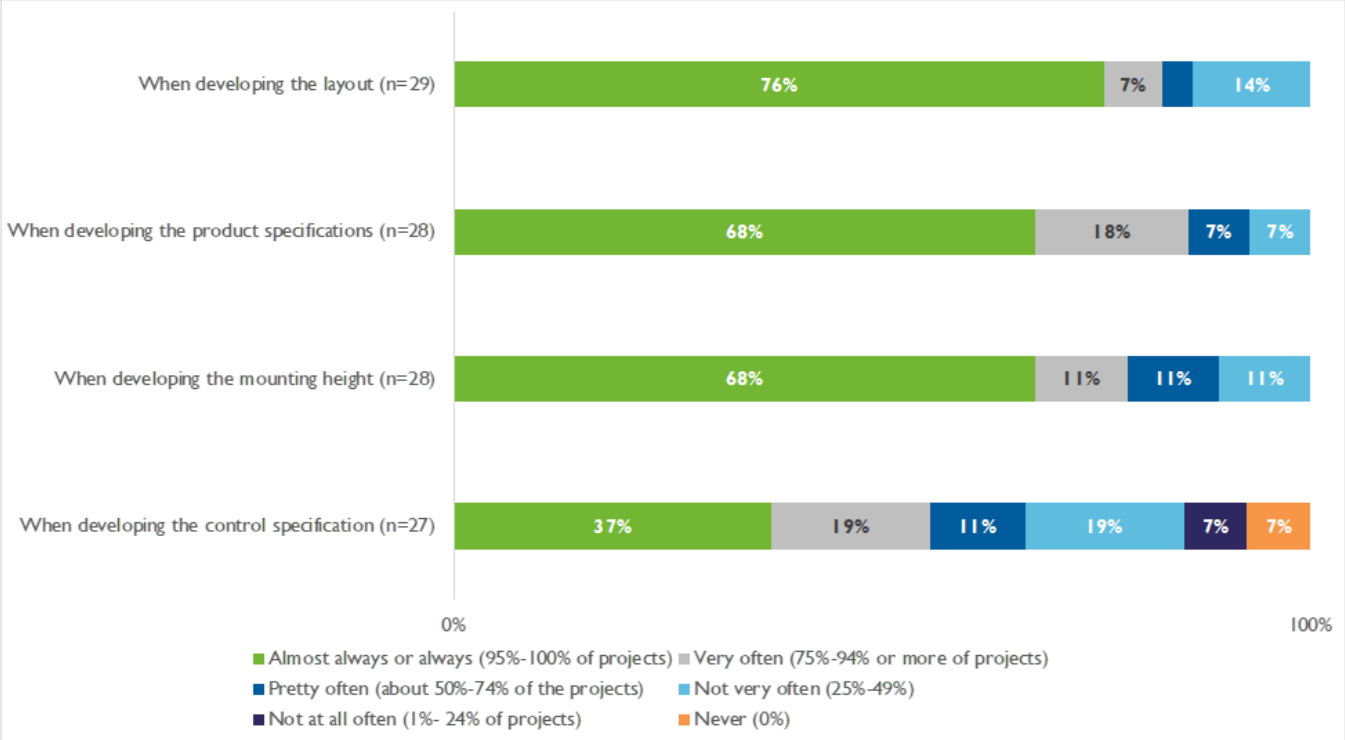

Figure 21: Frequency of consideration of light trespass in different scenarios.

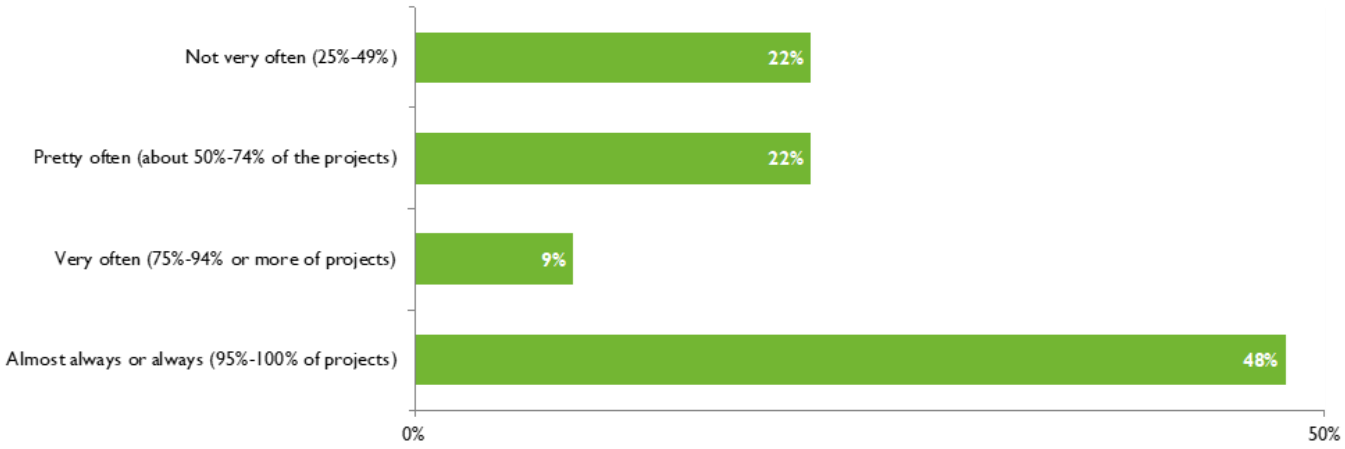

Figure 22: Frequency of generation of site photometric calculation to analyze potential light trespass into residential units (n=23).

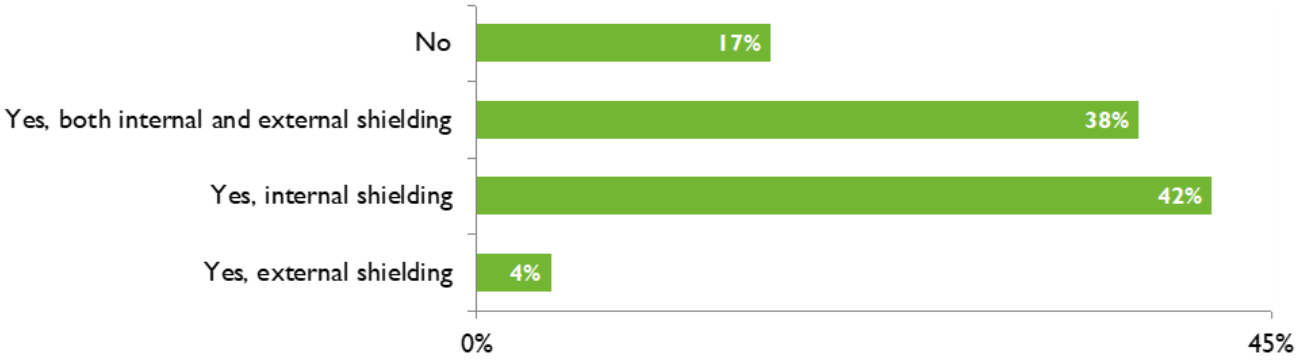

Figure 23: Use of internal and external shielding to ensure no light shines above 90 degrees from horizontal (n=29).

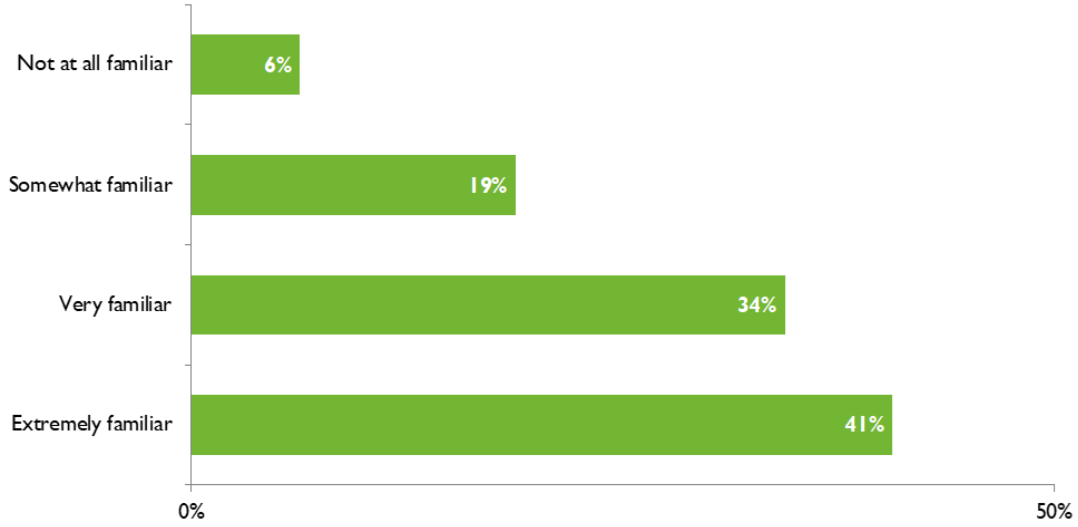

Figure 24: Familiarity with IES Backlight, Uplight, and Glare (BUG) rating system (n=32).

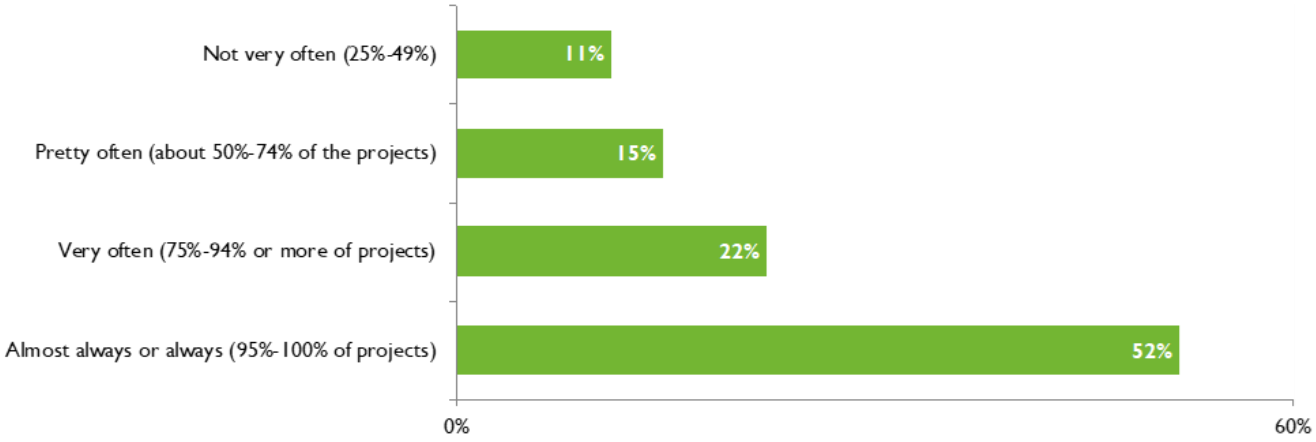

Figure 25: Frequency of specification or implementation of lighting products with specific cutoff attributes on multifamily lighting design projects to address light trespass concerns for residents (n=27).

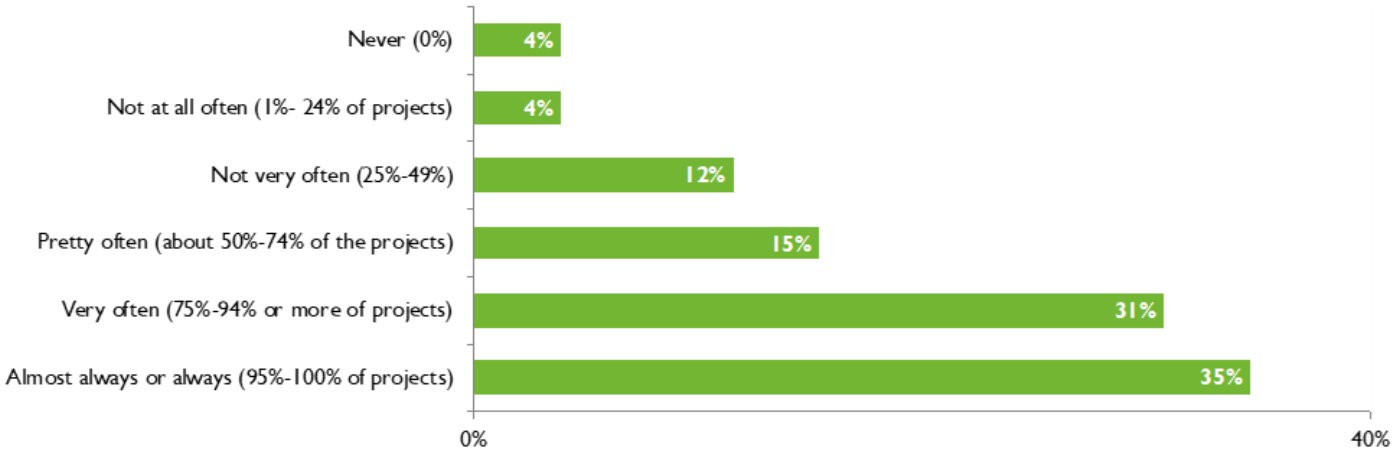

Figure 26: How often respondents specify or implement lighting with specific BUG attributes to address light trespass concerns (n=27).

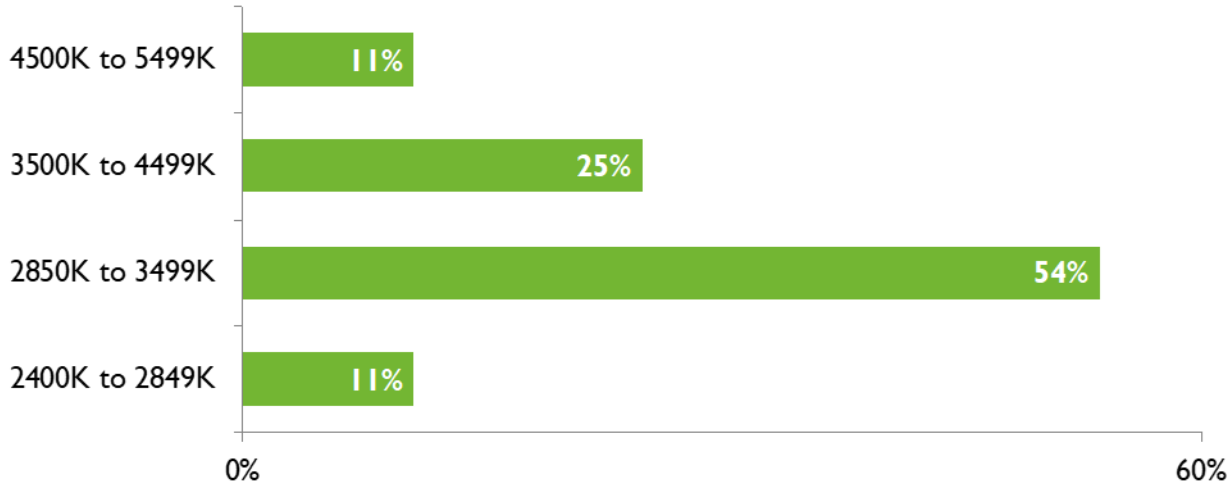

Figure 27: Color temperature preferences for outdoor lighting projects (n=28).

Sixty-four percent of respondents reported that the color temperature they use varies by different nonresidential outdoor lighting projects (e.g., commercial vs. industrial vs. retail vs. schools), compared to 36 percent who reported that the color temperature does not change by outdoor projects.

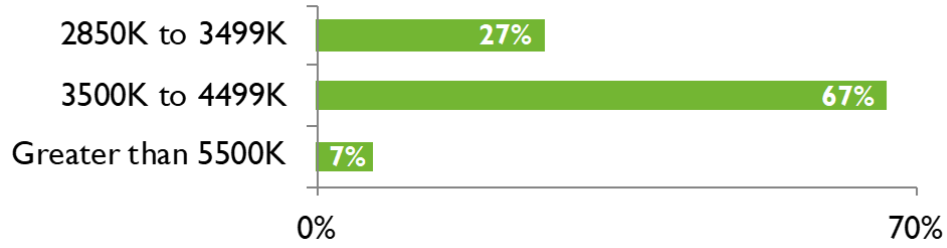

Figure 28: Color temperature preferences for nonresidential outdoor lighting projects (n=15).

Eighty percent of respondents reported that they do design or implement lighting controls for outdoor lighting. Of the 80 percent of respondents who design or implement lighting controls, 60 percent use dimmers, 55 percent use on-off controls, and 40 percent use bi-level lighting.

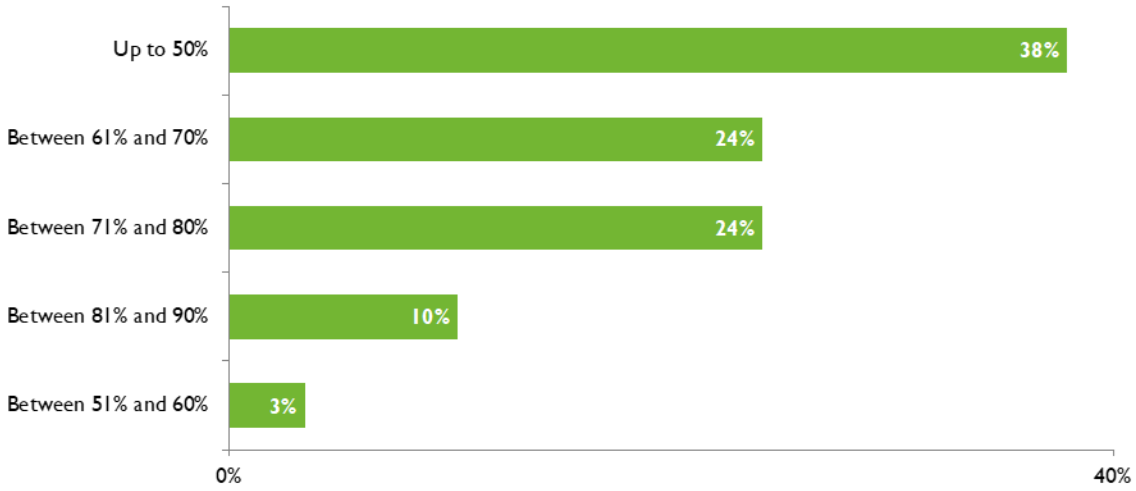

Figure 29: Reduction of lighting system from late-night setback for site lighting (n=29).

Appendix G: Multifamily Light and Health Topics

As part of developing the multifamily outdoor LPA measure, the Statewide CASE Team worked to understand how nighttime lighting impacts human health. As part of this, the Statewide CASE Team performed a literature review on the topic and solicited input from a subject matter expert to understand what the research supports when considering specific energy allowances for multifamily buildings.

Lighting at night has been associated with potential health problems such as disrupting human internal circadian rhythm. In a 2016 literature review, the American Medical Association found studies showing that "brighter residential nighttime lighting is associated with reduced sleep time, dissatisfaction of sleep quality, nighttime awakenings, excessive sleepiness, impaired daytime functioning and obesity" (American Medical Association 2016).

This may become more problematic with the increase in LED lighting. About 29 percent of 4000K LED light is emitted in the blue light spectrum (American Medical Association 2016) and melatonin suppression has the strongest response to short blue light wavelengths between 446 and 447 nm (West 2011). Although the effects of outdoor night lighting in a bedroom are not clear, it is important to take into consideration light levels that may affect melatonin levels and increased alertness.

Research Overview for Light and Health

The Statewide CASE Team focused on night lighting effects on melatonin suppression and increased alertness.

Literature shows that melatonin suppression is dependent on illuminance and irradiance levels but found suppression occurring at varying thresholds. A 1989 study tested melatonin suppression in thirteen subjects following one hour of light at midnight with intensities of 3,000, 1,000, 500, 350, and 200 lux (McIntyre 1989). Light was created using eight fluorescent tubes and melatonin levels were measured by taking blood samples. At all light levels except for 200 lux, the study observed a statistically significant decrease in melatonin levels after the study participants were exposed to the light. The study found the maximum percent suppression of melatonin to be 71, 67, 44, 38 and 16 percent at light intensity levels of 3,000, 1,000, 500, 350, and 200 lux respectively. A similar study in 2003 measured melatonin suppression after exposure to one hour of 509 nm monochromatic light at irradiance levels of 0.01, 0.3, 1.6, 5, and 13 $\mu W/cm^2$ and found the mean threshold irradiance for suppressing melatonin to be between 1.6 and 5 $\mu W/cm^2$ (Brainard 1988).

A 2000 study also tested melatonin suppression and circadian phase delay at a longer light exposure of 6.5 hours in twenty-three subjects (Zeitzer 2000). Light was

supplied from an overhead cool white fluorescent lamp filtered with a Lexan 9030 UV-restricting lens. The study tested light intensities ranging from three to 9,100 lux. Melatonin suppression and phase shift were observed to occur in a nearly stepped manner and were fit to a logistic model. The models indicated melatonin suppression saturating (90 percent of the asymptotic maximum response) at about 200 lux and phase-shifting responses saturating at about 550 lux.

On the other hand, literature shows varied results on the effects of nighttime lighting on alertness. In a 2009 study, effects of exposure to dim, narrowband blue light (460 nm, ~1 lux, 2 μW/cm^2), dim broad spectrum (white) ambient light (~0.2 lux, 0.5 μW/cm^2) and red light (640 nm, ~ 1lux, 0.7 μW/cm^2) were tested on eight participants (Phipps Nelson 2010). Different measurements of alertness were used such as subjective sleepiness using the Karolinska Sleepiness Scale (KSS), a two-hour simulated driving task (measuring lane and speed deviations), a psychomotor vigilance task (PVT) to measure reaction time, electroencephalographic (EEG) and electrooculographic (EOG) activity and salivary melatonin levels. Participants were exposed to one of the three light conditions from 23:30 until 05:30. Each participant tested the three light conditions on separate occasions with at least four weeks in between.

The study found PVT mean reaction times to be significantly faster in blue compared to ambient light, but no significant differences between red and ambient light conditions. EEG delta and theta activity and slow eye movement was also significantly reduced in blue than in ambient light. However, driving simulator lane and speed deviations and subjective sleepiness increased significantly across the night with no significant effect from light condition. Salivary melatonin levels also showed expected increase peaking at 23:00 with no significant effect from light condition.

Modeling Light Trespass Illuminance Values

Based on the literature review, the Statewide CASE Team found that at illuminance levels of about one lux, blue light had significant effects on alertness at night (Phipps Nelson 2010). The Statewide CASE Team used the lighting simulation software, AGi32, and modeled illuminance on the exterior of a window with two outdoor lighting arrangements in the case that interior vertical illuminance was one lux between five and six feet above finished floor and 10 feet into the room from the window wall. The first outdoor lighting arrangement used one LED luminaire, mounted 20 feet above grade, with Type V distribution, located 30 feet from the center of the window. The second lighting arrangement consisted of two LED luminaires, pole mounted at 20 feet above grade, with Type V distribution, spaced 60 feet apart centered on the window. For both arrangements, the lumen output of the of the luminaire was adjusted to achieve one lux at the interior calculation plane. These arrangements represent typical site lighting conditions that may occur on a multifamily property with pedestrian lighting to

characterize the amount of light on the façade that yields the target illuminance inside the window.

Modeling results indicated that the vertical illuminance at the exterior window was within two lux for both lighting arrangements, achieved with standard available lumen packages. Both lighting arrangements also achieved recommended horizontal illuminances for drives and parking.

The following room and window characteristics were used to model illuminance at the exterior of a window:

Table 49. Room and Window Modeling Properties

Location	Dimensions	Properties
Room	15ft by 15ft floor area, 8ft height	80% ceiling cavity reflectance 50% wall reflectance 20% floor cavity reflectance
Window	4ft height, 5ft length Windowsill at 3ft above finished floor	Transmission: 80%

Survey on Lighting and Health

The Statewide CASE Team surveyed subject matter experts in lighting about setting a threshold for outdoor lighting. Modeling of light trespass indicated that a one lux indoor threshold at eye level corresponded to a two-lux threshold at the exterior of the window. Given modeling results, the Statewide CASE Team asked the following questions:

1. Is it reasonable to consider an exterior light threshold limit at residential windows?
2. Given the variability of resident behavior within an interior space, is limiting exterior electric light on a window to two lux a benefit to residents?
3. It is known that nighttime setbacks for exterior lighting save energy. Do you think that establishing this type of threshold creates an opportunity to save more energy (than setback considerations, alone)?

Five subject matter experts responded to this survey. The following table shows answers from the respondents.

Table 50: Light and Health Survey Responses

Question Number	Response		
	Yes	No	Maybe/Don't Know
1	2	0	3
2	2	0	3
3	1	0	4

The “Maybe/Don’t Know” category includes respondents that did not answer the question and respondents that responded with a comment rather than a direct “Yes” or “No”. Some comments from the respondents included:

- “In any case, the illuminances that you are proposing certainly won’t have any circadian-related effects.”
- “Although I certainly understand that I am in a significant minority, I am not a fan of other-than-temporary light at night for exterior spaces. I do make exceptions for holiday and some monument/facade lighting. With the advent of small, low power, personal LED devices, I prefer to have folks carry a flashlight for illumination and wearable devices to be seen by others. If lighting large spaces is absolutely necessary or, more probably, desired, than I prefer motion-sensing or, better, addressable systems that are activated only when the space is occupied.”
- “I’m wondering if it makes sense to change the measurement point to the inside of the window rather that the outside, since many windows are not operable, and getting an illuminance meter up to a 6th story window is a challenge. That would knock off the vertical illuminance by 15-20 percent depending on the glass dirt and transmittance.”
- “This threshold is more likely to include a house-side shield, which saves no energy.”

Specific Impacts for Title 24 Multifamily Outdoor Lighting Sections

The Statewide CASE Team has collected this information with the intent to determine if “normal” parking lot and other lighting systems associated with multifamily housing are likely to be a source of light trespass into residents’ windows at night that approaches the level of concern for melatonin suppression or sleep retardation.

In lieu of definitive research results to support specific limits as part of a design criteria document, the safest approach for designers is to be aware of the issue and that the amount of light experienced inside the living spaces in a multifamily building should be kept to a minimum within reason. Minimizing this exposure involves both the amount of light at any given time, and the total light flux over a period of time, which can be considered a night’s worth of electric outdoor lighting.

This can be supported through Title 24, Part 6 in several ways:

- Promote lower light levels in situations where there is discretion and where the current practice is above that considered the minimum for safety and security. One way to do this is to eliminate LPAs for applications where the lighting application is inconsistent with residential land use or where the added value of the additional light levels is outweighed by the human health aspects of a residential environment. An example of this is the allowances in Table 140.7 -B Additional Lighting Power Allowance for Specific Applications. Some of these are clearly focused on retail applications and the argument can be made whether

they *should* be permitted. The energy code doesn't dictate whether they can be done on a multifamily housing project, but this proposed language would not provide additional LPA for these situations.

- Promote lower total light output by controlling the light better. This can be done be requiring a deeper reduction in light setback for after-hours conditions and encouraging even lower light levels when an outdoor space is not considered occupied. This is done by increasing the setback for after-hours light levels to match the 60 percent reduction in design criteria that the IES establishes in RP-20 and the Lighting Handbook, 10th Edition.

Lastly, the amount of high-angle light that emanates from the lighting equipment can be reduced to reduce light trespass, especially in the lower floors of multifamily housing projects. This is being addressed primarily through the CALGreen language that specifies the maximum G Rating by Lighting Zone that is permissible for specification in California. This section is not being changed by this code change proposal, but the method to ensure proper code compliance must be addressed to ensure that the limits are met. The current compliance documents do not have a direct comparison of the B, U, and G values and acceptable limits to ensure compliance.

Further Recommendations

Since the current IES documents and committees do not specifically address multifamily housing, the current approach in the California energy code is to apply nonresidential lighting design recommendations to this application (since the previous code versions has included multifamily housing over three floors in the nonresidential section of the code). This is similarly done in other design standards, including ASHRAE 90.1 and any codes based on the ASHRAE document.

The growing body of research pointing to risk factors associated with long term exposure to blue spectrum light at night is generating the needed support for IES to elevate this issue, so it can be addressed in the existing committee structures, Recommended Practice documents, and Handbook. Following is a list of potential actions that the IES can take to investigate this question.

- Update the IES-IDA MLO to address the problem that intra-site light trespass isn't suitably accounted for, specifically in the context of multifamily housing, but possibly for other applications that include sleeping quarters, including hospitals, assisted living facilities, dorms, barracks and other quasi-nonresidential building types.
- Create a subcommittee in the Roadway Lighting committee or similar appropriate location to investigate developing specific recommendations for lighting criteria and whether limits for light trespass or spill light should be considered for properties with residences within the same property as the source of the outdoor lighting. This committee should be incorporating the expertise of the Outdoor

Environmental Lighting committee, the Light and Human Health committee, and the Roadway Off-Roadway technical group.

- Introduce a subsection within the Lighting Handbook to specifically address internal property light trespass issues for multifamily housing and similarly for hotel/motel occupancy situations to increase sensitivity to these issues and present the results of the committee research. Since the handbook is a key source of design guidance for the industry, this step is crucial.
- Consider a review of all documents that may apply to multifamily outdoor lighting design to ensure that there are no other documents that may have coverage of this area and ensure that there is no conflicting guidance within the documentation.
- Collaborate with other international lighting standards-setting organizations and committees to evaluate what research has been done on this topic and what additional research needs exist to develop comprehensive and defensible guidance documents.

Appendix H: Multifamily Prototype Characterization

The Statewide CASE Team gathered nineteen plan sets from the California Multifamily New Homes Program, a utility incentive program, and classified them into the four prototypes based on the number of floors and site configuration for CASE analysis. While this is an above-code program, the Statewide CASE Team still thinks the sites are market representative since the information gathered from them for the purpose of this CASE measure is the shape of the site.

The Statewide CASE Team gathered information from the plan sets including number of floors, number of units, location, floor area, and whether the building has nonresidential spaces. The Statewide CASE Team then used a software program to calculate the building footprint, site, landscape, and hardscape area and perimeter for the purpose of being able to calculate lighting power allowances per Title 24, Part 6 Table 140.7-A General Hardscape Lighting Power Allowance. Three sites were removed from the data sample due to data quality issues including incomplete documentation or unreasonable results.

Table 60 and Table 61 at the end of this section show a summary of the data by site and by prototype.

To determine proposed LPA's for the 2022 multifamily code, the Statewide CASE Team performed the following steps for each site:

1. Calculate LPA based on existing 2019 Nonresidential requirements
2. Calculate 2019 equivalent allowance levels *without* linear allowance by adjusting initial and area allowances to create as nearly equivalent an allowance as is possible that excludes the linear allowance factor
3. Calculate LPA based on 2019 requirements without the linear allowance with the resultant initial and area allowances from step two
4. Calculate LPA based on the newly proposed 2022 Nonresidential allowances (to have a 2022 baseline for the comparison of the new MF proposed values)
5. Determine the average percent reduction in linear, area, and initial allowances between 2019 and 2022 nonresidential proposed requirements
6. Calculate proposed 2022 multifamily allowances by applying the average percentage reduction from step five to the allowances resulting from Step 3, (2019 equivalent allowances without linear allowance)

The Statewide CASE Team calculated the lighting power allowances for each site based on 2019 Title 24, Part 6 (Table 140.7-A) nonresidential allowances shown in Table 51 below with the takeoff data described above. For the case of LZ2 and LZ3 where there were both Asphalt and Concrete options, only the Asphalt option was

included because the proposed code reverts to the older Asphalt levels as the bases of design. The results are provided in Table 52.

Table 51: 2019 Nonresidential Lighting Power Allowance by Lighting Zone

Allowance	LZ1	LZ2A	LZ3A	LZ4
Area	0.018	0.023	0.025	0.03
Linear	0.15	0.17	0.25	0.35
Initial	180	250	350	400

Table 52: 2019 Calculated Lighting Power Allowance Wattage by Site Using 2019 NR Allowance Table

	LZ1	LZ2	LZ3	LZ4
Site 1	390	500	676	833
Site 2	901	1,109	1,472	1,890
Site 3	914	1,127	1,485	1,901
Site 4	949	1,176	1,525	1,938
Site 5	790	998	1,256	1,557
Site 6	1,033	1,278	1,652	2,103
Site 7	1,265	1,548	2,028	2,619
Site 8	1,143	1,412	1,818	2,319
Site 9	1,609	1,970	2,538	3,269
Site 10	1,743	2,130	2,748	3,550
Site 11	2,414	2,993	3,666	4,636
Site 12	2,446	3,042	3,695	4,651
Site 13	3,043	3,762	4,607	5,845
Site 14	5,696	6,912	8,756	11,380
Site 15	4,466	5,531	6,676	8,440
Site 16	8,581	10,393	13,157	17,134

The Statewide CASE Team then adjusted the 2019 initial and area allowances such that the resulting total LPA matches the total allowance per 2019 rules as closely as possible without resulting in a strong disadvantage to the allowances in the translation. These results are shown in Table 53 and Table 54 below.

Table 53: 2019 Equivalent Lighting Power Allowance without Linear Wattage Allowance

	LZ1	LZ2A	LZ3A	LZ4
Area	0.030	0.037	0.050	0.064
Linear	0	0	0	0
Initial	350	425	500	650

Table 54: 2019 Lighting Power Allowance Wattage by Site Using Alternate LPA Table Excluding Linear Wattage Allowance

	LZ1	LZ2A	LZ3A	LZ4
Site 1	491	599	735	951
Site 2	833	1,020	1,305	1,680
Site 3	879	1,077	1,381	1,778
Site 4	989	1,213	1,565	2,013
Site 5	1,013	1,243	1,605	2,064
Site 6	1,066	1,309	1,694	2,178
Site 7	1,132	1,390	1,804	2,319
Site 8	1,168	1,434	1,863	2,395
Site 9	1,513	1,859	2,438	3,131
Site 10	1,595	1,961	2,575	3,306
Site 11	2,790	3,435	4,567	5,856
Site 12	2,937	3,616	4,812	6,169
Site 13	3,438	4,234	5,647	7,238
Site 14	5,080	6,259	8,384	10,742
Site 15	5,248	6,466	8,664	11,099
Site 16	7,523	9,272	12,455	15,952

The Statewide CASE Team attempted to translate the allowances in this step as neutrally as possible so that it is neither more aggressive nor more lax when compared to the existing code. Due to the shape of the hardscape and area to perimeter ratios, this was not possible in all cases. For example, a site with many sidewalks will have a large hardscape perimeter and relatively small hardscape area leading to a low area to perimeter ratio (see Site 1 and Site 2 in Table 55 below) while a site with a large parking lot will have a larger perimeter area ratio due to the shape of the hardscape (see Site 8 in Table 55 below).

Essentially, the perimeter ratio reflects the “simplicity” of the site; the more complex (the greater the site deviates from an idealized square lot with a very simple square general hardscape area), the lower the ratio will become. Sites with large area to perimeter ratios are difficult to maintain overall comparable LPA values when removing the linear allowance without significantly increasing the LPA for sites with smaller area to perimeter ratios to ensure that the LPA formulas are neutral.

Table 55: Area to Perimeter Ratio by Site

Site ID	Area to Perimeter Ratio
Site 1	5.6
Site 2	5.6
Site 3	6.3
Site 4	8.3
Site 5	15.7
Site 6	8.5
Site 7	6.3
Site 8	40.3
Site 9	8.7
Site 10	7.9
Site 11	7.6
Site 12	15.9
Site 13	18.1
Site 14	15.3
Site 15	8.8
Site 16	18.2

The Statewide CASE Team remedied this issue with the use of the Excel Solver function where a user can select a value to minimize by altering the values in other cells. In this case, the cell to minimize was selected to be the *sum of the difference* in total LPA’s with and without linear allowances. The cells whose values were altered were the initial and area allowances values.

Table 56 below shows the percentage change in the total calculated effective LPA by site between existing 2019 allowances and the converted 2019 LPA formula without the linear allowance.

Table 56: Percent Change in Total Lighting Power Allowance by Site

	LZ1	LZ2A	LZ3A	LZ4
Site 1	26%	20%	9%	17%
Site 2	-8%	-8%	-11%	-14%
Site 3	-4%	-4%	-7%	-8%
Site 4	4%	3%	3%	5%
Site 5	28%	24%	28%	40%
Site 6	3%	2%	3%	5%
Site 7	-11%	-10%	-11%	-15%
Site 8	2%	2%	2%	4%
Site 9	-6%	-6%	-4%	-5%
Site 10	-9%	-8%	-6%	-9%
Site 11	16%	15%	25%	33%
Site 12	20%	19%	30%	41%
Site 13	13%	13%	23%	30%
Site 14	-11%	-9%	-4%	-7%
Site 15	18%	17%	30%	40%
Site 16	-12%	-11%	-5%	-9%

It is important to note that this process is not entirely automated, and attention was put on favoring the error to ensure that the MF LPA table for general hardscape does not penalize multifamily projects compared to the previous nonresidential LPA table. To do this, the Statewide CASE Team chose to favor over-allowance as opposed to under-allowance in the values that are set in the 2019 and 2022 proposed multifamily LPA tables. This means that if there is a difference in the allowance compared to the nonresidential cables, the project is likely to be given more LPA with the multifamily LPA table, not less, but it is not impossible to be allotted less. This is shown in Table 56 above when looking down a column of total allowed wattage differences, the error favors a positive error (resulting in greater positive error values and more sites with a positive error than a negative error).

The Statewide CASE Team also calculated the allowances for the 16 sites based on the proposed 2022 nonresidential lighting power allowances. Then, the Statewide CASE Team calculated the percentage reduction in allowances between 2019 and 2022 for LZ1-LZ4. These values are summarized in Table 57 and Table 58 below and were used to develop the proposed 2022 MF LPA values (which are based on the 2019 allowances without the linear allowance, calculated above, and reduced by the

respective average percentage for each lighting zone shown in Table 58). The proposed 2022 multifamily allowances are shown in Table 59.

Table 57: 2022 Proposed Nonresidential Lighting Power Allowance Values

	LZ1	LZ2A	LZ3A	LZ4
Area	0.015	0.018	0.021	0.24
Linear	0.13	0.15	0.2	0.29
Initial	150	200	250	320

Table 58: Percent Change in Lighting Power Allowance between 2019 and 2022 Nonresidential Lighting Power Allowance Values

	LZ1	LZ2A	LZ3A	LZ4
Area	-17%	-22%	-16%	-20%
Linear	-13%	-12%	-20%	-17%
Initial	-17%	-20%	-29%	-20%
Average	-15%	-18%	-20%	-19%

Table 59: 2022 Proposed Multifamily Allowance Values

	LZ1	LZ2A	LZ3A	LZ4
Area	0.026	0.030	0.038	0.055
Linear	0	0	0	0
Initial	300	350	400	450

Table 60 below provides the general summary of sites when grouped by the building prototype that each was assigned. These values represent the average characteristics for the sites when evaluated and compiled by prototype and do not represent any single site.

Table 60: Site Characteristics by Prototype

Prototype	Floor Area (ft2)	Unit Count	Building Footprint Area (ft2)	Site Area (ft2)	Landscape Area (ft2)	Hardscape Area (ft2)	Total Area (ft2)	Building Perimeter (ft)	Site Perimeter (ft)	Landscape Perimeter (ft)	Hardscape Perimeter (ft)
High-Rise	143,729	145	43,959	88,801	8,373	36,876	89,207	1,653	1,330	1,268	3,255
Mid-Rise	179,832	161	77,048	185,011	35,401	74,109	186,558	1,969	1,742	5,189	6,718
Low Rise - Garden	46,150	45	38,584	153,578	47,567	66,136	152,287	2,775	1,608	5,473	5,546
Low Rise - Corridor	40,521	70	32,608	92,979	36,122	24,087	92,816	1,502	1,284	3,192	2,759

Table 61 provides the general summary of sites when grouped by the building prototype that each was assigned. These values represent the average characteristics for the sites when evaluated and compiled by prototype and do not represent any single site.

Table 61: Evaluated Site Characteristics

Site	Prototype	Overall Prototype	Floor Area (total) (ft2)	Unit Count	Building Footprint Area (ft2)	Site Area (ft2)	Landscape Area (ft2)	Hardscape Area (ft2)	Total Area (ft2)	Building Perimeter (ft)	Site Perimeter (ft)	Landscape Perimeter (ft)	Hardscape Perimeter (ft)
Site 1	5 story mixed use	Mid Rise	43,649	24	55,507	60,731	-	4,705	60,212	989	1,033	-	835
Site 2	6 story mid-rise	High Rise	54,981	61	60,469	85,712	8,917	16,093	85,479	1,572	1,654	1,956	2,877
Site 3	Mid-rise	Mid Rise	350,774	249	41,817	64,954	5,059	17,621	64,497	1,401	1,188	1,374	2,777
Site 4	6 story mid-rise	High Rise	146,629	125	29,069	47,746	2,068	21,294	52,431	866	936	724	2,569
Site 5	3 story low rise	Low Rise - Corridor	28,305	49	18,263	51,084	10,112	22,101	50,476	901	940	1,833	1,412
Site 6	6 story mid-rise	High Rise	158,363	172	47,626	89,859	17,189	23,879	88,694	1,029	1,248	1,399	2,819
Site 7	3 story low rise	Low Rise - Corridor	52,737	90	46,952	134,873	62,131	26,072	135,155	2,103	1,628	4,551	4,107
Site 9	4 story low rise	Mid Rise	95,383	144	34,696	72,190	9,408	27,264	71,368	1,531	1,088	2,094	3,147
Site 10	Garden style	Low Rise - Garden	36,198	46	25,862	94,801	28,643	38,758	93,263	2,552	1,224	4,032	4,875
Site 11	2 story garden	Low Rise - Garden	21,366	36	17,862	94,097	34,451	41,504	93,817	2,146	1,241	4,840	5,443
Site 12	4 story LR + 10 townhomes	Low Rise - Garden	72,370	42	70,267	185,456	32,456	81,339	184,062	4,320	1,863	4,799	5,131
Site 13	6 story mixed use	High Rise	214,943	220	38,670	131,886	5,316	86,238	130,224	3,145	1,483	993	4,755
Site 14	Kind of garden style, 2 story	Low Rise - Garden	54,666	54	40,346	239,956	94,718	102,943	238,007	2,083	2,105	8,221	6,733
Site 15	5 story mid-rise	Mid Rise	175,864	174	183,581	389,824	68,124	157,683	409,388	3,502	2,569	13,058	17,855
Site 16	5 story mid-rise	Mid Rise	233,488	215	69,639	337,356	94,414	163,271	327,324	2,422	2,830	9,421	8,978

Appendix I: Multifamily Calculation Approach

The Statewide CASE Team used AGi32 lighting simulation software to calculate lighting layouts of various scenarios that are commonly found on multifamily projects: parking lot, plaza, and building entry lighting.

The Statewide CASE Team created a 3D model for each of the three scenarios and placed luminaires into the design scenarios in a manner consistent with good design practices and in keeping with the multifamily lighting survey results (to establish reasonable pole heights, wattages, and other variables that are commonly used in multifamily projects).

Based on product data gathered by as a sampling of the currently-available lighting products that may be suitable for specification, the Statewide CASE Team calculated the maximum vertical illuminance at various points on the façade of the building within the three prototypes to determine the maximum illumination that each floor of the building may receive.

Multifamily Calculation Methodology

The Statewide CASE Team set up a calculation matrix to analyze what effect the variables of interest have on light levels and light trespass into residential units. The intention was to determine optimal lighting design to ensure the maximum amount of light reaches the parking lot or building entry area while minimizing the amount of light that reaches the building façade. The Statewide CASE Team analyzed pole location, mounting height, different luminaire manufacturers, distribution type, and wattages for each of the scenarios described above.

The Statewide CASE Team varied the pole height and location while using real product data for the specifications. For example, in one simulation the Statewide CASE Team modelled 25-foot dual head poles located in the middle of a 120-foot-wide parking lot with an adjacent 6-foot strip of grass and sidewalk with a luminaire product with a Glare rating of G2, distribution Type III, and a total wattage of 70. AGi32 reports maximum illuminance levels at window height of each of the floors in each prototype.

Parking Lot Calculations

Parking space calculations were performed using AGI32 photometric modeling software. A representative model of the parking space, sidewalk, and building was built to the dimensions shown in Table 62 and Figure 30.

Table 62: Parking Lot Geometry Assumptions

Model Dimensions	Value
Curb-to-curb width	60 ft and 120 ft
Sidewalk width	5 ft
Grass width	6 ft
Building floor height	9.5 ft
Building floors	6

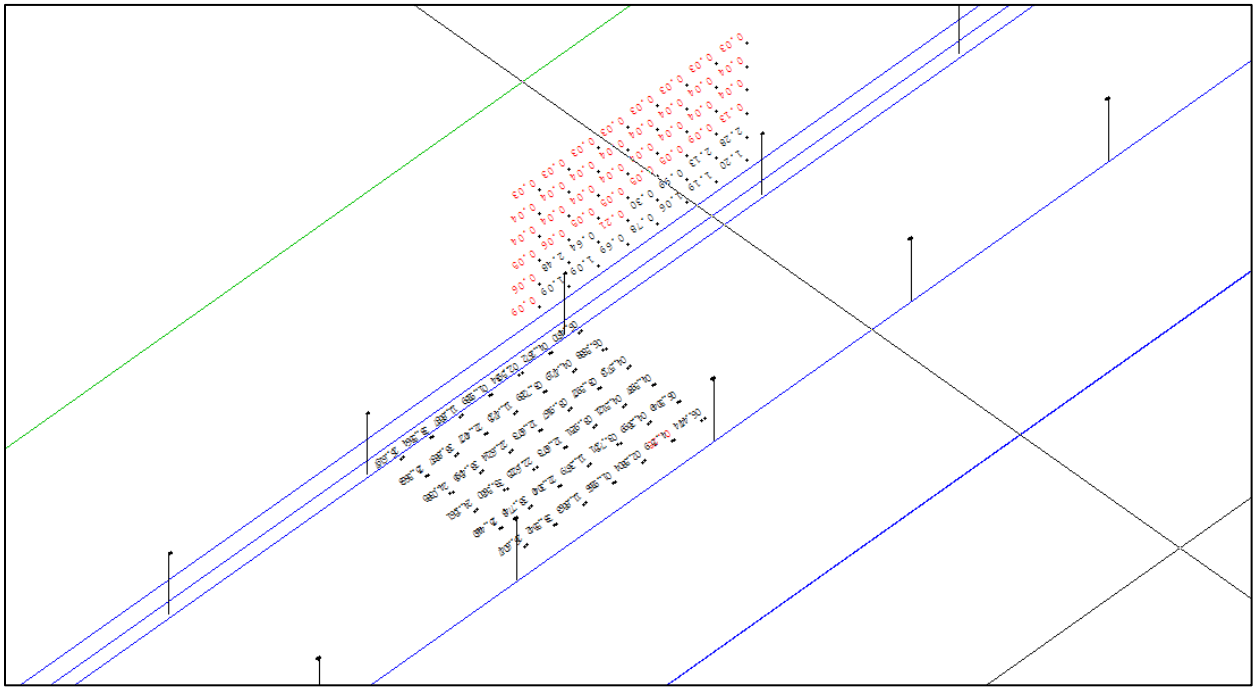

Figure 30: Parking space calculation model.

Five columns of pole fixtures were placed in the parking lot. The fixtures were placed using IES photometric files from a variety of manufacturers. The following fixture information was recorded:

- BUG G-Rating
- Luminaire manufacturer (using anonymized coding)
- Distribution Type
- Wattage
- Total Light Loss Factor (LLF), the product of two variables:
    - Lamp Lumen Depreciation (LLD)
    - Luminaire Dirt Depreciation (LDD)

The following lighting fixture characteristics were modified to create 184 unique cases:

- Fixture model
- Pole position

    - Center of the parking lot
    - Two rows: Center of the parking lot, and edge of the parking lot
- Fixture head configuration
    - One head
    - Two heads, back to back
- Pole height
    - 20 feet
    - 25 feet
    - 30 feet
    - 35 feet

Two calculation grids were placed in the model. One grid was placed on the parking lot, and one grid was placed on the adjacent building. The calculation grids were built using the following dimensions in Table 63 and Table 64.

Table 63: Parking Lot Calculation Grid Values

Parking Lot Grid Dimensions	Value
Left-to-right point spacing	5 ft
Top-to-bottom point spacing	4 ft
Left-to-right length	150 ft
Top-to-bottom width	12 ft

Table 64: Parking Lot Building Calculation Grid Values

Building Grid Dimensions	Value
Left-to-right point spacing	12 ft
Top-to-bottom point spacing	9.5 ft
Left-to-right length	84 ft
Top-to-bottom height	52 ft
Number of rows	6

Criteria for minimum allowable brightness and uniformity in the parking lot were established based on the IES recommended practices as detailed in the 10th Edition Handbook and the parking lot's calculation grid was used to determine when the criteria were met. The grid targeted the criteria as shown in Table 65.

Table 65: Parking Lot Calculation Design Criteria

Parking Lot Measurements	Criteria
Horizontal minimum illuminance	Minimum 0.5 fc
Vertical minimum illuminance	Minimum 0.25 fc
Horizontal maximum to minimum illuminance ratio	Maximum 15:1
Horizontal average to minimum illuminance ratio	Maximum 4:1

Once each unique case was built, pole-to-pole spacing was modified to find the maximum possible distance between poles while meeting the parking lot calculation grid's criteria. If the criteria could not be met with one row at the parking lot's edge at a minimum pole spacing of 50 feet, a second row would be added at the parking lot's center. If the criteria could not be met with two rows, the case would be considered not applicable.

Once the pole-to-pole spacing was found for each case, the building grid was used to measure lighting trespass into the adjacent building. Maximum vertical illuminance was measured and recoded for each floor of the building, represented by a row in the building's calculation grid.

Pedestrian Space Calculations

Pedestrian space calculations were performed using the same methodology as the parking lot calculations, with modified dimensions and criteria as shown in Table 66 and Figure 31

Table 66: Pedestrian Space Calculation Geometry Assumptions

Model Dimensions	Value
Curb-to-curb width	30 ft
Grass width	6 ft
Building floor height	9.5 ft
Building floors	6

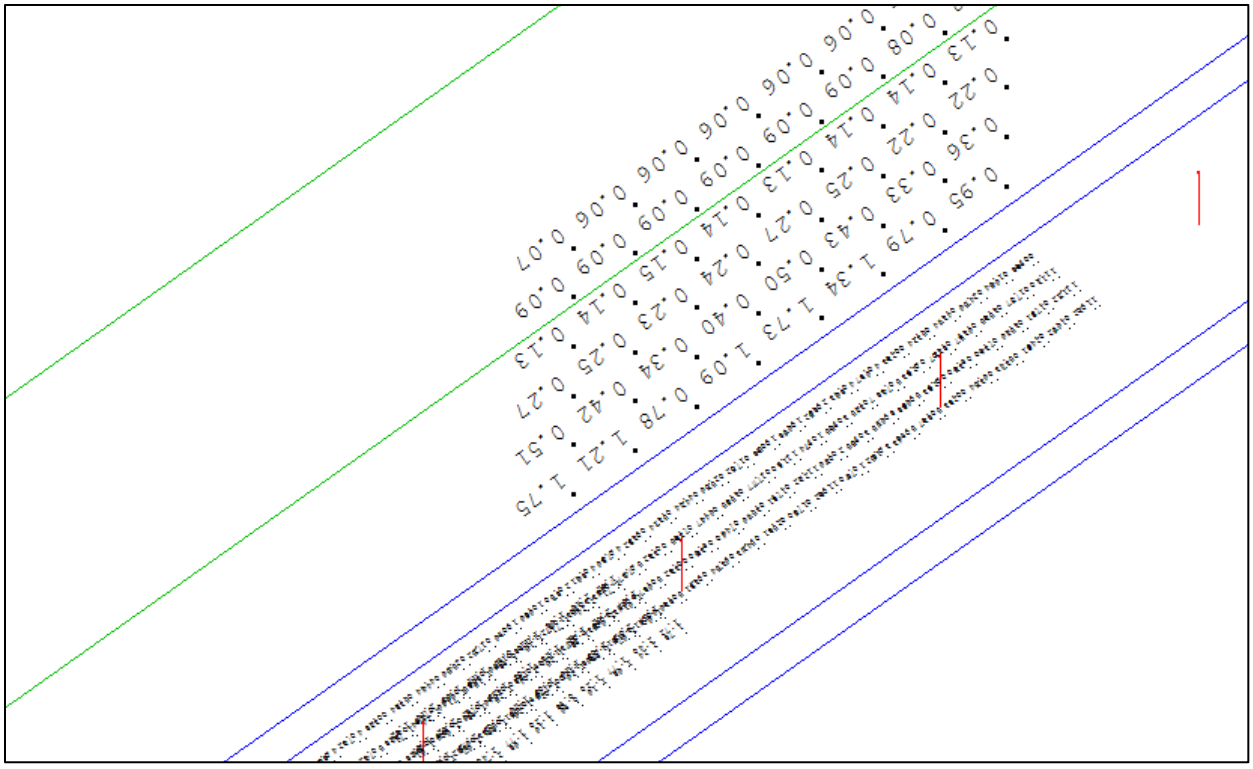

Figure 31: Pedestrian space calculation model.

The following lighting fixture characteristics were modified to create 123 unique cases:

- Fixture model
- Pole position
  - Center of the parking lot
  - Five feet inside the parking lot
- Fixture head configuration
  - One head
  - Two heads, back-to-back
- Pole height
  - 10 feet
  - 14 feet
  - 18 feet

Two calculation grids were placed in the model. One grid was placed on the parking lot, and one grid was placed on the adjacent building. The calculation grids were built using the following dimensions in Table 67 and Table 68.

Table 67: Pedestrian Space Calculation Grid Values

Plaza Grid Dimensions	Value
Left-to-right point spacing	5 ft
Top-to-bottom point spacing	4 ft
Left-to-right length	150 ft
Top-to-bottom width	12 ft

Table 68: Pedestrian Space Building Calculation Grid Values

Building Grid Dimensions	Value
Left-to-right point spacing	12 ft
Top-to-bottom point spacing	9.5 ft
Left-to-right length	84 ft
Top-to-bottom height	52 ft
Number of rows	6

Multifamily Calculation Goals

The final goal of this Final CASE Report was to create limits for outdoor lighting that are appropriate for circumstances and conditions associated with the residential nature of multifamily buildings. These calculations support the goal of the Final CASE Report by informing development of new general hardscape and entry LPA calculations in the existing Nonresidential Table 140.7-A and B of Title 24, Part 6. Based on the illumination levels at the windows of residential units generated by various mounting height and real luminaire specifications, the Statewide CASE Team will revise Table 140.7-A and B with new general hardscape and building entry LPAs.

Light and Health and Calculations Connection

One of the benefits of lower LPAs other than energy savings is the lower impact it has on human health. Recent research outlined in Appendix G explains the impact outdoor lighting at night can have on sleep. Light can have a significant impact on melatonin suppression and circadian rhythms which diminishes sleep quality, subjective sleepiness, and increases alertness. This issue is exacerbated by the increased use of LED lighting in outdoor lighting applications which has a higher proportion of emission in the blue light spectrum than traditional CFL or incandescent luminaires.

Researchers have proposed acceptable levels of illuminance in residential units to minimize the impact of light on circadian rhythms (McIntyre 1989), (Brainard 1988), (Zeitzer 2000), and (Phipps Nelson 2010). The intent of the calculations is to target these levels of illuminance while also ensuring adequate lighting is provided to exterior

spaces such as parking lots and building entry areas. The calculations will inform what realistic configurations achieve both goals in a cost-effective manner.

Multifamily Calculation Results

Based on the calculation procedures as detailed in this appendix, the following tables of calculation results present the overall lighting power density calculated through the scenarios that were set up to test the performance of modern outdoor LED luminaires.

Figure 32 below shows the trends of the parking lot and pedestrian zone calculations for effective lighting power density and luminaire wattage. There are clear differences in the trendlines for these two categories. The current infrastructure of the outdoor lighting LPA tables effectively relies on the more stringent (higher lighting power density) condition for both of these categories because they are both considered general hardscape. As a check against the proposed LPA values in the code, these graphs provide some good context, but not specifically for the Lighting Zones, which ultimately control what is permissible in the state.

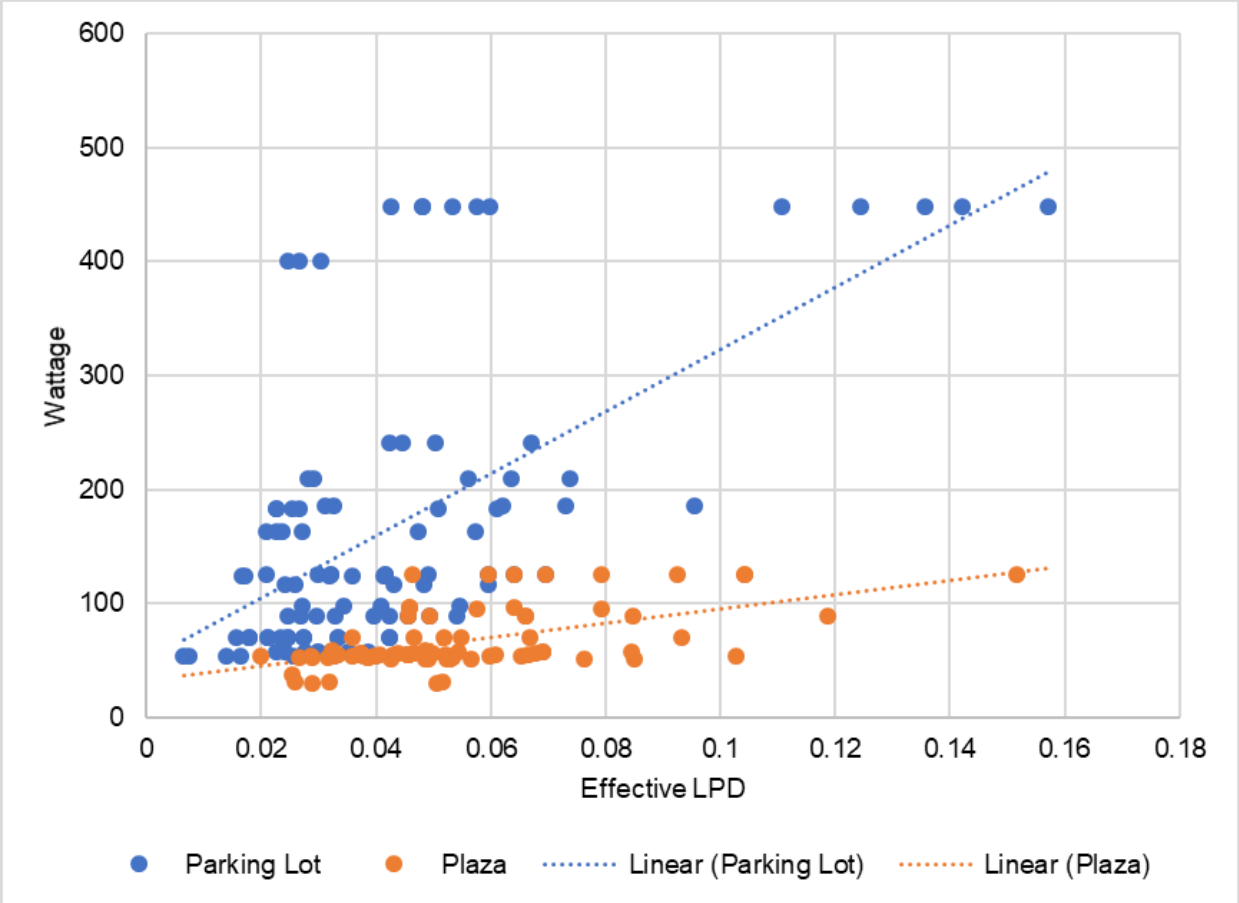

Figure 32: Calculation results graph: wattage vs. eLPD for parking lot and plaza scenarios.

Figure 33 below provides the same information with color coding for the Lighting Zone Uplight and Glare (UG) rating that each luminaire meets. Note that these results do not imply that these products can be applied on any location on the property (there are additional restrictions for Backlight when near the property boundary), but the lighting products should be applicable for much of the site without restriction.

The results indicate that there is a wide range of eLPD that the lighting systems may produce for any given circumstance, but clearly, some of these are not optimized and are not necessarily given the same weighting as the cluster of lighting products that are capable of efficiently meeting the lighting criteria as detailed by the Illumination Engineering Society.

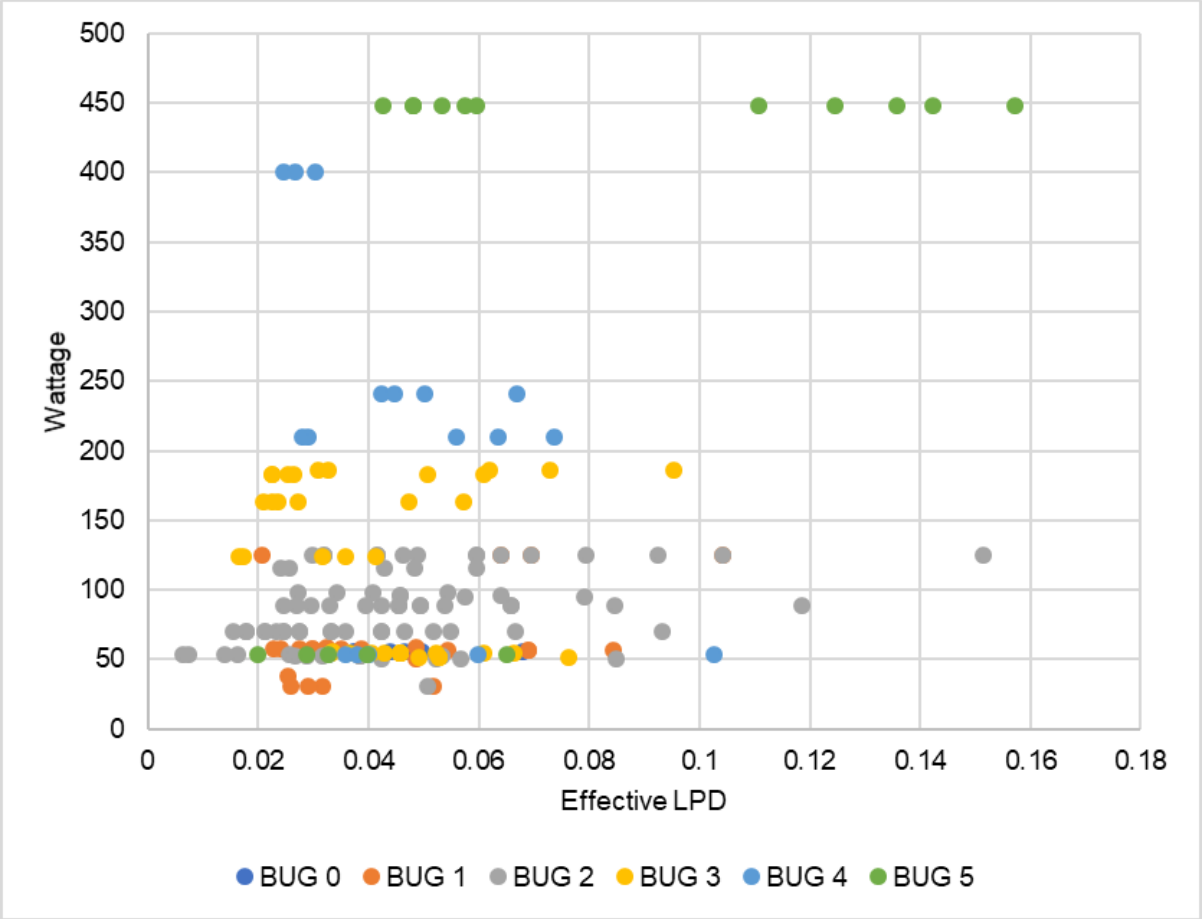

Figure 33: Calculation results graph: wattage vs. eLPD for parking lot and plaza scenarios with lighting zone differentiation.

Similarly, Figure 34 below provides the same information with color coding for the mounting height of the luminaires as part of the calculations. The results also indicate that there is a range of eLPD that the lighting systems may produce based on mounting height. Again, some of these are not optimized and are not necessarily given the same

weighting as the cluster of lighting products that are capable of efficiently meeting the lighting criteria as detailed by the Illumination Engineering Society.

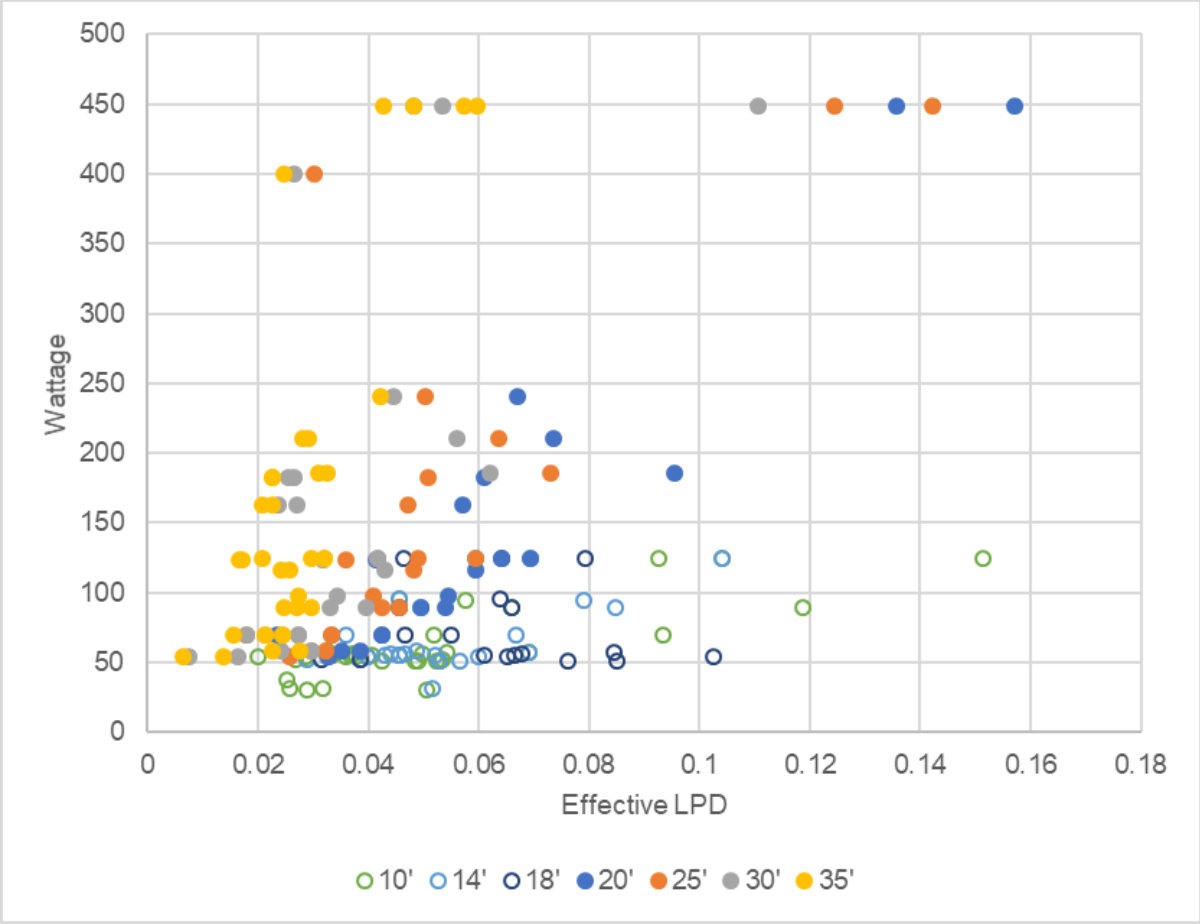

Figure 34: Calculation results graph: wattage vs. eLPD for parking lot and plaza scenarios with mounting height differentiation

The following group of tables provide the calculation results for each individual scenario that produce the results graphs above. Table 69 through Table 74 shows the results for the Parking Lot calculations. Table 75 through Table 78 shows the results for the Plaza calculations.

These tables show all the permutations of parking lot or plaza pole spacing scenarios for a given luminaire and not all of these are possible to achieve the desired design criteria. In some examples, the results FAIL to achieve criteria and for a variety of reasons. Those reasons are detailed in the “Notes” column just to the right of the center, and in these circumstances, no results are shown in the yellow criteria columns to the right.

In the circumstances where the luminaire (wattage, pole mounting height, and head configuration, etc.) is able to meet criteria, the results columns will show the results for

each particular criterion and the one highlighted in yellow will be the criterion that failed first, so it represents the “controlling criterion”.

If there is a design that is fairly well optimized for the space geometry and design criteria, more than one criterion will likely be on the verge of failing, so there may be sites where more than one column of criterion is shown in yellow. That is an indication that the luminaire was well suited for the circumstances of the site geometry to meet the design criteria efficiently without over-lighting.

Note, the following calculation tables are also available via excel spreadsheet, please send a request to info@title24stakeholders.com.

Table 69: Calculation Results – Parking Lot, Pt. 1

											Results		Horiz. Min.	Vert. Min.	Horiz. Max: Min	Horiz. Avg: Min			
Sim C	Condition	Poles	Other	BUG G-rati	Lum. Man	Dist. Typ	Total LL	Watt.	Q'tv	Notes	Pole-Pole Spacin	Curb-Curb Spacin	.5	.25	15:1	4:1	Eff. LP	MAX Ve	Initial MAX Ve
125	Parking Lot, 60' wide	20'	Opposite side poles	2	A	V	0.756	95	1	N/A - Min Vert of 0.1 @ 50' Pole-Pole		120							
126	Parking Lot, 60' wide	25'	Opposite side poles	2	A	V	0.756	95	1	N/A - Min Vert of 0.13 @ 50' Pole-Pole		120							
127	Parking Lot, 60' wide	30'	Opposite side poles	2	A	V	0.756	95	1	N/A - Min Vert of 0.15 @ 50' Pole-Pole		120							
128	Parking Lot, 60' wide	35'	Opposite side poles	2	A	V	0.756	95	1	N/A - Min Vert of 0.15 @ 50' Pole-Pole		120							
289	Parking Lot, 60' wide	20'	Near-side poles	2	D	III	0.819	70	1		50	60	2.09	0.38		1.70	0.02	0.92	1.12
290	Parking Lot, 60' wide	25'	Near-side poles	2	D	III	0.819	70	1		65	60	1.77	0.25		1.55	0.02	0.71	0.87
291	Parking Lot, 60' wide	30'	Near-side poles	2	D	III	0.819	70	1		65	60	1.50	0.34		1.71	0.02	0.87	1.06
292	Parking Lot, 60' wide	35'	Near-side poles	2	D	III	0.819	70	1		75	60	1.28	0.30		1.66	0.02	0.88	1.07
293	Parking Lot, 60' wide	20'	Opposite side poles	2	D	III	0.819	70	2	N/A - Min Vert of 0.02 @ 50' Pole-Pole		120							
294	Parking Lot, 60' wide	25'	Opposite side poles	2	D	III	0.819	70	2	N/A - Min Vert of 0.06 @ 50' Pole-Pole		120							
295	Parking Lot, 60' wide	30'	Opposite side poles	2	D	III	0.819	70	2	N/A - Min Vert of 0.18 @ 50' Pole-Pole		120							
296	Parking Lot, 60' wide	35'	Opposite side poles	2	D	III	0.819	70	2		55	120	0.68	0.27		2.62	0.02	0.75	0.92
297	Parking Lot, 60' wide	20'	Near-side poles	2	D	III	0.801	116	2		65	60	2.45	0.46		2.16	0.06	1.61	2.01
298	Parking Lot, 60' wide	25'	Near-side poles	2	D	III	0.801	116	2		80	60	1.26	0.25		2.95	0.05	2.48	3.10
299	Parking Lot, 60' wide	30'	Near-side poles	2	D	III	0.801	116	2		90	60	1.31	0.31		2.29	0.04	2.15	2.68
300	Parking Lot, 60' wide	35'	Near-side poles	2	D	III	0.801	116	1		75	60	0.67	0.28		2.70	0.03	2.26	2.82
301	Parking Lot, 60' wide	20'	Opposite side poles	2	D	III	0.801	116	2	N/A - Horiz Avg:Min >4		120							
302	Parking Lot, 60' wide	25'	Opposite side poles	2	D	III	0.801	116	2	N/A - Horiz Avg:Min >4		120							
303	Parking Lot, 60' wide	30'	Opposite side poles	2	D	III	0.801	116	2	N/A - Horiz. Avg:Min of 5.39 from 50'-		120							
304	Parking Lot, 60' wide	35'	Opposite side poles	2	D	III	0.801	116	2		80	120	0.70	0.28		3.31	0.02	0.89	1.11
313	Parking Lot, 60' wide	20'	Near-side poles	2	D	III	0.862	54	2		55	60	1.40	0.30		2.24	0.03	0.70	0.81
314	Parking Lot, 60' wide	25'	Near-side poles	2	D	III	0.862	54	2		70	60	1.56	0.25		1.57	0.03	0.58	0.67
315	Parking Lot, 60' wide	30'	Near-side poles	2	D	III	0.862	54	1		55	60	0.57	0.28		2.25	0.02	0.32	0.37
316	Parking Lot, 60' wide	35'	Near-side poles	2	D	III	0.862	54	1		65	60	0.66	0.27		1.52	0.01	0.31	0.36
317	Parking Lot, 60' wide	20'	Opposite side poles	2	D	III	0.862	54	1	N/A - Min Vert of 0.14 @ 50' Pole-Pole		120							
318	Parking Lot, 60' wide	25'	Opposite side poles	2	D	III	0.862	54	1	N/A - Min Vert of 0.22 @ 50' Pole-Pole		120							
319	Parking Lot, 60' wide	30'	Opposite side poles	2	D	III	0.862	54	1		60	120	0.58	0.27		2.21	0.01	0.71	0.82
320	Parking Lot, 60' wide	35'	Opposite side poles	2	D	III	0.862	54	1		70	120	0.69	0.25		1.46	0.01	0.84	0.97
333	Parking Lot, 60' wide	20'	Opposite side poles	2	D	V	0.862	74	1	N/A - Min Vert = 0.1 @ 50' Pole-Pole		120							
334	Parking Lot, 60' wide	25'	Opposite side poles	2	D	V	0.862	74	1	N/A - Min Vert = 0.15 @ 50' Pole-Pole		120							
335	Parking Lot, 60' wide	30'	Opposite side poles	2	D	V	0.862	74	1	N/A - Min Vert = 0.22 @ 50' Pole-Pole		120							
336	Parking Lot, 60' wide	35'	Opposite side poles	2	D	V	0.862	74	1	N/A - Min Vert = 0.23 @ 50' Pole-Pole		120							

Table 70: Calculation Results – Parking Lot, Pt. 2

											Results		Horiz. Min.	Vert. Min.	Horiz. Max: Min	Horiz. Avg: Min			
Sim C	Condition	Poles	Other	BUG G-rati	Lum. Man	Dist. Typ	Total Lu	Watt.	Q'ty	Notes	Pole-Pole Spacin	Curb-Curb Spacin	.5	.25	15:1	4:1	Eff. LP	MAX Ve	Initial MAX Ve
337	Parking Lot, 60' wide	20'	Near-side poles	2	D	III	0.819	70	2		55	60	1.40	0.30		2.24	0.04	0.70	0.85
338	Parking Lot, 60' wide	25'	Near-side poles	2	D	III	0.819	70	2		70	60	1.56	0.25		1.57	0.03	0.58	0.71
339	Parking Lot, 60' wide	30'	Near-side poles	2	D	III	0.819	70	2		85	60	1.32	0.27		1.42	0.03	0.50	0.61
340	Parking Lot, 60' wide	35'	Near-side poles	2	D	III	0.819	70	2		95	60	1.06	0.26		1.48	0.02	0.50	0.61
341	Parking Lot, 60' wide	20'	Opposite side poles	2	D	III	0.819	70	2	N/A - Horiz. Avg:Min >4, Min Vert <0.2		120							
342	Parking Lot, 60' wide	25'	Opposite side poles	2	D	III	0.819	70	2	N/A - Horiz. Avg:Min >4, Min Vert <0.2		120							
343	Parking Lot, 60' wide	30'	Opposite side poles	2	D	III	0.819	70	2	N/A - Horiz. Avg:Min >4, Min Vert <0.2		120							
344	Parking Lot, 60' wide	35'	Opposite side poles	2	D	III	0.819	70	2		55	120	0.68	0.27		2.62	0.02	0.75	0.92
369	Parking Lot, 60' wide	20'	Near-side poles	1	D	III	0.819	58	2		55	60	1.07	0.26		2.30	0.04	0.58	0.71
370	Parking Lot, 60' wide	25'	Near-side poles	1	D	III	0.819	58	2		65	60	1.36	0.33		1.51	0.03	0.56	0.68
371	Parking Lot, 60' wide	30'	Near-side poles	1	D	III	0.819	58	2		80	60	1.07	0.25		1.45	0.02	0.52	0.63
372	Parking Lot, 60' wide	35'	Near-side poles	1	D	III	0.819	58	2		85	60	0.95	0.29		1.46	0.02	0.55	0.67
373	Parking Lot, 60' wide	20'	Opposite side poles	1	D	III	0.819	58	2	N/A - Horiz. Avg:Min >4, Min Vert <0.2		120							
374	Parking Lot, 60' wide	25'	Opposite side poles	1	D	III	0.819	58	2	N/A - Horiz. Avg:Min >4, Min Vert <0.2		120							
375	Parking Lot, 60' wide	30'	Opposite side poles	1	D	III	0.819	58	2	N/A - Horiz. Avg:Min >4, Min Vert <0.2		120							
376	Parking Lot, 60' wide	35'	Opposite side poles	1	D	III	0.819	58	2	N/A - Horiz. Avg:Min >4, Min Vert <0.2		120							
377	Parking Lot, 60' wide	20'	Near-side poles	1	D	III	0.819	58	2		50	60	1.60	0.29		1.70	0.04	0.70	0.85
378	Parking Lot, 60' wide	25'	Near-side poles	1	D	III	0.819	58	2		60	60	1.55	0.26		1.45	0.03	0.59	0.72
379	Parking Lot, 60' wide	30'	Near-side poles	1	D	III	0.819	58	2		65	60	1.15	0.26		1.71	0.03	0.66	0.81
380	Parking Lot, 60' wide	35'	Near-side poles	1	D	III	0.819	58	2		70	60	1.05	0.27		1.65	0.03	0.72	0.88
381	Parking Lot, 60' wide	20'	Opposite side poles	1	D	III	0.819	58	2	N/A - Horiz. Avg:Min >4, Min Vert <0.2		120							
382	Parking Lot, 60' wide	25'	Opposite side poles	1	D	III	0.819	58	2	N/A - Horiz. Avg:Min >4, Min Vert <0.2		120							
383	Parking Lot, 60' wide	30'	Opposite side poles	1	D	III	0.819	58	2	N/A - Horiz. Avg:Min >4, Min Vert <0.2		120							
384	Parking Lot, 60' wide	35'	Opposite side poles	1	D	III	0.819	58	2	N/A - Min Vert = 0.24 @ 50' Pole-Pole		120							
401	Parking Lot, 60' wide	20'	Near-side poles	2	D	III	0.819	70	2		55	60	1.40	0.30		2.24	0.04	0.70	0.85
402	Parking Lot, 60' wide	25'	Near-side poles	2	D	III	0.819	70	2		70	60	1.56	0.25		1.57	0.03	0.58	0.71
403	Parking Lot, 60' wide	30'	Near-side poles	2	D	III	0.819	70	2		85	60	1.32	0.27		1.42	0.03	0.50	0.61
404	Parking Lot, 60' wide	35'	Near-side poles	2	D	III	0.819	70	2		95	60	1.06	0.26		1.48	0.02	0.50	0.61
405	Parking Lot, 60' wide	20'	Opposite side poles	2	D	III	0.819	70	2	N/A - Horiz Avg:Min >4 and Min Vert <		120							
406	Parking Lot, 60' wide	25'	Opposite side poles	2	D	III	0.819	70	2	N/A - Horiz Avg:Min >4 and Min Vert <		120							
407	Parking Lot, 60' wide	30'	Opposite side poles	2	D	III	0.819	70	2	N/A - Horiz Avg:Min >4 and Min Vert <		120							
408	Parking Lot, 60' wide	35'	Opposite side poles	2	D	III	0.819	70	2	N/A - Horiz. Avg:Min of 4.16 and Min V		120							

Table 71: Calculation Results – Parking Lot, Pt. 3

											Results		Horiz. Min.	Vert. Min.	Horiz. Max: Min	Horiz. Avg: Min			
Sim C	Condition	Poles	Other	BUG G-rati	Lum. Man	Dist. Typ	Total LL	Watt.	Q'ty	Notes	Pole-Pole Spacin	Curb-Curb Spacin	.5	.25	15:1	4:1	Eff. LP	MAX Ve	Initial MAX Ve
409	Parking Lot, 60' wide	20'	Near-side poles	2	D	III	0.819	89	2		60	60	1.50	0.26		2.37	0.05	0.77	0.94
410	Parking Lot, 60' wide	25'	Near-side poles	2	D	III	0.819	89	2		70	60	1.92	0.30		1.56	0.04	0.71	0.87
411	Parking Lot, 60' wide	30'	Near-side poles	2	D	III	0.819	89	2		90	60	1.45	0.28		1.46	0.03	0.62	0.76
412	Parking Lot, 60' wide	35'	Near-side poles	2	D	III	0.819	89	2		100	60	1.22	0.27		1.49	0.03	0.58	0.71
413	Parking Lot, 60' wide	20'	Opposite side poles	2	D	III	0.819	89	2	N/A - Horiz. Avg:Min >4		120							
414	Parking Lot, 60' wide	25'	Opposite side poles	2	D	III	0.819	89	2	N/A - Horiz. Avg:Min >4		120							
415	Parking Lot, 60' wide	30'	Opposite side poles	2	D	III	0.819	89	2	N/A - Horiz. Avg:Min >4		120							
416	Parking Lot, 60' wide	35'	Opposite side poles	2	D	III	0.819	89	2	N/A - Horiz. Avg:Min of 4.02 @ 60'		120							
417	Parking Lot, 60' wide	20'	Near-side poles	2	D	III	0.819	89	2		55	60	2.39	0.44		1.82	0.05	1.22	1.49
418	Parking Lot, 60' wide	25'	Near-side poles	2	D	III	0.819	89	2		65	60	2.12	0.31		1.59	0.05	0.88	1.07
419	Parking Lot, 60' wide	30'	Near-side poles	2	D	III	0.819	89	2		75	60	1.65	0.27		1.67	0.04	1.09	1.33
420	Parking Lot, 60' wide	35'	Near-side poles	2	D	III	0.819	89	1		55	60	0.78	0.29		2.24	0.03	0.88	1.07
421	Parking Lot, 60' wide	20'	Opposite side poles	2	D	III	0.819	89	2	N/A - Vert Min of 0.03 @ 50' Pole-Pole		120							
422	Parking Lot, 60' wide	25'	Opposite side poles	2	D	III	0.819	89	2	N/A - Vert Min of 0.08 @ 50' Pole-Pole		120							
423	Parking Lot, 60' wide	30'	Opposite side poles	2	D	III	0.819	89	2	N/A - Vert Min of 0.21 @ 50' Pole-Pole		120							
424	Parking Lot, 60' wide	35'	Opposite side poles	2	D	III	0.819	89	2		60	120	0.76	0.26		2.67	0.02	0.84	1.03
433	Parking Lot, 60' wide	20'	Near-side poles	2	D	III	0.819	98	2		60	60	1.68	0.28		2.49	0.05	0.93	1.14
434	Parking Lot, 60' wide	25'	Near-side poles	2	D	III	0.819	98	2		80	60	1.67	0.26		1.80	0.04	0.70	0.85
435	Parking Lot, 60' wide	30'	Near-side poles	2	D	III	0.819	98	2		95	60	1.53	0.27		1.52	0.03	0.71	0.87
436	Parking Lot, 60' wide	35'	Near-side poles	2	D	III	0.819	98	1		60	60	0.51	0.26		3.69	0.03	0.84	1.03
437	Parking Lot, 60' wide	20'	Opposite side poles	2	D	III	0.819	98	2	N/A - Horiz. Avg:Min >4		120							
438	Parking Lot, 60' wide	25'	Opposite side poles	2	D	III	0.819	98	2	N/A - Horiz. Avg:Min >4		120							
439	Parking Lot, 60' wide	30'	Opposite side poles	2	D	III	0.819	98	2	N/A - Horiz. Avg:Min >4		120							
440	Parking Lot, 60' wide	35'	Opposite side poles	2	D	III	0.819	98	2	N/A - Horiz. Avg:Min of 4.33 from 50'-7		120							
441	Parking Lot, 60' wide	20'	Near-side poles	5	D	III	0.819	570	2		65	60	7.62	0.61		3.09	0.29	15.03	18.35
442	Parking Lot, 60' wide	25'	Near-side poles	5	D	III	0.819	570	2		90	60	3.62	0.34		3.90	0.21	11.28	13.77
443	Parking Lot, 60' wide	30'	Near-side poles	5	D	III	0.819	570	2		110	60	3.22	0.34		3.38	0.17	9.82	11.99
444	Parking Lot, 60' wide	35'	Near-side poles	5	D	III	0.819	570	1		110	60	1.75	0.27		3.08	0.09	10.53	12.86
445	Parking Lot, 60' wide	20'	Opposite side poles	5	D	III	0.819	570	2	N/A - Horiz. Avg:Min >4		120							
446	Parking Lot, 60' wide	25'	Opposite side poles	5	D	III	0.819	570	2	N/A - Horiz. Avg:Min >4		120							
447	Parking Lot, 60' wide	30'	Opposite side poles	5	D	III	0.819	570	2	N/A - Horiz. Avg:Min >4		120							
448	Parking Lot, 60' wide	35'	Opposite side poles	5	D	III	0.819	570	2		120	120	1.83	0.28		3.49	0.08	2.11	2.58

Table 72: Calculation Results – Parking Lot, Pt. 4

											Results		Horiz. Min.	Vert. Min.	Horiz. Max: Min	Horiz. Avg: Min			
Sim C	Condition	Poles	Other	BUG G-rati	Lum. Man	Dist. Typ	Total LL	Watt.	Q'ty	Notes	Pole-Pole Spacin	Curb-Curb Spacin	.5	.25	15:1	4:1	Eff. LP	MAX Ve	Initial MAX Ve
449	Parking Lot, 60' wide	20'	Near-side poles	5	C	III	0.81	448	2		110	60	2.39	0.32		3.59	0.14	2.79	3.44
450	Parking Lot, 60' wide	25'	Near-side poles	5	C	III	0.81	448	2		120	60	2.60	0.26		2.77	0.12	2.76	3.41
451	Parking Lot, 60' wide	30'	Near-side poles	5	C	III	0.81	448	2		135	60	3.21	0.25		2.00	0.11	2.84	3.51
452	Parking Lot, 60' wide	35'	Near-side poles	5	C	III	0.81	448	1		125	60	1.13	0.30		2.99	0.06	2.47	3.05
453	Parking Lot, 60' wide	20'	Opposite side poles	5	C	III	0.81	448	2	N/A - Horiz. Avg:Min >4		120							
454	Parking Lot, 60' wide	25'	Opposite side poles	5	C	III	0.81	448	2	N/A - Horiz. Avg:Min >4		120							
455	Parking Lot, 60' wide	30'	Opposite side poles	5	C	III	0.81	448	2	N/A - Horiz. Avg:Min >4		120							
456	Parking Lot, 60' wide	35'	Opposite side poles	5	C	III	0.81	448	2		130	120	1.30	0.27		2.88	0.06	1.92	2.37
457	Parking Lot, 60' wide	20'	Near-side poles	5	V	III	0.815	448	2		95	60	1.40	0.25		3.14	0.16	5.91	7.25
458	Parking Lot, 60' wide	25'	Near-side poles	5	V	III	0.815	448	2		105	60	1.99	0.28		2.00	0.14	3.50	4.29
459	Parking Lot, 60' wide	30'	Near-side poles	5	V	III	0.815	448	1		140	60	0.94	0.25		3.32	0.05	8.14	9.98
460	Parking Lot, 60' wide	35'	Near-side poles	5	V	III	0.815	448	1		155	60	2.32	0.27		2.32	0.05	3.40	4.17
461	Parking Lot, 60' wide	20'	Opposite side poles	5	V	III	0.815	448	2	N/A - Horiz. Avg:Min >4		120							
462	Parking Lot, 60' wide	25'	Opposite side poles	5	V	III	0.815	448	2	N/A - Horiz. Avg:Min >4		120							
463	Parking Lot, 60' wide	30'	Opposite side poles	5	V	III	0.815	448	2		155	120	0.94	0.28		3.81	0.05	1.33	1.63
464	Parking Lot, 60' wide	35'	Opposite side poles	5	V	III	0.815	448	2		175	120	1.16	0.26		2.71	0.04	1.81	2.22
469	Parking Lot, 60' wide	20'	Opposite side poles	4	D	V	0.819	400	1	N/A - Horiz. Avg:Min >4		120							
470	Parking Lot, 60' wide	25'	Opposite side poles	4	D	V	0.819	400	1		110	120	0.84	0.26		3.01	0.03	1.61	1.97
471	Parking Lot, 60' wide	30'	Opposite side poles	4	D	V	0.819	400	1		125	120	0.95	0.26		2.19	0.03	1.83	2.23
472	Parking Lot, 60' wide	35'	Opposite side poles	4	D	V	0.819	400	1		135	120	0.94	0.27		1.90	0.02	1.84	2.25
477	Parking Lot, 60' wide	20'	Opposite side poles	4	V	III	0.815	241	2	N/A - Horiz. Avg:Min >4	60	120					0.07		
478	Parking Lot, 60' wide	25'	Opposite side poles	4	V	III	0.815	241	2		80	120	1.09	0.26		3.48	0.05	1.94	2.38
479	Parking Lot, 60' wide	30'	Opposite side poles	4	V	III	0.815	241	2		90	120	1.52	0.26		2.01	0.04	2.77	3.40
480	Parking Lot, 60' wide	35'	Opposite side poles	4	V	III	0.815	241	2		95	120	1.63	0.27		1.65	0.04	2.90	3.56
481	Parking Lot, 60' wide	20'	Near-side poles	4	C	III	0.81	210	2		95	60	2.45	0.28		2.93	0.07	2.52	3.11
482	Parking Lot, 60' wide	25'	Near-side poles	4	C	III	0.81	210	2		110	60	3.20	0.26		1.94	0.06	2.14	2.64
483	Parking Lot, 60' wide	30'	Near-side poles	4	C	III	0.81	210	2		125	60	3.25	0.29		1.66	0.06	2.21	2.73
484	Parking Lot, 60' wide	35'	Near-side poles	4	C	III	0.81	210	1		120	60	0.91	0.28		3.00	0.03	1.92	2.37
485	Parking Lot, 60' wide	20'	Opposite side poles	4	C	III	0.81	210	2	N/A - Horiz. Avg:Min >4		120							
486	Parking Lot, 60' wide	25'	Opposite side poles	4	C	III	0.81	210	2	N/A - Horiz. Avg:Min >4		120							
487	Parking Lot, 60' wide	30'	Opposite side poles	4	C	III	0.81	210	2	N/A - Horiz. Avg:Min >4		120							
488	Parking Lot, 60' wide	35'	Opposite side poles	4	C	III	0.81	210	2		125	120	1.03	0.26		2.94	0.03	1.56	1.93

Table 73: Calculation Results – Parking Lot, Pt. 5

											Results		Horiz. Min.	Vert. Min.	Horiz. Max: Min	Horiz. Avg: Min			
Sim C	Condition	Poles	Other	BUG G-rati	Lum. Man	Dist. Typ	Total Ll	Watt.	Q'ty	Notes	Pole-Pole Spacin	Curb-Curb Spacin	.5	.25	15:1	4:1	Eff. LP	MAX Ve	Initial MAX Ve
489	Parking Lot, 60' wide	20'	Near-side poles	3	D	III	0.801	186	2		65	60	1.72	0.25		2.83	0.10	1.00	1.25
490	Parking Lot, 60' wide	25'	Near-side poles	3	D	III	0.801	186	2		85	60	1.80	0.27		1.79	0.07	0.79	0.99
491	Parking Lot, 60' wide	30'	Near-side poles	3	D	III	0.801	186	2		100	60	1.67	0.27		1.57	0.06	0.98	1.22
492	Parking Lot, 60' wide	35'	Near-side poles	3	D	III	0.801	186	1		95	60	0.86	0.26		2.64	0.03	3.77	4.71
493	Parking Lot, 60' wide	20'	Opposite side poles	3	D	III	0.801	186	2	N/A - Horiz. Avg:Min >4		120							
494	Parking Lot, 60' wide	25'	Opposite side poles	3	D	III	0.801	186	2	N/A - Horiz. Avg:Min >4		120							
495	Parking Lot, 60' wide	30'	Opposite side poles	3	D	III	0.801	186	2	N/A - Horiz. Avg:Min >4		120							
496	Parking Lot, 60' wide	35'	Opposite side poles	3	D	III	0.801	186	2		100	120	0.94	0.27		3.00	0.03	1.18	1.47
497	Parking Lot, 60' wide	20'	Near-side poles	3	W	III	0.792	183	2		100	60	1.54	0.27		2.32	0.06	1.00	1.26
498	Parking Lot, 60' wide	25'	Near-side poles	3	W	III	0.792	183	2		120	60	1.32	0.27		2.29	0.05	0.99	1.25
499	Parking Lot, 60' wide	30'	Near-side poles	3	W	III	0.792	183	1		115	60	0.60	0.28		2.52	0.03	0.97	1.22
500	Parking Lot, 60' wide	35'	Near-side poles	3	W	III	0.792	183	1		135	60	0.74	0.26		1.65	0.02	0.87	1.10
501	Parking Lot, 60' wide	20'	Opposite side poles	3	W	III	0.792	183	2	N/A - Horiz. Avg:Min >4		120							
502	Parking Lot, 60' wide	25'	Opposite side poles	3	W	III	0.792	183	2	N/A - Horiz. Avg:Min >4		120							
503	Parking Lot, 60' wide	30'	Opposite side poles	3	W	III	0.792	183	2		120	120	0.68	0.25		2.60	0.03	0.68	0.86
504	Parking Lot, 60' wide	35'	Opposite side poles	3	W	III	0.792	183	2		135	120	0.82	0.27		1.84	0.02	1.14	1.44
505	Parking Lot, 60' wide	20'	Near-side poles	3	V	III	0.815	163	2		95	60	1.70	0.28		2.09	0.06	3.55	4.35
506	Parking Lot, 60' wide	25'	Near-side poles	3	V	III	0.815	163	2		115	60	1.49	0.26		1.97	0.05	1.09	1.34
507	Parking Lot, 60' wide	30'	Near-side poles	3	V	III	0.815	163	1		100	60	0.52	0.28		3.25	0.03	3.16	3.88
508	Parking Lot, 60' wide	35'	Near-side poles	3	V	III	0.815	163	1		120	60	0.69	0.27		1.91	0.02	1.32	1.62
509	Parking Lot, 60' wide	20'	Opposite side poles	3	V	III	0.815	163	2	N/A - Horiz. Avg:Min >4		120							
510	Parking Lot, 60' wide	25'	Opposite side poles	3	V	III	0.815	163	2	N/A - Horiz. Avg:Min >4		120							
511	Parking Lot, 60' wide	30'	Opposite side poles	3	V	III	0.815	163	2		115	120	0.61	0.27		2.90	0.02	0.73	0.90
512	Parking Lot, 60' wide	35'	Opposite side poles	3	V	III	0.815	163	2		130	120	0.76	0.28		1.97	0.02	0.96	1.18
513	Parking Lot, 60' wide	20'	Near-side poles	2	D	III	0.819	125	2		65	60	1.72	0.25		2.83	0.06	1.00	1.22
514	Parking Lot, 60' wide	25'	Near-side poles	2	D	III	0.819	125	2		85	60	1.80	0.27		1.79	0.05	0.79	0.96
515	Parking Lot, 60' wide	30'	Near-side poles	2	D	III	0.819	125	2		100	60	1.67	0.27		1.57	0.04	0.98	1.20
516	Parking Lot, 60' wide	35'	Near-side poles	2	D	III	0.819	125	1		65	60	0.56	0.29		3.66	0.03	0.93	1.14
517	Parking Lot, 60' wide	20'	Opposite side poles	2	D	III	0.819	125	2	N/A - Horiz. Avg:Min >4		120							
518	Parking Lot, 60' wide	25'	Opposite side poles	2	D	III	0.819	125	2	N/A - Horiz. Avg:Min >4		120							
519	Parking Lot, 60' wide	30'	Opposite side poles	2	D	III	0.819	125	2	N/A - Horiz. Avg:Min >4		120							
520	Parking Lot, 60' wide	35'	Opposite side poles	2	D	III	0.819	125	2	N/A - Horiz. Avg:Min >4		120							

Table 74: Calculation Results – Parking Lot, Pt. 6

											Results		Horiz. Min.	Vert. Min.	Horiz. Max: Min	Horiz. Avg: Min			
Sim C	Condition	Poles	Other	BUG G-rati	Lum. Man	Dist. Typ	Total LL	Watt.	Q'ty	Notes	Pole-Pole Spacin	Curb-Curb Spacin	.5	.25	15:1	4:1	Eff. LP	MAX Ve	Initial MAX Ve
521	Parking Lot, 60' wide	20'	Near-side poles	2	D	III	0.819	125	2		60	60	2.46	0.34		2.26	0.07	1.02	1.25
522	Parking Lot, 60' wide	25'	Near-side poles	2	D	III	0.819	125	2		70	60	2.25	0.25		1.95	0.06	1.28	1.56
523	Parking Lot, 60' wide	30'	Near-side poles	2	D	III	0.819	125	1		50	60	0.77	0.29		3.69	0.04	1.38	1.68
524	Parking Lot, 60' wide	35'	Near-side poles	2	D	III	0.819	125	1		65	60	0.93	0.28		2.24	0.03	1.20	1.47
525	Parking Lot, 60' wide	20'	Opposite side poles	2	D	III	0.819	125	2	N/A - Horiz. Avg:Min >4		120							
526	Parking Lot, 60' wide	25'	Opposite side poles	2	D	III	0.819	125	2	N/A - Horiz. Avg:Min >4		120							
527	Parking Lot, 60' wide	30'	Opposite side poles	2	D	III	0.819	125	2	N/A - Horiz. Avg:Min >4		120							
528	Parking Lot, 60' wide	35'	Opposite side poles	2	D	III	0.819	125	2		70	120	0.93	0.25		2.56	0.03	1.06	1.29
529	Parking Lot, 60' wide	20'	Opposite side poles	1	V	V	0.815	125	1	N/A - Horiz. Avg:Min >4		120							
530	Parking Lot, 60' wide	25'	Opposite side poles	1	V	V	0.815	125	1	N/A - Horiz. Avg:Min >4		120							
531	Parking Lot, 60' wide	30'	Opposite side poles	1	V	V	0.815	125	1	N/A - Horiz. Avg:Min >4		120							
532	Parking Lot, 60' wide	35'	Opposite side poles	1	V	V	0.815	125	1		50	120	0.59	0.26		3.15	0.02	0.38	0.47
533	Parking Lot, 60' wide	20'	Near-side poles	3	C	III	0.855	124	2		100	60	1.34	0.28		2.99	0.04	0.83	0.97
534	Parking Lot, 60' wide	25'	Near-side poles	3	C	III	0.855	124	2		115	60	1.60	0.28		2.20	0.04	0.57	0.67
535	Parking Lot, 60' wide	30'	Near-side poles	3	C	III	0.855	124	2		130	60	1.94	0.28		1.78	0.03	0.72	0.84
536	Parking Lot, 60' wide	35'	Near-side poles	3	C	III	0.855	124	1		120	60	0.06	0.29		2.69	0.02	0.38	0.44
537	Parking Lot, 60' wide	20'	Opposite side poles	3	C	III	0.855	124	2	N/A - Horiz. Avg:Min >4		120							
538	Parking Lot, 60' wide	25'	Opposite side poles	3	C	III	0.855	124	2	N/A - Horiz. Avg:Min >4		120							
539	Parking Lot, 60' wide	30'	Opposite side poles	3	C	III	0.855	124	2	N/A - Horiz. Avg:Min >4		120							
540	Parking Lot, 60' wide	35'	Opposite side poles	3	C	III	0.855	124	2		125	120	0.65	0.29		2.78	0.02	0.56	0.65
473	Parking Lot, 60' wide	20'	Near-side poles	4	V	III	0.815	241	2		65	60	1.58	0.30		3.78	0.12	44.86	55.02
474	Parking Lot, 60' wide	25'	Near-side poles	4	V	III	0.815	241	2		80	60	1.75	0.29		2.46	0.10	13.76	16.88
475	Parking Lot, 60' wide	30'	Near-side poles	4	V	III	0.815	241	1		75	60	0.67	0.28		3.16	0.05	34.90	42.80
476	Parking Lot, 60' wide	35'	Near-side poles	4	V	III	0.815	241	1		85	60	0.69	0.30		2.36	0.05	19.72	24.18

Table 75: Calculation Results – Plaza, Pt. 1

											Results		Horiz. Min.	Vert. Min.	Horiz. Max: Min	Horiz. Avg: Min			
Sim C	Condition	Poles	Other	BUG G-rati	Lumina ire Man	Distrib ution Typ	Total LL	Watt a	Q'ty	Notes	Pole-Pole Spacin	Plaza widtl	0.6	2	4:1	5:1	Eff. LP	MAX Ve	Initial MAX Ve
912	Plaza, 30' wide	10'	Single row, middle	2	A	V	0.756	95	1		55	30	2.56	2.19	2.53	1.74	0.06	2.28	3.02
913	Plaza, 30' wide	14'	Single row, middle	2	A	V	0.756	95	1		40	30	2.62	2.51	1.91	1.24	0.08	3.09	4.09
914	Plaza, 30' wide	18'	Single row, middle	2	A	V	0.756	95	1	Vert average <2		30							
954	Plaza, 30' wide	10'	Single row, middle	1	A	V	0.756	51	1		35	30	2.48	2.49	1.33	1.22	0.05	1.52	2.01
955	Plaza, 30' wide	14'	Single row, middle	1	A	V	0.756	51	1	Vert average <2		30							
956	Plaza, 30' wide	18'	Single row, middle	1	A	V	0.756	51	1	Vert average <2		30							
957	Plaza, 30' wide	10'	wo heads, middle (type II	2	A	III	0.756	51	2		65	30	2.57	2.98	3.67	2.09	0.05	2.23	2.95
958	Plaza, 30' wide	14'	wo heads, middle (type II	2	A	III	0.756	51	2		60	30	2.08	2.08	1.84	1.84	0.06	2.67	3.53
959	Plaza, 30' wide	18'	wo heads, middle (type II	2	A	III	0.756	51	2		40	30	2.52	2.04	1.70	1.37	0.09	2.98	3.94
960	Plaza, 30' wide	10'	ow, five feet from edge (t	2	A	III	0.756	51	1		40	30	2.40	2.01	1.90	1.58	0.04	1.73	2.29
961	Plaza, 30' wide	14'	ow, five feet from edge (t	2	A	III	0.756	51	1	Vert average <2		30							
962	Plaza, 30' wide	18'	ow, five feet from edge (t	2	A	III	0.756	51	1	Vert average <2		30							
966	Plaza, 30' wide	10'	Single row, middle	1	A	V	0.756	31	1		40	30	2.23	2.43	1.78	1.57	0.03	0.49	0.65
967	Plaza, 30' wide	14'	Single row, middle	1	A	V	0.756	31	1	Vert average <2		30							
968	Plaza, 30' wide	18'	Single row, middle	1	A	V	0.756	31	1	Vert average <2		30							
969	Plaza, 30' wide	10'	wo heads, middle (type II	1	A	III	0.756	31	2		65	30	1.57	2.08	3.65	2.09	0.03	1.36	1.80
970	Plaza, 30' wide	14'	wo heads, middle (type II	1	A	III	0.756	31	2	Vert average <2	40	30					0.05		
971	Plaza, 30' wide	18'	wo heads, middle (type II	1	A	III	0.756	31	2	Vert average <2		30							
972	Plaza, 30' wide	10'	ow, five feet from edge (t	1	A	III	0.756	31	1	Vert average <2		30							
973	Plaza, 30' wide	14'	ow, five feet from edge (t	1	A	III	0.756	31	1	Vert average <2		30							
974	Plaza, 30' wide	18'	ow, five feet from edge (t	1	A	III	0.756	31	1	Vert average <2		30							
927	Plaza, 30' wide	10'	Single row, middle	1	B	V	0.85	58	1		60	30	1.64	2.47	3.71	1.91	0.03	1.84	2.17
928	Plaza, 30' wide	14'	Single row, middle	1	B	V	0.85	58	1		40	30	2.02	2.12	1.16	2.20	0.05	2.81	3.31
929	Plaza, 30' wide	18'	Single row, middle	1	B	V	0.85	58	1	Vert average <2		30							
930	Plaza, 30' wide	10'	wo heads, middle (type II	1	B	III	0.81	57	2		55	30	3.15	3.40	2.86	1.97	0.07	0.68	0.84
931	Plaza, 30' wide	14'	wo heads, middle (type II	1	B	III	0.81	57	2		55	30	2.08	2.13	1.39	1.29	0.07	2.75	3.40
932	Plaza, 30' wide	18'	wo heads, middle (type II	1	B	III	0.81	57	2		45	30	2.56	2.07	1.98	1.34	0.08	3.30	4.07
933	Plaza, 30' wide	10'	ow, five feet from edge (t	1	B	III	0.81	57	1	Vert average <2		30							
934	Plaza, 30' wide	14'	ow, five feet from edge (t	1	B	III	0.81	57	1	Vert average <2		30							
935	Plaza, 30' wide	18'	ow, five feet from edge (t	1	B	III	0.81	57	1	Vert average <2		30							
936	Plaza, 30' wide	10'	Single row, middle	1	B	V	0.81	57	1		35	30	1.60	2.09	1.70	1.41	0.05	0.82	1.01
937	Plaza, 30' wide	14'	Single row, middle	1	B	V	0.81	57	1	Vert average <2		30							

Table 76: Calculation Results – Plaza, Pt. 2

											Results		Horiz. Min.	Vert. Min.	Horiz. Max: Min	Horiz. Avg: Min			
Sim C	Condition	Poles	Other	BUG G-rati	Luminaire Man	Distribution Typ	Total LL	Watta	Q'ty	Notes	Pole-Pole Spacin	Plaza widtl	0.6	2	4:1	5:1	Eff. LP	MAX Ve	Initial MAX Ve
938	Plaza, 30' wide	18'	Single row, middle	1	B	V	0.81	57	1	Vert average <2		30							
939	Plaza, 30' wide	10'	wo heads, middle (type I	0	BE	III	0.81	56	2		75	30	2.23	3.32	3.33	2.94	0.05	2.48	3.06
940	Plaza, 30' wide	14'	wo heads, middle (type I	0	BE	III	0.81	56	2		85	30	1.63	2.06	2.26	2.15	0.04	2.80	3.46
941	Plaza, 30' wide	18'	wo heads, middle (type I	0	BE	III	0.81	56	2		55	30	2.34	2.17	2.07	1.36	0.07	2.64	3.26
942	Plaza, 30' wide	10'	ow, five feet from edge (	0	BE	III	0.81	56	1		50	30	2.26	2.03	2.40	1.71	0.04	1.50	1.85
943	Plaza, 30' wide	14'	ow, five feet from edge (	0	BE	III	0.81	56	1		40	30	2.16	2.04	2.77	1.38	0.05	1.41	1.74
944	Plaza, 30' wide	18'	ow, five feet from edge (	0	BE	III	0.81	56	1	Vert average <2		30							
945	Plaza, 30' wide	10'	Single row, middle	0	BE	V	0.81	56	1		50	30	1.81	2.19	1.87	1.82	0.04	1.79	2.21
946	Plaza, 30' wide	14'	Single row, middle	0	BE	V	0.81	56	1	Vert average <2		30							
947	Plaza, 30' wide	18'	Single row, middle	0	BE	V	0.81	56	1	Vert average <2		30							
948	Plaza, 30' wide	10'	wo heads, middle (type I	2	C	III	0.864	52	2		65	30	4.90	5.68	3.36	2.16	0.05	1.03	1.19
949	Plaza, 30' wide	14'	wo heads, middle (type I	2	C	III	0.864	52	2		90	30	2.64	2.42	3.47	2.16	0.04	2.05	2.37
950	Plaza, 30' wide	18'	wo heads, middle (type I	2	C	III	0.864	52	2		90	30	2.48	2.07	1.69	1.41	0.04	1.86	2.15
951	Plaza, 30' wide	10'	ow, five feet from edge (	2	C	III	0.864	52	1		65	30	2.70	2.61	2.69	2.03	0.03	0.50	0.58
952	Plaza, 30' wide	14'	ow, five feet from edge (	2	C	III	0.864	52	1		60	30	2.27	2.21	1.39	1.19	0.03	0.26	0.30
953	Plaza, 30' wide	18'	ow, five feet from edge (	2	C	III	0.864	52	1		55	30	2.51	2.20	1.28	1.16	0.03	0.51	0.59
903	Plaza, 30' wide	10'	wo heads, middle (type I	2	D	III	0.819	125	2		55	30	14.37	10.83	3.03	2.62	0.15	2.63	3.21
904	Plaza, 30' wide	14'	wo heads, middle (type I	2	D	III	0.819	125	2		80	30	7.56	5.90	3.53	2.60	0.10	4.81	5.87
905	Plaza, 30' wide	18'	wo heads, middle (type I	2	D	III	0.819	125	2		105	30	4.82	2.89	3.80	2.55	0.08	4.68	5.71
906	Plaza, 30' wide	10'	ow, five feet from edge (	2	D	III	0.819	125	1		45	30	8.83	4.81	3.08	2.80	0.09	1.00	1.22
907	Plaza, 30' wide	14'	ow, five feet from edge (	2	D	III	0.819	125	1		70	30	5.03	3.29	3.33	2.61	0.06	0.89	1.09
908	Plaza, 30' wide	18'	ow, five feet from edge (	2	D	III	0.819	125	1		90	30	3.44	2.19	3.07	2.37	0.05	0.84	1.03
915	Plaza, 30' wide	10'	wo heads, middle (type I	2	D	III	0.819	89	2		50	30	9.36	7.50	3.64	1.64	0.12	3.32	4.05
916	Plaza, 30' wide	14'	wo heads, middle (type I	2	D	III	0.819	89	2		70	30	5.09	3.88	3.69	1.58	0.08	6.87	8.39
917	Plaza, 30' wide	18'	wo heads, middle (type I	2	D	III	0.819	89	2		90	30	3.20	2.30	3.68	1.56	0.07	7.43	9.07
918	Plaza, 30' wide	10'	ow, five feet from edge (	2	D	III	0.819	89	1		45	30	6.78	3.49	3.85	2.33	0.07	0.39	0.48
919	Plaza, 30' wide	14'	ow, five feet from edge (	2	D	III	0.819	89	1		60	30	2.80	2.92	3.05	1.92	0.05	0.77	0.94
920	Plaza, 30' wide	18'	ow, five feet from edge (	2	D	III	0.819	89	1		65	30	3.12	2.01	1.88	1.56	0.05	0.88	1.07
921	Plaza, 30' wide	10'	wo heads, middle (type I	2	D	III	0.819	70	2		50	30	7.68	6.14	3.63	1.64	0.09	2.72	3.32
922	Plaza, 30' wide	14'	wo heads, middle (type I	2	D	III	0.819	70	2		70	30	4.16	3.17	3.68	1.58	0.07	5.62	6.86
923	Plaza, 30' wide	18'	wo heads, middle (type I	2	D	III	0.819	70	2		85	30	2.78	2.08	3.02	1.47	0.05	6.08	7.42
924	Plaza, 30' wide	10'	ow, five feet from edge (	2	D	III	0.819	70	1		45	30	5.51	2.90	3.42	2.19	0.05	0.35	0.43

Table 77: Calculation Results – Plaza, Pt. 3

											Results		Horiz. Min.	Vert. Min.	Horiz. Max: Min	Horiz. Avg: Min			
Sim C	Condition	Poles	Other	BUG G-rati	Luminaire Man	Distribution Typ	Total LL	Watta	Q'ty	Notes	Pole-Pole Spacin	Plaza widtl	0.6	2	4:1	5:1	Eff. LP	MAX Ve	Initial MAX Ve
925	Plaza, 30' wide	14'	ow, five feet from edge (t	2	D	III	0.819	70	1		65	30	3.14	2.18	3.45	2.00	0.04	0.64	0.78
926	Plaza, 30' wide	18'	ow, five feet from edge (t	2	D	III	0.819	70	1		50	30	3.31	3.23	1.47	1.32	0.05	0.86	1.05
963	Plaza, 30' wide	10'	Single row, middle	1	E	V	0.801	38	1		50	30	2.00	2.01	2.51	1.71	0.03	1.47	1.84
964	Plaza, 30' wide	14'	Single row, middle	1	E	V	0.801	38	1	Avg/Min > 4		30							
965	Plaza, 30' wide	18'	Single row, middle	1	E	V	0.801	38	1	Avg/Min > 4		30							
900	Plaza, 30' wide	10'	Single row, middle	1	V	V	0.815	125	1	Avg/Min > 4	40	30					0.10		
901	Plaza, 30' wide	14'	Single row, middle	1	V	V	0.815	125	1		60	30	3.93	3.23	3.57	2.42	0.07		
902	Plaza, 30' wide	18'	Single row, middle	1	V	V	0.815	125	1		65	30	3.12	2.05	1.70	1.93	0.06	4.11	5.04
909	Plaza, 30' wide	10'	Single row, middle	2	W	V	0.801	96	1		70	30	2.19	2.72	3.98	2.71	0.05	2.88	3.60
910	Plaza, 30' wide	14'	Single row, middle	2	W	V	0.801	96	1		70	30	1.83	2.06	1.91	1.72	0.05	3.70	4.62
911	Plaza, 30' wide	18'	Single row, middle	2	W	V	0.801	96	1		50	30	3.41	3.40	1.88	1.33	0.06	3.62	4.52
975	Plaza, 30' wide	10'	Single row, middle	1	W	V	0.801	30	1		35	30	1.97	2.06	1.19	1.25	0.03	1.15	1.44
976	Plaza, 30' wide	14'	Single row, middle	1	W	V	0.801	30	1	Vert Average < 2		30							
977	Plaza, 30' wide	18'	Single row, middle	1	W	V	0.801	30	1	Vert Average < 2		30							
978	Plaza, 30' wide	10'	wo heads, middle (type II	2	W	IV	0.801	30	2		40	30	1.89	2.24	10.50	1.58	0.05	0.43	0.54
979	Plaza, 30' wide	14'	wo heads, middle (type II	2	W	IV	0.801	30	2	Vert Average < 2		30							
980	Plaza, 30' wide	18'	wo heads, middle (type II	2	W	IV	0.801	30	2	Vert Average < 2		30							
981	Plaza, 30' wide	10'	ow, five feet from edge (t	2	W	IV	0.801	30	1	Vert Average < 2		30							
982	Plaza, 30' wide	14'	ow, five feet from edge (t	2	W	IV	0.801	30	1	Vert Average < 2		30							
983	Plaza, 30' wide	18'	ow, five feet from edge (t	2	W	IV	0.801	30	1	Vert Average < 2		30							
984	Plaza, 30' wide	10'	wo heads, middle (type II	3	BE	V	0.765	52	2		65	30	2.38	3.70	3.84	3.45	0.05	2.92	3.82
985	Plaza, 30' wide	14'	wo heads, middle (type II	3	BE	V	0.765	52	2		65	30	2.00	2.15	2.30	2.22	0.05	3.06	4.00
986	Plaza, 30' wide	18'	wo heads, middle (type II	3	BE	V	0.765	52	2		45	30	2.62	2.11	2.57	1.26	0.08	2.92	3.82
987	Plaza, 30' wide	10'	ow, five feet from edge (t	3	BE	V	0.765	52	1		35	30	2.69	2.07	1.92	1.64	0.05	2.78	3.63
988	Plaza, 30' wide	14'	ow, five feet from edge (t	3	BE	V	0.765	52	1	Vert Average < 2		30							
989	Plaza, 30' wide	18'	ow, five feet from edge (t	3	BE	V	0.765	52	1	Vert Average < 2		30							
990	Plaza, 30' wide	10'	wo heads, middle (type II	4	BE	V	0.765	54	2		95	30	1.07	2.07	1.95	1.74	0.04	4.15	5.42
991	Plaza, 30' wide	14'	wo heads, middle (type II	4	BE	V	0.765	54	2		60	30	1.36	2.04	1.14	1.18	0.06	2.66	3.48
992	Plaza, 30' wide	18'	wo heads, middle (type II	4	BE	V	0.765	54	2		35	30	1.70	2.04	1.39	1.21	0.10	7.66	10.01
993	Plaza, 30' wide	10'	ow, five feet from edge (t	4	BE	V	0.765	54	1		45	30	1.10	2.08	1.26	1.17	0.04	3.35	4.38
994	Plaza, 30' wide	14'	ow, five feet from edge (t	4	BE	V	0.765	54	1	Vert Average < 2		30							
995	Plaza, 30' wide	18'	ow, five feet from edge (t	4	BE	V	0.765	54	1	Vert Average < 2		30							

Table 78: Calculation Results – Plaza, Pt. 4

											Results		Horiz. Min.	Vert. Min.	Horiz. Max: Min	Horiz. Avg: Min			
Sim C	Condition	Poles	Other	BUG G-rati	Lumina ire Man	Distrib ution Typ	Total LL	Watt a	Q'ty	Notes	Pole-Pole Spacin	Plaza widtl	0.6	2	4:1	5:1	Eff. LP	MAX Ve	Initial MAX Ve
996	Plaza, 30' wide	10'	Single row, middle	4	BE	V	0.765	54	1		50	30	1.04	2.11	1.14	1.17	0.04	3.33	4.35
997	Plaza, 30' wide	14'	Single row, middle	4	BE	V	0.765	54	1	Vert Average < 2		30							
998	Plaza, 30' wide	18'	Single row, middle	4	BE	V	0.765	54	1	Vert Average < 2		30							
1002	Plaza, 30' wide	10'	wo heads, middle (type II	5	BE	IV	0.765	54	2		125	30	1.29	2.05	3.00	2.25	0.03	2.77	3.62
1003	Plaza, 30' wide	14'	wo heads, middle (type II	5	BE	IV	0.765	54	2		90	30	1.18	2.04	1.55	1.85	0.04	2.44	3.19
1004	Plaza, 30' wide	18'	wo heads, middle (type II	5	BE	IV	0.765	54	2		55	30	1.52	2.11	1.24	1.21	0.07	3.61	4.72
1005	Plaza, 30' wide	10'	ow, five feet from edge (t	5	BE	IV	0.765	54	1		90	30	1.02	2.06	2.49	2.36	0.02	0.66	0.86
1006	Plaza, 30' wide	14'	ow, five feet from edge (t	5	BE	IV	0.765	54	1		55	30	1.38	2.05	1.57	1.49	0.03	1.02	1.33
1007	Plaza, 30' wide	18'	ow, five feet from edge (t	5	BE	IV	0.765	54	1	Vert Average < 2		30							
1008	Plaza, 30' wide	10'	Single row, middle	3	BE	V	0.765	55	1		50	30	1.71	2.07	1.80	1.60	0.04	1.75	2.29
1009	Plaza, 30' wide	14'	Single row, middle	3	BE	V	0.765	55	1	Vert Average < 2		30							
1010	Plaza, 30' wide	18'	Single row, middle	3	BE	V	0.765	55	1	Vert Average < 2		30							
1014	Plaza, 30' wide	10'	wo heads, middle (type II	3	BE	IV	0.765	55	2		80	30	2.19	3.41	3.71	2.67	0.05	2.89	3.78
1015	Plaza, 30' wide	14'	wo heads, middle (type II	3	BE	IV	0.765	55	2		85	30	1.66	2.17	2.08	1.98	0.04	3.04	3.97
1016	Plaza, 30' wide	18'	wo heads, middle (type II	3	BE	IV	0.765	55	2		60	30	2.23	2.02	1.77	1.24	0.06	2.69	3.52
1017	Plaza, 30' wide	10'	ow, five feet from edge (t	3	BE	IV	0.765	55	1		55	30	2.03	2.07	2.48	1.96	0.03	1.75	2.29
1018	Plaza, 30' wide	14'	ow, five feet from edge (t	3	BE	IV	0.765	55	1		40	30	2.21	2.16	2.23	1.33	0.05	1.56	2.04
1019	Plaza, 30' wide	18'	ow, five feet from edge (t	3	BE	IV	0.765	55	1	Vert Average < 2		30							
1020	Plaza, 30' wide	10'	Single row, middle	3	BE	V	0.765	55	1		55	30	1.66	2.13	2.02	1.82	0.03	1.95	2.55
1021	Plaza, 30' wide	14'	Single row, middle	3	BE	V	0.765	55	1	Vert Average < 2		30							
1022	Plaza, 30' wide	18'	Single row, middle	3	BE	V	0.765	55	1	Vert Average < 2		30							
1026	Plaza, 30' wide	10'	wo heads, middle (type II	3	BE	IV	0.765	55	2		80	30	2.01	3.10	3.65	2.74	0.05	2.60	3.40
1027	Plaza, 30' wide	14'	wo heads, middle (type II	3	BE	IV	0.765	55	2		80	30	1.61	2.05	1.89	1.91	0.05	2.68	3.50
1028	Plaza, 30' wide	18'	wo heads, middle (type II	3	BE	IV	0.765	55	2		55	30	2.17	2.06	1.61	1.29	0.07	2.58	3.37
1029	Plaza, 30' wide	10'	ow, five feet from edge (t	3	BE	IV	0.765	55	1		45	30	2.30	2.15	1.83	1.47	0.04	1.70	2.22
1030	Plaza, 30' wide	14'	ow, five feet from edge (t	3	BE	IV	0.765	55	1		35	30	2.25	2.02	1.88	1.40	0.05	1.63	2.13
1031	Plaza, 30' wide	18'	ow, five feet from edge (t	3	BE	IV	0.765	55	1	Vert Average < 2		30							

Appendix J: Lighting Zone Calculations

The tables below list the weighting and cost per watt determined for each special application. The special application calculations were developed used 119 different products from 58 manufacturers, listed by the luminaire manufacturer letter and luminaire product number. Each of the luminaires studied are commercially available and represent typical LED luminaire offered in 2019.

Table 79: Building Entrances and Exits Cost per Watt

2019 LED									Weighting					Weighted Cost per Watt			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4	Total $/W	LZ1	LZ2	LZ3	LZ4
Area Light																	
B	002	$ 1,381	25	0.93	1,170	1	2	1	0.091	0.063	0.063	0.063	$ 55	$ 5.02	$ 3.45	$ 3.45	$ 3.45
B	002	$ 1,381	25	0.93	1,216	1	1	1	0.091	0.063	0.063	0.063	$ 55	$ 5.02	$ 3.45	$ 3.45	$ 3.45
B	002	$ 1,381	25	0.93	1,735	1	0	1	0.091	0.063	0.063	0.063	$ 55	$ 5.02	$ 3.45	$ 3.45	$ 3.45
A	002	$ 1,553	21	0.83	2,051	1	0	1	0.091	0.063	0.063	0.063	$ 74	$ 6.72	$ 4.62	$ 4.62	$ 4.62
A	002	$ 1,553	21	0.83	2,189	1	0	1	0.091	0.063	0.063	0.063	$ 74	$ 6.72	$ 4.62	$ 4.62	$ 4.62
A	002	$ 1,553	21	0.83	2,114	1	0	1	0.091	0.063	0.063	0.063	$ 74	$ 6.72	$ 4.62	$ 4.62	$ 4.62
A	002	$ 1,553	30	0.83	2,760	1	0	1	0.091	0.063	0.063	0.063	$ 52	$ 4.71	$ 3.24	$ 3.24	$ 3.24
B	002	$ 1,381	25	0.93	1,830	1	0	1	0.091	0.063	0.063	0.063	$ 55	$ 5.02	$ 3.45	$ 3.45	$ 3.45
W	002	$ 1,970	22	0.84	2,117	1	0	1	0.091	0.063	0.063	0.063	$ 90	$ 8.14	$ 5.60	$ 5.60	$ 5.60
BD	001	$ 1,434	36	0.92	2,221	1	0	1		0.063	0.063	0.063	$ 40	$ -	$ 2.49	$ 2.49	$ 2.49
W	003	$ 1,071	30	0.84	3,126	1	0	1	0.091	0.063	0.063	0.063	$ 36	$ 3.24	$ 2.23	$ 2.23	$ 2.23
BD	001	$ 1,434	52	0.92	3,178	1	0	1		0.063	0.063	0.063	$ 28	$ -	$ 1.72	$ 1.72	$ 1.72
AF	003	$ 1,776	48	0.70	4,247	1	0	1		0.063	0.063	0.063	$ 37	$ -	$ 2.31	$ 2.31	$ 2.31
A	001	$ 1,379	22	0.84	1,888	1	0	1	0.091	0.063	0.063	0.063	$ 63	$ 5.70	$ 3.92	$ 3.92	$ 3.92
A	001	$ 1,379	51	0.84	4,431	2	0	2		0.063	0.063	0.063	$ 27	$ -	$ 1.69	$ 1.69	$ 1.69
A	001	$ 1,379	51	0.84	4,348	1	0	1		0.063	0.063	0.063	$ 27	$ -	$ 1.69	$ 1.69	$ 1.69
A	001	$ 1,450	95	0.84	7,312	2	0	2					$ 15	$ -	$ -	$ -	$ -
W	004	$ 1,063	96	0.89	10,231	3	0	2					$ 11	$ -	$ -	$ -	$ -
								SUM	1.00	1.00	1.00	1.00	$867.4	$ 62.06	$ 52.57	$ 52.57	$ 52.57
Cylindrical - Wall Mounted, Up/Down																	
C	003	$ 619	10	0.87	838	2	5	0	0.200	0.125	0.125	0.125	$ 62	$ 12.38	$ 7.74	$ 7.74	$ 7.74
M	001	$ 950	8	0.70	900	1	1	0	0.200	0.125	0.125	0.125	$ 119	$ 23.74	$ 14.84	$ 14.84	$ 14.84
AO	001	$ 349	13	0.70	931	1	1	0	0.200	0.125	0.125	0.125	$ 27	$ 5.37	$ 3.36	$ 3.36	$ 3.36
H	003	$ 434	21	0.81	1,047	1	4	0	0.200	0.125	0.125	0.125	$ 21	$ 4.14	$ 2.58	$ 2.58	$ 2.58
F	001	$ 1,056	34	0.70	2,212	2	5	0		0.125	0.125	0.125	$ 31	$ -	$ 3.88	$ 3.88	$ 3.88
C	003	$ 862	29	0.70	2,319	2	5	0	0.200	0.125	0.125	0.125	$ 30	$ 6.05	$ 3.78	$ 3.78	$ 3.78
F	001	$ 1,067	42	0.70	3,288	3	5	0		0.125	0.125	0.125	$ 25	$ -	$ 3.18	$ 3.18	$ 3.18
F	001	$ 1,352	57	0.70	4,607	3	5	0		0.125	0.125	0.125	$ 24	$ -	$ 2.97	$ 2.97	$ 2.97
AF	004	$ 1,214	76	0.70	4,884	1	5	1					$ 16	$ -	$ -	$ -	$ -
								SUM	1.00	1.00	1.00	1.00	$354.6	$ 51.68	$ 42.32	$ 42.32	$ 42.32
Downlight																	
J	001	$ 561	10	0.70	647	1	0	0	0.040	0.040	0.040	0.040	$ 56	$ 2.25	$ 2.25	$ 2.25	$ 2.25
K	001	$ 220	13	0.70	780	1	1	0	0.040	0.040	0.040	0.040	$ 17	$ 0.68	$ 0.68	$ 0.68	$ 0.68
J	001	$ 561	14	0.70	884	1	0	0	0.040	0.040	0.040	0.040	$ 40	$ 1.60	$ 1.60	$ 1.60	$ 1.60
P	001	$ 208	14	0.89	1,066	1	1	0	0.040	0.040	0.040	0.040	$ 15	$ 0.60	$ 0.60	$ 0.60	$ 0.60
K	001	$ 286	22	0.70	1,170	2	1	0	0.040	0.040	0.040	0.040	$ 13	$ 0.52	$ 0.52	$ 0.52	$ 0.52
K	001	$ 272	22	0.70	1,426	2	1	0	0.040	0.040	0.040	0.040	$ 12	$ 0.49	$ 0.49	$ 0.49	$ 0.49
K	002	$ 236	19	0.70	1,461	2	0	0	0.040	0.040	0.040	0.040	$ 13	$ 0.51	$ 0.51	$ 0.51	$ 0.51
K	002	$ 236	23	0.70	1,860	2	0	0	0.040	0.040	0.040	0.040	$ 10	$ 0.41	$ 0.41	$ 0.41	$ 0.41
P	001	$ 237	36	0.89	1,995	2	1	0	0.040	0.040	0.040	0.040	$ 7	$ 0.26	$ 0.26	$ 0.26	$ 0.26
C	005	$ 94	21	0.70	1,914	2	0	0	0.040	0.040	0.040	0.040	$ 4	$ 0.18	$ 0.18	$ 0.18	$ 0.18
P	001	$ 237	35	0.89	2,130	2	1	0	0.040	0.040	0.040	0.040	$ 7	$ 0.27	$ 0.27	$ 0.27	$ 0.27
C	005	$ 112	28	0.70	2,203	2	0	0	0.040	0.040	0.040	0.040	$ 4	$ 0.16	$ 0.16	$ 0.16	$ 0.16
K	002	$ 251	30	0.70	2,521	2	0	0	0.040	0.040	0.040	0.040	$ 9	$ 0.34	$ 0.34	$ 0.34	$ 0.34
P	001	$ 257	41	0.89	2,621	3	1	0	0.040	0.040	0.040	0.040	$ 6	$ 0.25	$ 0.25	$ 0.25	$ 0.25
K	002	$ 266	37	0.70	2,917	3	0	0	0.040	0.040	0.040	0.040	$ 7	$ 0.29	$ 0.29	$ 0.29	$ 0.29
K	002	$ 310	48	0.70	3,029	3	0	0	0.040	0.040	0.040	0.040	$ 6	$ 0.26	$ 0.26	$ 0.26	$ 0.26
P	001	$ 256	44	0.89	3,184	3	1	0	0.040	0.040	0.040	0.040	$ 6	$ 0.23	$ 0.23	$ 0.23	$ 0.23
C	005	$ 112	42	0.70	3,300	3	0	0	0.040	0.040	0.040	0.040	$ 3	$ 0.11	$ 0.11	$ 0.11	$ 0.11
K	002	$ 295	48	0.70	3,839	3	0	0	0.040	0.040	0.040	0.040	$ 6	$ 0.25	$ 0.25	$ 0.25	$ 0.25
K	002	$ 310	47	0.70	4,234	3	0	0	0.040	0.040	0.040	0.040	$ 7	$ 0.26	$ 0.26	$ 0.26	$ 0.26
K	002	$ 324	49	0.70	4,982	3	0	0	0.040	0.040	0.040	0.040	$ 7	$ 0.27	$ 0.27	$ 0.27	$ 0.27
K	002	$ 427	75	0.70	6,168	3	0	0	0.040	0.040	0.040	0.040	$ 6	$ 0.23	$ 0.23	$ 0.23	$ 0.23
AR	002	$ 585	57	0.70	5,716	3	1	1	0.040	0.040	0.040	0.040	$ 10	$ 0.41	$ 0.41	$ 0.41	$ 0.41
C	005	$ 175	115	0.70	7,816	4	0	0	0.040	0.040	0.040	0.040	$ 2	$ 0.06	$ 0.06	$ 0.06	$ 0.06
K	002	$ 530	115	0.70	11,296	3	0	0	0.040	0.040	0.040	0.040	$ 5	$ 0.18	$ 0.18	$ 0.18	$ 0.18
								SUM	1.00	1.00	1.00	1.00	277	$ 11.07	$ 11.07	$ 11.07	$ 11.07

Table 80: Building Entrances and Exits Cost per Watt, continued

2019 LED									Weighting					Weighted Cost per Watt			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4	Total $/W	LZ1	LZ2	LZ3	LZ4
Recessed Linear																	
AB	002	$ 424	18	0.70	1,371	1	0	1	0.045	0.037	0.032	0.032	$ 24	$ 1.07	$ 0.87	$ 0.76	$ 0.76
AB	002	$ 424	38	0.70	2,560	1	0	1	0.045	0.037	0.032	0.032	$ 11	$ 0.51	$ 0.41	$ 0.36	$ 0.36
AV	001	$ 549	30	0.95	2,068	1	0	1	0.045	0.037	0.032	0.032	$ 19	$ 0.84	$ 0.69	$ 0.60	$ 0.60
AV	001	$ 549	39	0.95	2,756	1	0	1	0.045	0.037	0.032	0.032	$ 14	$ 0.64	$ 0.52	$ 0.45	$ 0.45
AV	001	$ 549	24	0.95	3,444	1	0	1	0.045	0.037	0.032	0.032	$ 23	$ 1.02	$ 0.83	$ 0.73	$ 0.73
AW	001	$ 610	22	0.70	2,000	1	0	1	0.045	0.037	0.032	0.032	$ 28	$ 1.26	$ 1.03	$ 0.89	$ 0.89
AW	001	$ 610	33	0.70	3,000	1	0	1	0.045	0.037	0.032	0.032	$ 18	$ 0.84	$ 0.68	$ 0.59	$ 0.59
AW	001	$ 610	44	0.70	4,000	2	0	1	0.045	0.037	0.032	0.032	$ 14	$ 0.62	$ 0.51	$ 0.44	$ 0.44
Y	001	$ 631	14	0.70	1,056	1	0	1	0.045	0.037	0.032	0.032	$ 44	$ 1.99	$ 1.62	$ 1.41	$ 1.41
Y	001	$ 631	18	0.70	1,328	1	0	1	0.045	0.037	0.032	0.032	$ 34	$ 1.56	$ 1.27	$ 1.11	$ 1.11
Y	001	$ 631	28	0.70	2,004	1	0	1	0.045	0.037	0.032	0.032	$ 22	$ 1.01	$ 0.82	$ 0.72	$ 0.72
Y	001	$ 631	37	0.70	2,580	1	0	1	0.045	0.037	0.032	0.032	$ 17	$ 0.78	$ 0.64	$ 0.55	$ 0.55
AA	001	$ 440	42	0.70	2,050	1	1	0	0.045	0.037	0.032	0.032	$ 11	$ 0.48	$ 0.39	$ 0.34	$ 0.34
AZ	001	$ 329	12	0.70	580	0	1	0	0.045	0.037	0.032	0.032	$ 27	$ 1.21	$ 0.98	$ 0.86	$ 0.86
AZ	001	$ 376	30	0.70	1,520	0	1	0	0.045	0.037	0.032	0.032	$ 12	$ 0.56	$ 0.46	$ 0.40	$ 0.40
Z	002	$ 574	23	0.70	2,000	1	0	1	0.045	0.037	0.032	0.032	$ 25	$ 1.13	$ 0.92	$ 0.81	$ 0.81
Z	002	$ 574	36	0.70	3,000	1	0	1	0.045	0.037	0.032	0.032	$ 16	$ 0.73	$ 0.60	$ 0.52	$ 0.52
Z	002	$ 574	49	0.70	4,000	2	0	1	0.045	0.037	0.032	0.032	$ 12	$ 0.53	$ 0.43	$ 0.38	$ 0.38
Z	001	$ 599	31	0.70	2,914	1	0	1	0.045	0.037	0.032	0.032	$ 19	$ 0.88	$ 0.72	$ 0.63	$ 0.63
BE	001	$ 160	10	0.70	1,236	0	1	0	0.045	0.037	0.032	0.032	$ 17	$ 0.76	$ 0.62	$ 0.54	$ 0.54
BE	001	$ 245	18	0.70	1,696	0	1	0	0.045	0.037	0.032	0.032	$ 14	$ 0.63	$ 0.51	$ 0.45	$ 0.45
BE	001	$ 329	26	0.70	2,308	0	1	0	0.045	0.037	0.032	0.032	$ 12	$ 0.57	$ 0.46	$ 0.40	$ 0.40
AX	001	$ 589	19	0.70	1,008	1	2	1		0.037	0.032	0.032	$ 31	$ -	$ 1.16	$ 1.01	$ 1.01
AX	001	$ 589	35	0.70	1,876	1	2	1		0.037	0.032	0.032	$ 17	$ -	$ 0.63	$ 0.55	$ 0.55
AY	001	$ 574	8	0.70	1,400	1	2	1		0.037	0.032	0.032	$ 72	$ -	$ 2.66	$ 2.31	$ 2.31
AY	001	$ 574	12	0.70	2,200	1	2	1		0.037	0.032	0.032	$ 49	$ -	$ 1.83	$ 1.60	$ 1.60
AY	001	$ 574	19	0.70	3,200	1	3	1			0.032	0.032	$ 30	$ -	$ -	$ 0.96	$ 0.96
AY	001	$ 574	24	0.70	4,000	1	3	1			0.032	0.032	$ 24	$ -	$ -	$ 0.77	$ 0.77
AY	001	$ 574	30	0.70	4,800	2	3	1			0.032	0.032	$ 19	$ -	$ -	$ 0.62	$ 0.62
AY	001	$ 574	65	0.70	8,800	2	3	1			0.032	0.032	$ 9	$ -	$ -	$ 0.28	$ 0.28
Z	001	$ 599	42	0.70	3,885	2	2	1		0.037	0.032	0.032	$ 14	$ -	$ 0.53	$ 0.46	$ 0.46
								SUM	1.00	1.00	1.00	1.00	$ 697	$ 19.63	$ 22.80	$ 22.49	$ 22.49
Surface Mounted Downlight																	
AC	001	$ 99	20	0.70	1,813	1	0	1	0.250	0.167	0.111	0.111	$ 5	$ 1.22	$ 0.82	$ 0.54	$ 0.54
BB	001	$ 793	19	0.70	1,509	1	0	0	0.250	0.167	0.111	0.111	$ 42	$ 10.43	$ 6.95	$ 4.64	$ 4.64
Q	002	$ 61	14	0.70	1,081	1	1	0	0.250	0.167	0.111	0.111	$ 5	$ 1.13	$ 0.75	$ 0.50	$ 0.50
T	001	$ 272	24	0.70	3,055	2	3	2			0.111	0.111	$ 11	$ -	$ -	$ 1.24	$ 1.24
C	006	$ 363	28	0.70	3,293	1	0	1	0.250	0.167	0.111	0.111	$ 13	$ 3.24	$ 2.16	$ 1.44	$ 1.44
AL	002	$ 455	31	0.70	4,210	2	2	1		0.167	0.111	0.111	$ 15	$ -	$ 2.45	$ 1.63	$ 1.63
T	001	$ 296	38	0.70	4,443	2	3	2			0.111	0.111	$ 8	$ -	$ -	$ 0.86	$ 0.86
C	006	$ 398	45	0.70	4,949	3	0	2		0.167	0.111	0.111	$ 9	$ -	$ 1.47	$ 0.98	$ 0.98
T	001	$ 465	55	0.70	6,959	2	3	2			0.111	0.111	$ 9	$ -	$ -	$ 0.95	$ 0.95
								SUM	1.00	1.00	1.00	1.00	$ 115	$ 16.03	$ 14.61	$ 12.79	$ 12.79

Table 81: Building Entrances and Exits Cost per Watt, continued

2019 LED									Weighting					Weighted Cost per Watt			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4	Total $/W	LZ1	LZ2	LZ3	LZ4
Surface Mounted Linear																	
AB	002	$ 524	18	0.70	1,663	1	0	1	0.040	0.034	0.030	0.030	$ 29	$ 1.16	$ 1.00	$ 0.88	$ 0.88
AB	002	$ 524	38	0.70	3,111	2	0	1	0.040	0.034	0.030	0.030	$ 14	$ 0.55	$ 0.48	$ 0.42	$ 0.42
AB	003	$ 930	38	0.70	1,539	1	1	1	0.040	0.034	0.030	0.030	$ 24	$ 0.97	$ 0.83	$ 0.73	$ 0.73
AV	001	$ 549	30	0.95	2,068	1	0	1	0.040	0.034	0.030	0.030	$ 19	$ 0.74	$ 0.64	$ 0.56	$ 0.56
AV	001	$ 549	39	0.95	2,756	1	0	1	0.040	0.034	0.030	0.030	$ 14	$ 0.56	$ 0.48	$ 0.42	$ 0.42
AV	001	$ 579	24	0.95	3,444	1	0	1	0.040	0.034	0.030	0.030	$ 24	$ 0.95	$ 0.82	$ 0.72	$ 0.72
AW	001	$ 639	22	0.70	2,000	1	0	1	0.040	0.034	0.030	0.030	$ 29	$ 1.16	$ 1.00	$ 0.88	$ 0.88
AW	001	$ 639	33	0.70	3,000	1	0	1	0.040	0.034	0.030	0.030	$ 19	$ 0.77	$ 0.66	$ 0.58	$ 0.58
AW	001	$ 639	44	0.70	4,000	2	0	1	0.040	0.034	0.030	0.030	$ 14	$ 0.58	$ 0.50	$ 0.44	$ 0.44
BC	001	$ 524	16	0.70	1,560	2	0	1	0.040	0.034	0.030	0.030	$ 33	$ 1.31	$ 1.13	$ 0.99	$ 0.99
BC	001	$ 524	32	0.70	3,100	2	0	1	0.040	0.034	0.030	0.030	$ 16	$ 0.66	$ 0.56	$ 0.50	$ 0.50
BC	001	$ 524	41	0.70	4,000	2	0	1	0.040	0.034	0.030	0.030	$ 13	$ 0.51	$ 0.44	$ 0.39	$ 0.39
Y	001	$ 569	14	0.70	1,056	1	0	1	0.040	0.034	0.030	0.030	$ 40	$ 1.58	$ 1.36	$ 1.20	$ 1.20
Y	001	$ 569	18	0.70	1,328	1	0	1	0.040	0.034	0.030	0.030	$ 31	$ 1.24	$ 1.07	$ 0.94	$ 0.94
Y	001	$ 569	28	0.70	2,004	1	0	1	0.040	0.034	0.030	0.030	$ 20	$ 0.80	$ 0.69	$ 0.61	$ 0.61
Y	001	$ 569	37	0.70	2,580	1	0	1	0.040	0.034	0.030	0.030	$ 15	$ 0.62	$ 0.53	$ 0.47	$ 0.47
AZ	001	$ 405	12	0.70	560	0	1	0	0.040	0.034	0.030	0.030	$ 34	$ 1.35	$ 1.16	$ 1.02	$ 1.02
AZ	001	$ 470	30	0.70	1,680	1	1	1	0.040	0.034	0.030	0.030	$ 15	$ 0.62	$ 0.53	$ 0.47	$ 0.47
AZ	001	$ 529	30	0.70	2,480	1	1	1	0.040	0.034	0.030	0.030	$ 17	$ 0.70	$ 0.60	$ 0.53	$ 0.53
Z	002	$ 624	17	0.70	2,000	1	0	1	0.040	0.034	0.030	0.030	$ 38	$ 1.51	$ 1.30	$ 1.15	$ 1.15
Z	002	$ 624	26	0.70	3,000	1	0	1	0.040	0.034	0.030	0.030	$ 24	$ 0.98	$ 0.84	$ 0.74	$ 0.74
Z	002	$ 624	35	0.70	4,000	2	0	1	0.040	0.034	0.030	0.030	$ 18	$ 0.71	$ 0.61	$ 0.54	$ 0.54
BE	001	$ 160	10	0.70	1,236	0	1	0	0.040	0.034	0.030	0.030	$ 17	$ 0.67	$ 0.57	$ 0.50	$ 0.50
BE	001	$ 245	18	0.70	1,696	0	1	0	0.040	0.034	0.030	0.030	$ 14	$ 0.56	$ 0.48	$ 0.42	$ 0.42
BE	001	$ 329	26	0.70	2,308	0	1	0	0.040	0.034	0.030	0.030	$ 12	$ 0.50	$ 0.43	$ 0.38	$ 0.38
AX	001	$ 589	19	0.70	1,008	0	2	1		0.034	0.030	0.030	$ 31	$ -	$ 1.08	$ 0.95	$ 0.95
AX	001	$ 589	35	0.70	1,876	1	2	1		0.034	0.030	0.030	$ 17	$ -	$ 0.58	$ 0.51	$ 0.51
AY	001	$ 524	8	0.70	1,400	1	2	1		0.034	0.030	0.030	$ 66	$ -	$ 2.26	$ 1.99	$ 1.99
AY	001	$ 524	12	0.70	2,200	1	2	1		0.034	0.030	0.030	$ 45	$ -	$ 1.56	$ 1.37	$ 1.37
AY	001	$ 524	19	0.70	3,200	1	3	1			0.030	0.030	$ 27	$ -	$ -	$ 0.83	$ 0.83
AY	001	$ 524	24	0.70	4,000	1	3	1			0.030	0.030	$ 22	$ -	$ -	$ 0.66	$ 0.66
AY	001	$ 524	30	0.70	4,800	2	3	1			0.030	0.030	$ 17	$ -	$ -	$ 0.53	$ 0.53
AY	001	$ 524	65	0.70	8,800	2	3	1			0.030	0.030	$ 8	$ -	$ -	$ 0.24	$ 0.24
								SUM	1.00	1.00	1.00	1.00	$ 777	$ 21.74	$ 24.22	$ 23.55	$ 23.55
Wall Mounted																	
C	001	$ 409	16	0.95	696	0	4	0				0.056	$ 26	$ -	$ -	$ -	$ 1.47
H	002	$ 639	14	0.70	846	0	4	0				0.056	$ 46	$ -	$ -	$ -	$ 2.54
S	001	$ 147	26	0.70	823	1	0	0	0.083	0.083	0.071	0.056	$ 6	$ 0.47	$ 0.47	$ 0.40	$ 0.31
AH	001	$ 815	24	0.70	950	1	3	1			0.071	0.056	$ 34	$ -	$ -	$ 2.42	$ 1.89
C	001	$ 409	16	0.95	1,084	0	4	0				0.056	$ 26	$ -	$ -	$ -	$ 1.47
S	002	$ 162	18	0.70	1,189	1	1	0	0.083	0.083	0.071	0.056	$ 9	$ 0.75	$ 0.75	$ 0.64	$ 0.50
C	001	$ 409	16	0.95	1,214	0	4	0				0.056	$ 26	$ -	$ -	$ -	$ 1.47
H	001	$ 1,125	17	0.81	1,216	1	1	0	0.083	0.083	0.071	0.056	$ 66	$ 5.52	$ 5.52	$ 4.73	$ 3.68
AF	001	$ 809	40	0.70	1,290	1	1	1	0.083	0.083	0.071	0.056	$ 20	$ 1.67	$ 1.67	$ 1.43	$ 1.11
V	005	$ 381	13	0.91	1,415	0	0	1	0.083	0.083	0.071	0.056	$ 29	$ 2.44	$ 2.44	$ 2.09	$ 1.63
V	004	$ 408	12	0.90	1,494	0	0	0	0.083	0.083	0.071	0.056	$ 34	$ 2.84	$ 2.84	$ 2.43	$ 1.89
B	004	$ 1,719	88	0.70	3,003	1	3	0			0.071	0.056	$ 20	$ -	$ -	$ 1.40	$ 1.09
V	005	$ 381	19	0.91	1,957	1	0	1	0.083	0.083	0.071	0.056	$ 20	$ 1.67	$ 1.67	$ 1.43	$ 1.11
V	005	$ 381	19	0.91	2,031	1	0	1	0.083	0.083	0.071	0.056	$ 20	$ 1.67	$ 1.67	$ 1.43	$ 1.11
AE	001	$ 163	27	0.70	2,075	1	1	0	0.083	0.083	0.071	0.056	$ 6	$ 0.50	$ 0.50	$ 0.43	$ 0.34
AF	002	$ 368	20	0.70	2,054	1	1	1	0.083	0.083	0.071	0.056	$ 19	$ 1.56	$ 1.56	$ 1.34	$ 1.04
V	004	$ 449	25	0.90	3,163	1	0	1	0.083	0.083	0.071	0.056	$ 18	$ 1.50	$ 1.50	$ 1.28	$ 1.00
V	004	$ 490	50	0.90	6,025	1	0	1	0.083	0.083	0.071	0.056	$ 10	$ 0.82	$ 0.82	$ 0.70	$ 0.54
								SUM	1.00	1.00	1.00	1.00	$ 435	$ 21.41	$ 21.41	$ 22.18	$ 24.18
									1.00	1.00	1.00	1.00		$ 29.09	$ 27.00	$ 26.71	$ 27.00

Table 82: Primary Entrances Cost per Watt

2019 LED									Weighting					Weighted Cost per Watt			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4	Total $/W	LZ1	LZ2	LZ3	LZ4
Area Light																	
B	002	$ 1,381	25	0.93	1,170	1	2	1	0.063	0.063	0.063	0.063	$ 55	$ 3.45	$ 3.45	$ 3.45	$ 3.45
B	002	$ 1,381	25	0.93	1,216	1	1	1	0.063	0.063	0.063	0.063	$ 55	$ 3.45	$ 3.45	$ 3.45	$ 3.45
B	002	$ 1,381	25	0.93	1,735	1	0	1	0.063	0.063	0.063	0.063	$ 55	$ 3.45	$ 3.45	$ 3.45	$ 3.45
A	002	$ 1,553	21	0.83	2,051	1	0	1	0.063	0.063	0.063	0.063	$ 74	$ 4.62	$ 4.62	$ 4.62	$ 4.62
A	002	$ 1,553	21	0.83	2,189	1	0	1	0.063	0.063	0.063	0.063	$ 74	$ 4.62	$ 4.62	$ 4.62	$ 4.62
A	002	$ 1,553	21	0.83	2,114	1	0	1	0.063	0.063	0.063	0.063	$ 74	$ 4.62	$ 4.62	$ 4.62	$ 4.62
A	002	$ 1,553	30	0.83	2,760	1	0	1	0.063	0.063	0.063	0.063	$ 52	$ 3.24	$ 3.24	$ 3.24	$ 3.24
B	002	$ 1,381	25	0.93	1,830	1	0	1	0.063	0.063	0.063	0.063	$ 55	$ 3.45	$ 3.45	$ 3.45	$ 3.45
W	002	$ 1,970	22	0.84	2,117	1	0	1	0.063	0.063	0.063	0.063	$ 90	$ 5.60	$ 5.60	$ 5.60	$ 5.60
BD	001	$ 1,434	36	0.92	2,221	1	0	1	0.063	0.063	0.063	0.063	$ 40	$ 2.49	$ 2.49	$ 2.49	$ 2.49
W	003	$ 1,071	30	0.84	3,126	1	0	1	0.063	0.063	0.063	0.063	$ 36	$ 2.23	$ 2.23	$ 2.23	$ 2.23
BD	001	$ 1,434	52	0.92	3,178	1	0	1	0.063	0.063	0.063	0.063	$ 28	$ 1.72	$ 1.72	$ 1.72	$ 1.72
AF	003	$ 1,776	48	0.70	4,247	1	0	1	0.063	0.063	0.063	0.063	$ 37	$ 2.31	$ 2.31	$ 2.31	$ 2.31
A	001	$ 1,379	22	0.84	1,888	1	0	1	0.063	0.063	0.063	0.063	$ 63	$ 3.92	$ 3.92	$ 3.92	$ 3.92
A	001	$ 1,379	51	0.84	4,431	2	0	2	0.063	0.063	0.063	0.063	$ 27	$ 1.69	$ 1.69	$ 1.69	$ 1.69
A	001	$ 1,379	51	0.84	4,348	1	0	1	0.063	0.063	0.063	0.063	$ 27	$ 1.69	$ 1.69	$ 1.69	$ 1.69
A	001	$ 1,450	95	0.84	7,312	2	0	2					$ 15	$ -	$ -	$ -	$ -
W	004	$ 1,063	96	0.89	10,231	3	0	2					$ 11	$ -	$ -	$ -	$ -
								SUM	1.00	1.00	1.00	1.00	$ 867	$52.57	$52.57	$52.57	$52.57

Cylindrical - Wall Mounted up/down																	
2019 LED									Weighting					Weighted Cost			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4		LZ1	LZ2	LZ3	LZ4
C	003	$ 619	10	0.87	838	2	5	0	0.111	0.111	0.111	0.111	$ 62	$ 6.88	$ 6.88	$ 6.88	$ 6.88
M	001	$ 950	8	0.70	900	1	1	0	0.111	0.111	0.111	0.111	$ 119	$ 13.19	$ 13.19	$ 13.19	$ 13.19
AO	001	$ 349	13	0.70	931	1	1	0	0.111	0.111	0.111	0.111	$ 27	$ 2.99	$ 2.99	$ 2.99	$ 2.99
H	003	$ 434	21	0.81	1,047	1	4	0	0.111	0.111	0.111	0.111	$ 21	$ 2.30	$ 2.30	$ 2.30	$ 2.30
F	001	$ 1,056	34	0.70	2,212	2	5	0	0.111	0.111	0.111	0.111	$ 31	$ 3.45	$ 3.45	$ 3.45	$ 3.45
C	003	$ 862	29	0.70	2,319	2	5	0	0.111	0.111	0.111	0.111	$ 30	$ 3.36	$ 3.36	$ 3.36	$ 3.36
F	001	$ 1,067	42	0.70	3,288	3	5	0	0.111	0.111	0.111	0.111	$ 25	$ 2.82	$ 2.82	$ 2.82	$ 2.82
F	001	$ 1,352	57	0.70	4,607	3	5	0	0.111	0.111	0.111	0.111	$ 24	$ 2.64	$ 2.64	$ 2.64	$ 2.64
AF	004	$ 1,214	76	0.70	4,884	1	5	1	0.111	0.111	0.111	0.111	$ 16	$ 1.78	$ 1.78	$ 1.78	$ 1.78
								SUM	0.89	0.89	0.89	0.89		$39.41	$39.41	$39.41	$39.41

Downlight																	
2019 LED									Weighting					Weighted Cost			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4		LZ1	LZ2	LZ3	LZ4
J	001	$ 561	10	0.70	647	1	0	0	0.043	0.040	0.040	0.040	$ 56	$ 2.44	$ 2.25	$ 2.25	$ 2.25
K	001	$ 220	13	0.70	780	1	1	0	0.043	0.040	0.040	0.040	$ 17	$ 0.74	$ 0.68	$ 0.68	$ 0.68
J	001	$ 561	14	0.70	884	1	0	0	0.043	0.040	0.040	0.040	$ 40	$ 1.74	$ 1.60	$ 1.60	$ 1.60
P	001	$ 208	14	0.89	1,066	1	1	0	0.043	0.040	0.040	0.040	$ 15	$ 0.65	$ 0.60	$ 0.60	$ 0.60
K	001	$ 286	22	0.70	1,170	2	1	0	0.043	0.040	0.040	0.040	$ 13	$ 0.57	$ 0.52	$ 0.52	$ 0.52
K	001	$ 272	22	0.70	1,426	2	1	0	0.043	0.040	0.040	0.040	$ 12	$ 0.54	$ 0.49	$ 0.49	$ 0.49
K	002	$ 236	19	0.70	1,461	2	0	0	0.043	0.040	0.040	0.040	$ 13	$ 0.56	$ 0.51	$ 0.51	$ 0.51
K	002	$ 236	23	0.70	1,860	2	0	0	0.043	0.040	0.040	0.040	$ 10	$ 0.44	$ 0.41	$ 0.41	$ 0.41
P	001	$ 237	36	0.89	1,995	2	1	0	0.043	0.040	0.040	0.040	$ 7	$ 0.29	$ 0.26	$ 0.26	$ 0.26
C	005	$ 94	21	0.70	1,914	2	0	0	0.043	0.040	0.040	0.040	$ 4	$ 0.19	$ 0.18	$ 0.18	$ 0.18
P	001	$ 237	35	0.89	2,130	2	1	0	0.043	0.040	0.040	0.040	$ 7	$ 0.29	$ 0.27	$ 0.27	$ 0.27
C	005	$ 112	28	0.70	2,203	2	0	0	0.043	0.040	0.040	0.040	$ 4	$ 0.18	$ 0.16	$ 0.16	$ 0.16
K	002	$ 251	30	0.70	2,521	2	0	0	0.043	0.040	0.040	0.040	$ 9	$ 0.37	$ 0.34	$ 0.34	$ 0.34
P	001	$ 257	41	0.89	2,621	3	1	0	0.043	0.040	0.040	0.040	$ 6	$ 0.28	$ 0.25	$ 0.25	$ 0.25
K	002	$ 266	37	0.70	2,917	3	0	0	0.043	0.040	0.040	0.040	$ 7	$ 0.32	$ 0.29	$ 0.29	$ 0.29
K	002	$ 310	48	0.70	3,029	3	0	0	0.043	0.040	0.040	0.040	$ 6	$ 0.28	$ 0.26	$ 0.26	$ 0.26
P	001	$ 256	44	0.89	3,184	3	1	0	0.043	0.040	0.040	0.040	$ 6	$ 0.25	$ 0.23	$ 0.23	$ 0.23
C	005	$ 112	42	0.70	3,300	3	0	0	0.043	0.040	0.040	0.040	$ 3	$ 0.12	$ 0.11	$ 0.11	$ 0.11
K	002	$ 295	48	0.70	3,839	3	0	0	0.043	0.040	0.040	0.040	$ 6	$ 0.27	$ 0.25	$ 0.25	$ 0.25
K	002	$ 310	47	0.70	4,234	3	0	0	0.043	0.040	0.040	0.040	$ 7	$ 0.29	$ 0.26	$ 0.26	$ 0.26
K	002	$ 324	49	0.70	4,982	3	0	0	0.043	0.040	0.040	0.040	$ 7	$ 0.29	$ 0.27	$ 0.27	$ 0.27
K	002	$ 427	75	0.70	6,168	3	0	0	0.043	0.040	0.040	0.040	$ 6	$ 0.25	$ 0.23	$ 0.23	$ 0.23
AR	002	$ 585	57	0.70	5,716	3	1	1	0.043	0.040	0.040	0.040	$ 10	$ 0.45	$ 0.41	$ 0.41	$ 0.41
C	005	$ 175	115	0.70	7,816	4	0	0		0.040	0.040	0.040	$ 2	$ -	$ 0.06	$ 0.06	$ 0.06
K	002	$ 530	115	0.70	11,296	3	0	0		0.040	0.040	0.040	$ 5	$ -	$ 0.18	$ 0.18	$ 0.18
								SUM	1.00	1.00	1.00	1.00		$11.77	$11.07	$11.07	$11.07

Table 83: Primary Entrances Cost per Watt, continued

2019 LED									Weighting					Weighted Cost per Watt			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4	Total $/W	LZ1	LZ2	LZ3	LZ4
Recessed Linear																	
AB	002	$ 424	18	0.70	1,371	1	0	1	0.032	0.032	0.031	0.031	$ 24	$ 0.76	$ 0.76	$ 0.74	$ 0.74
AB	002	$ 424	38	0.70	2,560	1	0	1	0.032	0.032	0.031	0.031	$ 11	$ 0.36	$ 0.36	$ 0.35	$ 0.35
AB	001	$ 151	39	0.70	3,088	1	0	1	0.032	0.032	0.031	0.031	$ 4	$ 0.13	$ 0.13	$ 0.12	$ 0.12
AV	001	$ 549	30	0.95	2,068	1	0	1	0.032	0.032	0.031	0.031	$ 19	$ 0.60	$ 0.60	$ 0.58	$ 0.58
AV	001	$ 549	39	0.95	2,756	1	0	1	0.032	0.032	0.031	0.031	$ 14	$ 0.45	$ 0.45	$ 0.44	$ 0.44
AV	001	$ 549	24	0.95	3,444	1	0	1	0.032	0.032	0.031	0.031	$ 23	$ 0.73	$ 0.73	$ 0.70	$ 0.70
AW	001	$ 610	22	0.70	2,000	1	0	1	0.032	0.032	0.031	0.031	$ 28	$ 0.89	$ 0.89	$ 0.87	$ 0.87
AW	001	$ 610	33	0.70	3,000	1	0	1	0.032	0.032	0.031	0.031	$ 18	$ 0.59	$ 0.59	$ 0.57	$ 0.57
AW	001	$ 610	44	0.70	4,000	2	0	1	0.032	0.032	0.031	0.031	$ 14	$ 0.44	$ 0.44	$ 0.43	$ 0.43
Y	001	$ 631	14	0.70	1,056	1	0	1	0.032	0.032	0.031	0.031	$ 44	$ 1.41	$ 1.41	$ 1.37	$ 1.37
Y	001	$ 631	18	0.70	1,328	1	0	1	0.032	0.032	0.031	0.031	$ 34	$ 1.11	$ 1.11	$ 1.07	$ 1.07
Y	001	$ 631	28	0.70	2,004	1	0	1	0.032	0.032	0.031	0.031	$ 22	$ 0.72	$ 0.72	$ 0.69	$ 0.69
Y	001	$ 631	37	0.70	2,580	1	0	1	0.032	0.032	0.031	0.031	$ 17	$ 0.55	$ 0.55	$ 0.54	$ 0.54
AA	001	$ 440	42	0.70	2,050	1	1	0	0.032	0.032	0.031	0.031	$ 11	$ 0.34	$ 0.34	$ 0.33	$ 0.33
AZ	001	$ 329	12	0.70	580	0	1	0	0.032	0.032	0.031	0.031	$ 27	$ 0.86	$ 0.86	$ 0.83	$ 0.83
AZ	001	$ 376	30	0.70	1,520	0	1	0	0.032	0.032	0.031	0.031	$ 12	$ 0.40	$ 0.40	$ 0.39	$ 0.39
Z	002	$ 574	23	0.70	2,000	1	0	1	0.032	0.032	0.031	0.031	$ 25	$ 0.81	$ 0.81	$ 0.78	$ 0.78
Z	002	$ 574	36	0.70	3,000	1	0	1	0.032	0.032	0.031	0.031	$ 16	$ 0.52	$ 0.52	$ 0.51	$ 0.51
Z	002	$ 574	49	0.70	4,000	2	0	1	0.032	0.032	0.031	0.031	$ 12	$ 0.38	$ 0.38	$ 0.37	$ 0.37
Z	001	$ 599	31	0.70	2,914	1	0	1	0.032	0.032	0.031	0.031	$ 19	$ 0.63	$ 0.63	$ 0.61	$ 0.61
BE	001	$ 160	10	0.70	1,236	0	1	0	0.032	0.032	0.031	0.031	$ 17	$ 0.54	$ 0.54	$ 0.52	$ 0.52
BE	001	$ 245	18	0.70	1,696	0	1	0	0.032	0.032	0.031	0.031	$ 14	$ 0.45	$ 0.45	$ 0.43	$ 0.43
BE	001	$ 329	26	0.70	2,308	0	1	0	0.032	0.032	0.031	0.031	$ 12	$ 0.40	$ 0.40	$ 0.39	$ 0.39
AX	001	$ 589	19	0.70	1,008	1	2	1	0.032	0.032	0.031	0.031	$ 31	$ 1.01	$ 1.01	$ 0.98	$ 0.98
AX	001	$ 589	35	0.70	1,876	1	2	1	0.032	0.032	0.031	0.031	$ 17	$ 0.55	$ 0.55	$ 0.53	$ 0.53
AY	001	$ 574	8	0.70	1,400	1	2	1	0.032	0.032	0.031	0.031	$ 72	$ 2.31	$ 2.31	$ 2.24	$ 2.24
AY	001	$ 574	12	0.70	2,200	1	2	1	0.032	0.032	0.031	0.031	$ 49	$ 1.60	$ 1.60	$ 1.55	$ 1.55
AY	001	$ 574	19	0.70	3,200	1	3	1	0.032	0.032	0.031	0.031	$ 30	$ 0.96	$ 0.96	$ 0.93	$ 0.93
AY	001	$ 574	24	0.70	4,000	1	3	1	0.032	0.032	0.031	0.031	$ 24	$ 0.77	$ 0.77	$ 0.75	$ 0.75
AY	001	$ 574	30	0.70	4,800	2	3	1	0.032	0.032	0.031	0.031	$ 19	$ 0.62	$ 0.62	$ 0.60	$ 0.60
AY	001	$ 574	65	0.70	8,800	2	3	1			0.031	0.031	$ 9	$ -	$ -	$ 0.28	$ 0.28
Z	001	$ 599	42	0.70	3,885	2	2	1	0.032	0.032	0.031	0.031	$ 14	$ 0.46	$ 0.46	$ 0.44	$ 0.44
								SUM	1.00	1.00	1.00	1.00		$22.34	$22.34	$21.91	$21.91
Surface Mounted Linear																	
AB	002	$ 524	18	0.70	1,663	1	0	1	0.031	0.031	0.030	0.030	$ 29	$ 0.91	$ 0.91	$ 0.88	$ 0.88
AB	002	$ 524	38	0.70	3,111	2	0	1	0.031	0.031	0.030	0.030	$ 14	$ 0.43	$ 0.43	$ 0.42	$ 0.42
AB	003	$ 930	38	0.70	1,539	1	1	1	0.031	0.031	0.030	0.030	$ 24	$ 0.76	$ 0.76	$ 0.73	$ 0.73
AV	001	$ 549	30	0.95	2,068	1	0	1	0.031	0.031	0.030	0.030	$ 19	$ 0.58	$ 0.58	$ 0.56	$ 0.56
AV	001	$ 549	39	0.95	2,756	1	0	1	0.031	0.031	0.030	0.030	$ 14	$ 0.44	$ 0.44	$ 0.42	$ 0.42
AV	001	$ 579	24	0.95	3,444	1	0	1	0.031	0.031	0.030	0.030	$ 24	$ 0.74	$ 0.74	$ 0.72	$ 0.72
AW	001	$ 639	22	0.70	2,000	1	0	1	0.031	0.031	0.030	0.030	$ 29	$ 0.91	$ 0.91	$ 0.88	$ 0.88
AW	001	$ 639	33	0.70	3,000	1	0	1	0.031	0.031	0.030	0.030	$ 19	$ 0.60	$ 0.60	$ 0.58	$ 0.58
AW	001	$ 639	44	0.70	4,000	2	0	1	0.031	0.031	0.030	0.030	$ 14	$ 0.45	$ 0.45	$ 0.44	$ 0.44
BC	001	$ 524	16	0.70	1,560	2	0	1	0.031	0.031	0.030	0.030	$ 33	$ 1.02	$ 1.02	$ 0.99	$ 0.99
BC	001	$ 524	32	0.70	3,100	2	0	1	0.031	0.031	0.030	0.030	$ 16	$ 0.51	$ 0.51	$ 0.50	$ 0.50
BC	001	$ 524	41	0.70	4,000	2	0	1	0.031	0.031	0.030	0.030	$ 13	$ 0.40	$ 0.40	$ 0.39	$ 0.39
Y	001	$ 569	14	0.70	1,056	1	0	1	0.031	0.031	0.030	0.030	$ 40	$ 1.23	$ 1.23	$ 1.20	$ 1.20
Y	001	$ 569	18	0.70	1,328	1	0	1	0.031	0.031	0.030	0.030	$ 31	$ 0.97	$ 0.97	$ 0.94	$ 0.94
Y	001	$ 569	28	0.70	2,004	1	0	1	0.031	0.031	0.030	0.030	$ 20	$ 0.63	$ 0.63	$ 0.61	$ 0.61
Y	001	$ 569	37	0.70	2,580	1	0	1	0.031	0.031	0.030	0.030	$ 15	$ 0.48	$ 0.48	$ 0.47	$ 0.47
AZ	001	$ 405	12	0.70	560	0	1	0	0.031	0.031	0.030	0.030	$ 34	$ 1.06	$ 1.06	$ 1.02	$ 1.02
AZ	001	$ 470	30	0.70	1,680	1	1	1	0.031	0.031	0.030	0.030	$ 15	$ 0.48	$ 0.48	$ 0.47	$ 0.47
AZ	001	$ 529	30	0.70	2,480	1	1	1	0.031	0.031	0.030	0.030	$ 17	$ 0.54	$ 0.54	$ 0.53	$ 0.53
Z	002	$ 624	17	0.70	2,000	1	0	1	0.031	0.031	0.030	0.030	$ 38	$ 1.18	$ 1.18	$ 1.15	$ 1.15
Z	002	$ 624	26	0.70	3,000	1	0	1	0.031	0.031	0.030	0.030	$ 24	$ 0.76	$ 0.76	$ 0.74	$ 0.74
Z	002	$ 624	35	0.70	4,000	2	0	1	0.031	0.031	0.030	0.030	$ 18	$ 0.56	$ 0.56	$ 0.54	$ 0.54
BE	001	$ 160	10	0.70	1,236	0	1	0	0.031	0.031	0.030	0.030	$ 17	$ 0.52	$ 0.52	$ 0.50	$ 0.50
BE	001	$ 245	18	0.70	1,696	0	1	0	0.031	0.031	0.030	0.030	$ 14	$ 0.43	$ 0.43	$ 0.42	$ 0.42
BE	001	$ 329	26	0.70	2,308	0	1	0	0.031	0.031	0.030	0.030	$ 12	$ 0.39	$ 0.39	$ 0.38	$ 0.38
AX	001	$ 589	19	0.70	1,008	0	2	1	0.031	0.031	0.030	0.030	$ 31	$ 0.98	$ 0.98	$ 0.95	$ 0.95
AX	001	$ 589	35	0.70	1,876	1	2	1	0.031	0.031	0.030	0.030	$ 17	$ 0.53	$ 0.53	$ 0.51	$ 0.51
AY	001	$ 524	8	0.70	1,400	1	2	1	0.031	0.031	0.030	0.030	$ 66	$ 2.05	$ 2.05	$ 1.99	$ 1.99
AY	001	$ 524	12	0.70	2,200	1	2	1	0.031	0.031	0.030	0.030	$ 45	$ 1.41	$ 1.41	$ 1.37	$ 1.37
AY	001	$ 524	19	0.70	3,200	1	3	1	0.031	0.031	0.030	0.030	$ 27	$ 0.85	$ 0.85	$ 0.83	$ 0.83
AY	001	$ 524	24	0.70	4,000	1	3	1	0.031	0.031	0.030	0.030	$ 22	$ 0.68	$ 0.68	$ 0.66	$ 0.66
AY	001	$ 524	30	0.70	4,800	2	3	1	0.031	0.031	0.030	0.030	$ 17	$ 0.55	$ 0.55	$ 0.53	$ 0.53
AY	001	$ 524	65	0.70	8,800	2	3	1			0.030	0.030	$ 8	$ -	$ -	$ 0.24	$ 0.24
								SUM	1.00	1.00	1.00	1.00		$24.03	$24.03	$23.55	$23.55

Table 84: Primary Entrances Cost per Watt, continued

2019 LED									Weighting					Weighted Cost per Watt			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4	Total $/W	LZ1	LZ2	LZ3	LZ4
Surface Mounted Downlight																	
AC	001	$ 99	20	0.70	1,813	1	0	1	0.125	0.125	0.111	0.111	$ 5	$ 0.61	$ 0.61	$ 0.54	$ 0.54
BB	001	$ 793	19	0.70	1,509	1	0	0	0.125	0.125	0.111	0.111	$ 42	$ 5.22	$ 5.22	$ 4.64	$ 4.64
Q	002	$ 61	14	0.70	1,081	1	1	0	0.125	0.125	0.111	0.111	$ 5	$ 0.57	$ 0.57	$ 0.50	$ 0.50
T	001	$ 272	24	0.70	3,055	2	3	2	0.125	0.125	0.111	0.111	$ 11	$ 1.40	$ 1.40	$ 1.24	$ 1.24
C	006	$ 363	28	0.70	3,293	1	0	1	0.125	0.125	0.111	0.111	$ 13	$ 1.62	$ 1.62	$ 1.44	$ 1.44
AL	002	$ 455	31	0.70	4,210	2	2	1	0.125	0.125	0.111	0.111	$ 15	$ 1.84	$ 1.84	$ 1.63	$ 1.63
T	001	$ 296	38	0.70	4,443	2	3	2	0.125	0.125	0.111	0.111	$ 8	$ 0.97	$ 0.97	$ 0.86	$ 0.86
C	006	$ 398	45	0.70	4,949	3	0	2	0.125	0.125	0.111	0.111	$ 9	$ 1.11	$ 1.11	$ 0.98	$ 0.98
T	001	$ 465	55	0.70	6,959	2	3	2			0.111	0.111	$ 9	$ -	$ -	$ 0.95	$ 0.95
								SUM	1.00	1.00	1.00	1.00		$13.33	$13.33	$12.79	$12.79
Wall Mounted																	
C	001	$ 409	16	0.95	696	0	4	0	0.045	0.042	0.040	0.040	$ 26	$ 1.20	$ 1.10	$ 1.06	$ 1.06
H	002	$ 639	14	0.70	846	0	4	0	0.045	0.042	0.040	0.040	$ 46	$ 2.07	$ 1.90	$ 1.83	$ 1.83
S	001	$ 147	26	0.70	823	1	0	0	0.045	0.042	0.040	0.040	$ 6	$ 0.25	$ 0.23	$ 0.22	$ 0.22
AH	001	$ 815	24	0.70	950	1	3	1	0.045	0.042	0.040	0.040	$ 34	$ 1.54	$ 1.41	$ 1.36	$ 1.36
C	001	$ 409	16	0.95	1,084	0	4	0	0.045	0.042	0.040	0.040	$ 26	$ 1.20	$ 1.10	$ 1.06	$ 1.06
S	002	$ 162	18	0.70	1,189	1	1	0	0.045	0.042	0.040	0.040	$ 9	$ 0.41	$ 0.38	$ 0.36	$ 0.36
C	001	$ 409	16	0.95	1,214	0	4	0	0.045	0.042	0.040	0.040	$ 26	$ 1.20	$ 1.10	$ 1.06	$ 1.06
H	001	$ 1,125	17	0.81	1,216	1	1	0	0.045	0.042	0.040	0.040	$ 66	$ 3.01	$ 2.76	$ 2.65	$ 2.65
AF	001	$ 809	40	0.70	1,290	1	1	1	0.045	0.042	0.040	0.040	$ 20	$ 0.91	$ 0.83	$ 0.80	$ 0.80
V	005	$ 381	13	0.91	1,415	0	0	1	0.045	0.042	0.040	0.040	$ 29	$ 1.33	$ 1.22	$ 1.17	$ 1.17
V	004	$ 408	12	0.90	1,494	0	0	0	0.045	0.042	0.040	0.040	$ 34	$ 1.55	$ 1.42	$ 1.36	$ 1.36
B	004	$ 1,719	88	0.70	3,003	1	3	0	0.045	0.042	0.040	0.040	$ 20	$ 0.89	$ 0.82	$ 0.79	$ 0.79
V	005	$ 381	19	0.91	1,957	1	0	1	0.045	0.042	0.040	0.040	$ 20	$ 0.91	$ 0.84	$ 0.80	$ 0.80
V	005	$ 381	19	0.91	2,031	1	0	1	0.045	0.042	0.040	0.040	$ 20	$ 0.91	$ 0.84	$ 0.80	$ 0.80
AE	001	$ 163	27	0.70	2,075	1	1	0	0.045	0.042	0.040	0.040	$ 6	$ 0.27	$ 0.25	$ 0.24	$ 0.24
AF	002	$ 368	20	0.70	2,054	1	1	1	0.045	0.042	0.040	0.040	$ 19	$ 0.85	$ 0.78	$ 0.75	$ 0.75
V	005	$ 381	26	0.91	2,623	1	0	1	0.045	0.042	0.040	0.040	$ 15	$ 0.67	$ 0.61	$ 0.59	$ 0.59
AG	001	$ 518	36	0.70	2,603	1	0	1	0.045	0.042	0.040	0.040	$ 14	$ 0.65	$ 0.60	$ 0.58	$ 0.58
V	004	$ 449	25	0.90	3,163	1	0	1	0.045	0.042	0.040	0.040	$ 18	$ 0.82	$ 0.75	$ 0.72	$ 0.72
V	005	$ 506	35	0.91	3,912	1	0	2	0.05	0.042	0.040	0.040	$ 14	$ 0.66	$ 0.60	$ 0.58	$ 0.58
V	004	$ 490	50	0.90	6,025	1	0	1	0.045	0.042	0.040	0.040	$ 10	$ 0.45	$ 0.41	$ 0.39	$ 0.39
B	004	$ 707	52	0.70	4,390	1	0	0	0.045	0.042	0.040	0.040	$ 14	$ 0.62	$ 0.57	$ 0.54	$ 0.54
V	005	$ 506	73	0.91	6,865	1	0	2		0.042	0.040	0.040	$ 7	$ -	$ 0.29	$ 0.28	$ 0.28
W	004	$ 1,027	76	0.70	8,051	3	0	3			0.040	0.040	$ 14	$ -	$ -	$ 0.54	$ 0.54
W	004	$ 1,107	101	0.70	12,064	2	0	2		0.042	0.040	0.040	$ 11	$ -	$ 0.46	$ 0.44	$ 0.44
								SUM	1.00	1.00	1.00	1.00		$22.38	$21.26	$20.95	$20.95
									1.0	1.0	1.0	1.0		$26.55	$26.29	$26.04	$26.04

Table 85: Drive-Up Window Cost per Watt

2019 LED									Weighted					Weighted Cost			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4		LZ1	LZ2	LZ3	LZ4
Cylindrical - Wall Mounted up/down																	
C	003	$ 619	10	0.87	838	2	5	0	0.09	0.09	0.09	0.09		$ 62	$ 5.63	$ 5.63	$ 5.63	$ 5.63
M	001	$ 950	8	0.70	900	1	1	0	0.09	0.09	0.09	0.09		$ 119	$10.79	$10.79	$10.79	$10.79
AO	001	$ 349	13	0.70	931	1	1	0	0.09	0.09	0.09	0.09		$ 27	$ 2.44	$ 2.44	$ 2.44	$ 2.44
H	003	$ 434	21	0.81	1,047	1	4	0	0.09	0.09	0.09	0.09		$ 21	$ 1.88	$ 1.88	$ 1.88	$ 1.88
AN	001	$ -	24	0.70	1,333	1	3	2	0.09	0.09	0.09	0.09		$ -	$ -	$ -	$ -	$ -
F	001	$ 1,056	34	0.70	2,212	2	5	0	0.09	0.09	0.09	0.09		$ 31	$ 2.82	$ 2.82	$ 2.82	$ 2.82
C	003	$ 862	29	0.70	2,319	2	5	0	0.09	0.09	0.09	0.09		$ 30	$ 2.75	$ 2.75	$ 2.75	$ 2.75
F	001	$ 1,067	42	0.70	3,288	3	5	0	0.09	0.09	0.09	0.09		$ 25	$ 2.31	$ 2.31	$ 2.31	$ 2.31
BA	001	$ -	34	0.70	3,800	3	5	0	0.09	0.09	0.09	0.09		$ -	$ -	$ -	$ -	$ -
F	001	$ 1,352	57	0.70	4,607	3	5	0	0.09	0.09	0.09	0.09		$ 24	$ 2.16	$ 2.16	$ 2.16	$ 2.16
AF	004	$ 1,214	76	0.70	4,884	1	5	1	0.09	0.09	0.09	0.09		$ 16	$ 1.46	$ 1.46	$ 1.46	$ 1.46
								SUM	1.00	1.00	1.00	1.00			$32.24	$32.24	$32.24	$32.24
Downlight																	
J	001	$ 561	10	0.70	647	1	0	0	0.03	0.03	0.03	0.03		$ 56	$ 1.94	$ 1.94	$ 1.94	$ 1.94
K	001	$ 220	13	0.70	780	1	1	0	0.03	0.03	0.03	0.03		$ 17	$ 0.58	$ 0.58	$ 0.58	$ 0.58
J	001	$ 561	14	0.70	884	1	0	0	0.03	0.03	0.03	0.03		$ 40	$ 1.38	$ 1.38	$ 1.38	$ 1.38
P	001	$ 208	14	0.89	1,066	1	1	0	0.03	0.03	0.03	0.03		$ 15	$ 0.51	$ 0.51	$ 0.51	$ 0.51
K	001	$ 286	22	0.70	1,170	2	1	0	0.03	0.03	0.03	0.03		$ 13	$ 0.45	$ 0.45	$ 0.45	$ 0.45
K	001	$ 272	22	0.70	1,426	2	1	0	0.03	0.03	0.03	0.03		$ 12	$ 0.43	$ 0.43	$ 0.43	$ 0.43
K	002	$ 236	19	0.70	1,461	2	0	0	0.03	0.03	0.03	0.03		$ 13	$ 0.44	$ 0.44	$ 0.44	$ 0.44
K	002	$ 236	23	0.70	1,860	2	0	0	0.03	0.03	0.03	0.03		$ 10	$ 0.35	$ 0.35	$ 0.35	$ 0.35
P	001	$ 237	36	0.89	1,995	2	1	0	0.03	0.03	0.03	0.03		$ 7	$ 0.23	$ 0.23	$ 0.23	$ 0.23
C	005	$ 94	21	0.70	1,914	2	0	0	0.03	0.03	0.03	0.03		$ 4	$ 0.15	$ 0.15	$ 0.15	$ 0.15
P	001	$ 237	35	0.89	2,130	2	1	0	0.03	0.03	0.03	0.03		$ 7	$ 0.23	$ 0.23	$ 0.23	$ 0.23
C	005	$ 112	28	0.70	2,203	2	0	0	0.03	0.03	0.03	0.03		$ 4	$ 0.14	$ 0.14	$ 0.14	$ 0.14
K	002	$ 251	30	0.70	2,521	2	0	0	0.03	0.03	0.03	0.03		$ 9	$ 0.29	$ 0.29	$ 0.29	$ 0.29
P	001	$ 257	41	0.89	2,621	3	1	0	0.03	0.03	0.03	0.03		$ 6	$ 0.22	$ 0.22	$ 0.22	$ 0.22
Q	001	$ -	29	0.90	2,754	2	0	0	0.03	0.03	0.03	0.03		$ -	$ -	$ -	$ -	$ -
K	002	$ 266	37	0.70	2,917	3	0	0	0.03	0.03	0.03	0.03		$ 7	$ 0.25	$ 0.25	$ 0.25	$ 0.25
Q	001	$ -	29	0.90	2,944	2	0	0	0.03	0.03	0.03	0.03		$ -	$ -	$ -	$ -	$ -
K	002	$ 310	48	0.70	3,029	3	0	0	0.03	0.03	0.03	0.03		$ 6	$ 0.22	$ 0.22	$ 0.22	$ 0.22
P	001	$ 256	44	0.89	3,184	3	1	0	0.03	0.03	0.03	0.03		$ 6	$ 0.20	$ 0.20	$ 0.20	$ 0.20
C	005	$ 112	42	0.70	3,300	3	0	0	0.03	0.03	0.03	0.03		$ 3	$ 0.09	$ 0.09	$ 0.09	$ 0.09
K	002	$ 295	48	0.70	3,839	3	0	0	0.03	0.03	0.03	0.03		$ 6	$ 0.21	$ 0.21	$ 0.21	$ 0.21
K	002	$ 310	47	0.70	4,234	3	0	0	0.03	0.03	0.03	0.03		$ 7	$ 0.23	$ 0.23	$ 0.23	$ 0.23
Q	001	$ -	41	0.90	4,327	3	0	0	0.03	0.03	0.03	0.03		$ -	$ -	$ -	$ -	$ -
K	002	$ 324	49	0.70	4,982	3	0	0	0.03	0.03	0.03	0.03		$ 7	$ 0.23	$ 0.23	$ 0.23	$ 0.23
Q	001	$ -	58	0.80	6,305	4	0	0	0.03	0.03	0.03	0.03		$ -	$ -	$ -	$ -	$ -
K	002	$ 427	75	0.70	6,168	3	0	0	0.03	0.03	0.03	0.03		$ 6	$ 0.20	$ 0.20	$ 0.20	$ 0.20
AR	002	$ 585	57	0.70	5,716	3	1	1	0.03	0.03	0.03	0.03		$ 10	$ 0.35	$ 0.35	$ 0.35	$ 0.35
C	005	$ 175	115	0.70	7,816	4	0	0	0.03	0.03	0.03	0.03		$ 2	$ 0.05	$ 0.05	$ 0.05	$ 0.05
K	002	$ 530	115	0.70	11,296	3	0	0	0.03	0.03	0.03	0.03		$ 5	$ 0.16	$ 0.16	$ 0.16	$ 0.16
								SUM	1	1	1	1			$ 9.54	$ 9.54	$ 9.54	$ 9.54
Surface Mounted Downlight																	
AC	001	$ 99	20	0.70	1,813	1	0	1	0.11	0.11	0.10	0.10		$ 5	$ 0.54	$ 0.54	$ 0.49	$ 0.49
BB	001	$ 793	19	0.70	1,509	1	0	0	0.11	0.11	0.10	0.10		$ 42	$ 4.64	$ 4.64	$ 4.17	$ 4.17
Q	002	$ 61	14	0.70	1,081	1	1	0	0.11	0.11	0.10	0.10		$ 5	$ 0.50	$ 0.50	$ 0.45	$ 0.45
T	001	$ 272	24	0.70	3,055	2	3	2	0.11	0.11	0.10	0.10		$ 11	$ 1.24	$ 1.24	$ 1.12	$ 1.12
C	006	$ 363	28	0.70	3,293	1	0	1	0.11	0.11	0.10	0.10		$ 13	$ 1.44	$ 1.44	$ 1.30	$ 1.30
BB	002	$ -	35	0.70	3,147	1	0	1	0.11	0.11	0.10	0.10		$ -	$ -	$ -	$ -	$ -
AL	002	$ 455	31	0.70	4,210	2	2	1	0.11	0.11	0.10	0.10		$ 15	$ 1.63	$ 1.63	$ 1.47	$ 1.47
T	001	$ 296	38	0.70	4,443	2	3	2	0.11	0.11	0.10	0.10		$ 8	$ 0.86	$ 0.86	$ 0.78	$ 0.78
C	006	$ 398	45	0.70	4,949	3	0	2	0.11	0.11	0.10	0.10		$ 9	$ 0.98	$ 0.98	$ 0.88	$ 0.88
T	001	$ 465	55	0.70	6,959	2	3	2			0.10	0.10		$ 9	$ -	$ -	$ 0.85	$ 0.85
								SUM	1.00	1.00	1.00	1.00		$ 115	$11.84	$11.84	$11.51	$11.51

Table 86: Drive-Up Window Cost per Watt, continued

2019 LED									Weighted					Weighted Cost			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4		LZ1	LZ2	LZ3	LZ4
Recessed Linear																	
AB	002	$ 424	18	0.70	1,371	1	0	1	0.03	0.03	0.03	0.03	$ 24	$ 0.76	$ 0.74	$ 0.74	$ 0.74
AB	002	$ 424	38	0.70	2,560	1	0	1	0.03	0.03	0.03	0.03	$ 11	$ 0.36	$ 0.35	$ 0.35	$ 0.35
AB	001	$ 151	39	0.70	3,088	1	0	1	0.03	0.03	0.03	0.03	$ 4	$ 0.13	$ 0.12	$ 0.12	$ 0.12
AV	001	$ 549	30	0.95	2,068	1	0	1	0.03	0.03	0.03	0.03	$ 19	$ 0.60	$ 0.58	$ 0.58	$ 0.58
AV	001	$ 549	39	0.95	2,756	1	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.45	$ 0.44	$ 0.44	$ 0.44
AV	001	$ 549	24	0.95	3,444	1	0	1	0.03	0.03	0.03	0.03	$ 23	$ 0.73	$ 0.70	$ 0.70	$ 0.70
AW	001	$ 610	22	0.70	2,000	1	0	1	0.03	0.03	0.03	0.03	$ 28	$ 0.89	$ 0.87	$ 0.87	$ 0.87
AW	001	$ 610	33	0.70	3,000	1	0	1	0.03	0.03	0.03	0.03	$ 18	$ 0.59	$ 0.57	$ 0.57	$ 0.57
AW	001	$ 610	44	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.44	$ 0.43	$ 0.43	$ 0.43
Y	001	$ 631	14	0.70	1,056	1	0	1	0.03	0.03	0.03	0.03	$ 44	$ 1.41	$ 1.37	$ 1.37	$ 1.37
Y	001	$ 631	18	0.70	1,328	1	0	1	0.03	0.03	0.03	0.03	$ 34	$ 1.11	$ 1.07	$ 1.07	$ 1.07
Y	001	$ 631	28	0.70	2,004	1	0	1	0.03	0.03	0.03	0.03	$ 22	$ 0.72	$ 0.69	$ 0.69	$ 0.69
Y	001	$ 631	37	0.70	2,580	1	0	1	0.03	0.03	0.03	0.03	$ 17	$ 0.55	$ 0.54	$ 0.54	$ 0.54
AA	001	$ 440	42	0.70	2,050	1	1	0	0.03	0.03	0.03	0.03	$ 11	$ 0.34	$ 0.33	$ 0.33	$ 0.33
AZ	001	$ 329	12	0.70	580	0	1	0	0.03	0.03	0.03	0.03	$ 27	$ 0.86	$ 0.83	$ 0.83	$ 0.83
AZ	001	$ 376	30	0.70	1,520	0	1	0	0.03	0.03	0.03	0.03	$ 12	$ 0.40	$ 0.39	$ 0.39	$ 0.39
Z	002	$ 574	23	0.70	2,000	1	0	1	0.03	0.03	0.03	0.03	$ 25	$ 0.81	$ 0.78	$ 0.78	$ 0.78
Z	002	$ 574	36	0.70	3,000	1	0	1	0.03	0.03	0.03	0.03	$ 16	$ 0.52	$ 0.51	$ 0.51	$ 0.51
Z	002	$ 574	49	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 12	$ 0.38	$ 0.37	$ 0.37	$ 0.37
Z	001	$ 599	31	0.70	2,914	1	0	1	0.03	0.03	0.03	0.03	$ 19	$ 0.63	$ 0.61	$ 0.61	$ 0.61
BE	001	$ 160	10	0.70	1,236	0	1	0	0.03	0.03	0.03	0.03	$ 17	$ 0.54	$ 0.52	$ 0.52	$ 0.52
BE	001	$ 245	18	0.70	1,696	0	1	0	0.03	0.03	0.03	0.03	$ 14	$ 0.45	$ 0.43	$ 0.43	$ 0.43
BE	001	$ 329	26	0.70	2,308	0	1	0	0.03	0.03	0.03	0.03	$ 12	$ 0.40	$ 0.39	$ 0.39	$ 0.39
AX	001	$ 589	19	0.70	1,008	1	2	1	0.03	0.03	0.03	0.03	$ 31	$ 1.01	$ 0.98	$ 0.98	$ 0.98
AX	001	$ 589	35	0.70	1,876	1	2	1	0.03	0.03	0.03	0.03	$ 17	$ 0.55	$ 0.53	$ 0.53	$ 0.53
AY	001	$ 574	8	0.70	1,400	1	2	1	0.03	0.03	0.03	0.03	$ 72	$ 2.31	$ 2.24	$ 2.24	$ 2.24
AY	001	$ 574	12	0.70	2,200	1	2	1	0.03	0.03	0.03	0.03	$ 49	$ 1.60	$ 1.55	$ 1.55	$ 1.55
AY	001	$ 574	19	0.70	3,200	1	3	1	0.03	0.03	0.03	0.03	$ 30	$ 0.96	$ 0.93	$ 0.93	$ 0.93
AY	001	$ 574	24	0.70	4,000	1	3	1	0.03	0.03	0.03	0.03	$ 24	$ 0.77	$ 0.75	$ 0.75	$ 0.75
AY	001	$ 574	30	0.70	4,800	2	3	1	0.03	0.03	0.03	0.03	$ 19	$ 0.62	$ 0.60	$ 0.60	$ 0.60
AY	001	$ 574	65	0.70	8,800	2	3	1		0.03	0.03	0.03	$ 9	$ -	$ 0.28	$ 0.28	$ 0.28
Z	001	$ 599	42	0.70	3,885	2	2	1	0.03	0.03	0.03	0.03	$ 14	$ 0.46	$ 0.44	$ 0.44	$ 0.44
								SUM	1.00	1.00	1.00	1.00		$22.34	$21.91	$21.91	$21.91
Surface Mounted Linear																	
AB	002	$ 524	18	0.70	1,663	1	0	1	0.03	0.03	0.03	0.03	$ 29	$ 0.91	$ 0.91	$ 0.88	$ 0.88
AB	002	$ 524	38	0.70	3,111	2	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.43	$ 0.43	$ 0.42	$ 0.42
AB	003	$ 930	38	0.70	1,539	1	1	1	0.03	0.03	0.03	0.03	$ 24	$ 0.76	$ 0.76	$ 0.73	$ 0.73
AV	001	$ 549	30	0.95	2,068	1	0	1	0.03	0.03	0.03	0.03	$ 19	$ 0.58	$ 0.58	$ 0.56	$ 0.56
AV	001	$ 549	39	0.95	2,756	1	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.44	$ 0.44	$ 0.42	$ 0.42
AV	001	$ 579	24	0.95	3,444	1	0	1	0.03	0.03	0.03	0.03	$ 24	$ 0.74	$ 0.74	$ 0.72	$ 0.72
AW	001	$ 639	22	0.70	2,000	1	0	1	0.03	0.03	0.03	0.03	$ 29	$ 0.91	$ 0.91	$ 0.88	$ 0.88
AW	001	$ 639	33	0.70	3,000	1	0	1	0.03	0.03	0.03	0.03	$ 19	$ 0.60	$ 0.60	$ 0.58	$ 0.58
AW	001	$ 639	44	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.45	$ 0.45	$ 0.44	$ 0.44
BC	001	$ 524	16	0.70	1,560	2	0	1	0.03	0.03	0.03	0.03	$ 33	$ 1.02	$ 1.02	$ 0.99	$ 0.99
BC	001	$ 524	32	0.70	3,100	2	0	1	0.03	0.03	0.03	0.03	$ 16	$ 0.51	$ 0.51	$ 0.50	$ 0.50
BC	001	$ 524	41	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 13	$ 0.40	$ 0.40	$ 0.39	$ 0.39
Y	001	$ 569	14	0.70	1,056	1	0	1	0.03	0.03	0.03	0.03	$ 40	$ 1.23	$ 1.23	$ 1.20	$ 1.20
Y	001	$ 569	18	0.70	1,328	1	0	1	0.03	0.03	0.03	0.03	$ 31	$ 0.97	$ 0.97	$ 0.94	$ 0.94
Y	001	$ 569	28	0.70	2,004	1	0	1	0.03	0.03	0.03	0.03	$ 20	$ 0.63	$ 0.63	$ 0.61	$ 0.61
Y	001	$ 569	37	0.70	2,580	1	0	1	0.03	0.03	0.03	0.03	$ 15	$ 0.48	$ 0.48	$ 0.47	$ 0.47
AZ	001	$ 405	12	0.70	560	0	1	0	0.03	0.03	0.03	0.03	$ 34	$ 1.06	$ 1.06	$ 1.02	$ 1.02
AZ	001	$ 470	30	0.70	1,680	1	1	1	0.03	0.03	0.03	0.03	$ 15	$ 0.48	$ 0.48	$ 0.47	$ 0.47
AZ	001	$ 529	30	0.70	2,480	1	1	1	0.03	0.03	0.03	0.03	$ 17	$ 0.54	$ 0.54	$ 0.53	$ 0.53
Z	002	$ 624	17	0.70	2,000	1	0	1	0.03	0.03	0.03	0.03	$ 38	$ 1.18	$ 1.18	$ 1.15	$ 1.15
Z	002	$ 624	26	0.70	3,000	1	0	1	0.03	0.03	0.03	0.03	$ 24	$ 0.76	$ 0.76	$ 0.74	$ 0.74
Z	002	$ 624	35	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 18	$ 0.56	$ 0.56	$ 0.54	$ 0.54
BE	001	$ 160	10	0.70	1,236	0	1	0	0.03	0.03	0.03	0.03	$ 17	$ 0.52	$ 0.52	$ 0.50	$ 0.50
BE	001	$ 245	18	0.70	1,696	0	1	0	0.03	0.03	0.03	0.03	$ 14	$ 0.43	$ 0.43	$ 0.42	$ 0.42
BE	001	$ 329	26	0.70	2,308	0	1	0	0.03	0.03	0.03	0.03	$ 12	$ 0.39	$ 0.39	$ 0.38	$ 0.38
AX	001	$ 589	19	0.70	1,008	0	2	1	0.03	0.03	0.03	0.03	$ 31	$ 0.98	$ 0.98	$ 0.95	$ 0.95
AX	001	$ 589	35	0.70	1,876	1	2	1	0.03	0.03	0.03	0.03	$ 17	$ 0.53	$ 0.53	$ 0.51	$ 0.51
AY	001	$ 524	8	0.70	1,400	1	2	1	0.03	0.03	0.03	0.03	$ 66	$ 2.05	$ 2.05	$ 1.99	$ 1.99
AY	001	$ 524	12	0.70	2,200	1	2	1	0.03	0.03	0.03	0.03	$ 45	$ 1.41	$ 1.41	$ 1.37	$ 1.37
AY	001	$ 524	19	0.70	3,200	1	3	1	0.03	0.03	0.03	0.03	$ 27	$ 0.85	$ 0.85	$ 0.83	$ 0.83
AY	001	$ 524	24	0.70	4,000	1	3	1	0.03	0.03	0.03	0.03	$ 22	$ 0.68	$ 0.68	$ 0.66	$ 0.66
AY	001	$ 524	30	0.70	4,800	2	3	1	0.03	0.03	0.03	0.03	$ 17	$ 0.55	$ 0.55	$ 0.53	$ 0.53
AY	001	$ 524	65	0.70	8,800	2	3	1			0.03	0.03	$ 8	$ -	$ -	$ 0.24	$ 0.24
								SUM	1.00	1.00	1.00	1.00	$ 777	$24.03	$24.03	$23.55	$23.55

Table 87: Drive-Up Window Cost per Watt, continued

2019 LED									Weighted					Weighted Cost			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4		LZ1	LZ2	LZ3	LZ4
Wall Mounted																	
C	001	$ 409	16	0.95	696	0	4	0	0.05	0.05	0.05	0.05		$ 26	$ 1.20	$ 1.20	$ 1.20	$ 1.20
H	002	$ 639	14	0.70	846	0	4	0	0.05	0.05	0.05	0.05		$ 46	$ 2.07	$ 2.07	$ 2.07	$ 2.07
S	001	$ 147	26	0.70	823	1	0	0	0.05	0.05	0.05	0.05		$ 6	$ 0.25	$ 0.25	$ 0.25	$ 0.25
AH	001	$ 815	24	0.70	950	1	3	1	0.05	0.05	0.05	0.05		$ 34	$ 1.54	$ 1.54	$ 1.54	$ 1.54
C	001	$ 409	16	0.95	1,084	0	4	0	0.05	0.05	0.05	0.05		$ 26	$ 1.20	$ 1.20	$ 1.20	$ 1.20
S	002	$ 162	18	0.70	1,189	1	1	0	0.05	0.05	0.05	0.05		$ 9	$ 0.41	$ 0.41	$ 0.41	$ 0.41
C	001	$ 409	16	0.95	1,214	0	4	0	0.05	0.05	0.05	0.05		$ 26	$ 1.20	$ 1.20	$ 1.20	$ 1.20
H	001	$ 1,125	17	0.81	1,216	1	1	0	0.05	0.05	0.05	0.05		$ 66	$ 3.01	$ 3.01	$ 3.01	$ 3.01
AF	001	$ 809	40	0.70	1,290	1	1	1	0.05	0.05	0.05	0.05		$ 20	$ 0.91	$ 0.91	$ 0.91	$ 0.91
V	005	$ 381	13	0.91	1,415	0	0	1	0.05	0.05	0.05	0.05		$ 29	$ 1.33	$ 1.33	$ 1.33	$ 1.33
V	004	$ 408	12	0.90	1,494	0	0	0	0.05	0.05	0.05	0.05		$ 34	$ 1.55	$ 1.55	$ 1.55	$ 1.55
B	004	$ 1,719	88	0.70	3,003	1	3	0	0.05	0.05	0.05	0.05		$ 20	$ 0.89	$ 0.89	$ 0.89	$ 0.89
V	005	$ 381	19	0.91	1,957	1	0	1	0.05	0.05	0.05	0.05		$ 20	$ 0.91	$ 0.91	$ 0.91	$ 0.91
V	005	$ 381	19	0.91	2,031	1	0	1	0.05	0.05	0.05	0.05		$ 20	$ 0.91	$ 0.91	$ 0.91	$ 0.91
AE	001	$ 163	27	0.70	2,075	1	1	0	0.05	0.05	0.05	0.05		$ 6	$ 0.27	$ 0.27	$ 0.27	$ 0.27
AF	002	$ 368	20	0.70	2,054	1	1	1	0.05	0.05	0.05	0.05		$ 19	$ 0.85	$ 0.85	$ 0.85	$ 0.85
V	005	$ 381	26	0.91	2,623	1	0	1	0.05	0.05	0.05	0.05		$ 15	$ 0.67	$ 0.67	$ 0.67	$ 0.67
AG	001	$ 518	36	0.70	2,603	1	0	1	0.05	0.05	0.05	0.05		$ 14	$ 0.65	$ 0.65	$ 0.65	$ 0.65
V	004	$ 449	25	0.90	3,163	1	0	1	0.05	0.05	0.05	0.05		$ 18	$ 0.82	$ 0.82	$ 0.82	$ 0.82
V	005	$ 506	35	0.91	3,912	1	0	2	0.05	0.05	0.05	0.05		$ 14	$ 0.66	$ 0.66	$ 0.66	$ 0.66
V	004	$ 490	50	0.90	6,025	1	0	1	0.05	0.05	0.05	0.05		$ 10	$ 0.45	$ 0.45	$ 0.45	$ 0.45
B	004	$ 707	52	0.70	4,390	1	0	0	0.05	0.05	0.05	0.05		$ 14	$ 0.62	$ 0.62	$ 0.62	$ 0.62
								SUM	1.00	1.00	1.00	1.00		$ 492	$22.38	$22.38	$22.38	$22.38
									1	1	1	1			$20.40	$20.33	$20.19	$20.19

Table 88: Uncovered Fuel Dispenser Cost per Watt

2019 LED									Weighting					Weighted Cost			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4		LZ1	LZ2	LZ3	LZ4
Area																	
W	003	$ 1,061	51	0.84	5,229	3	0	2	0.50	0.20	0.11	0.09	$ 21	$10.40	$ 4.16	$ 2.31	$ 1.89
A	001	$ 1,450	95	0.84	7,312	2	0	2		0.20	0.11	0.09	$ 15	$ -	$ 3.05	$ 1.70	$ 1.39
A	001	$ 1,450	95	0.84	7,572	3	0	2		0.20	0.11	0.09	$ 15	$ -	$ 3.05	$ 1.70	$ 1.39
W	004	$ 1,063	96	0.89	10,231	3	0	2		0.20	0.11	0.09	$ 11	$ -	$ 2.21	$ 1.23	$ 1.01
C	009	$ 863	124	0.95	14,200	2	0	3			0.11	0.09	$ 7	$ -	$ -	$ 0.77	$ 0.63
V	002	$ 1,074	125	0.91	13,999	3	0	1	0.50	0.20	0.11	0.09	$ 9	$ 4.29	$ 1.72	$ 0.95	$ 0.78
C	008	$ 1,544	149	0.96	18,132	3	0	3			0.11	0.09	$ 10	$ -	$ -	$ 1.15	$ 0.94
W	005	$ 960	183	0.88	18,162	3	0	3			0.11	0.09	$ 5	$ -	$ -	$ 0.58	$ 0.48
V	002	$ 1,081	163	0.91	17,683	3	0	3			0.11	0.09	$ 7	$ -	$ -	$ 0.74	$ 0.60
C	009	$ 1,114	210	0.90	23,769	3	0	4				0.09	$ 5	$ -	$ -	$ -	$ 0.48
V	002	$ 1,159	241	0.91	24,870	3	0	4				0.09	$ 5	$ -	$ -	$ -	$ 0.44
C	009	$ 1,384	448	0.90	45,673	3	0	5					$ 3	$ -	$ -	$ -	$ -
V	003	$ 1,603	448	0.91	45,686	4	0	5					$ 4	$ -	$ -	$ -	$ -
								SUM	1.00	1.00	1.00	1.00		$14.69	$14.20	$11.13	$10.03
Flood																	
AT	001	$ 571	70	0.93	7,389				0.33	0.25	0.17	0.13	$ 8	$ 2.72	$ 2.04	$ 1.36	$ 1.02
AL	001	$ 256	64	0.87	9,275				0.33	0.25	0.17	0.13	$ 4	$ 1.33	$ 1.00	$ 0.67	$ 0.50
AT	002	$ 953	90	0.92	10,699					0.25	0.17	0.13	$ 11	$ -	$ 2.65	$ 1.77	$ 1.32
C	007	$ 1,305	99	0.70	11,100				0.33	0.25	0.17	0.13	$ 13	$ 4.40	$ 3.30	$ 2.20	$ 1.65
AT	002	$ 1,017	135	0.92	13,709						0.17	0.13	$ 8	$ -	$ -	$ 1.26	$ 0.94
AT	002	$ 1,079	175	0.92	17,615						0.17	0.13	$ 6	$ -	$ -	$ 1.03	$ 0.77
W	001	$ 1,039	213	0.96	20,138							0.13	$ 5	$ -	$ -	$ -	$ 0.61
V	001	$ 690	244	0.96	28,237							0.13	$ 3	$ -	$ -	$ -	$ 0.35
								SUM	1.00	1.00	1.00	1.00		$ 8.45	$ 8.98	$ 8.27	$ 7.17
Wall Mounted																	
V	005	$ 506	35	0.91	3,912	1	0	2	0.25	0.17	0.14	0.14	$ 14	$ 3.61	$ 2.41	$ 2.06	$ 2.06
V	004	$ 490	50	0.90	6,025	1	0	1	0.25	0.17	0.14	0.14	$ 10	$ 2.45	$ 1.63	$ 1.40	$ 1.40
W	007	$ -	52	0.99	6,076	1	0	2	0.25	0.17	0.14	0.14	$-	$ -	$ -	$ -	$ -
V	004	$ 490	50	0.90	6,025	1	0	1	0.25	0.17	0.14	0.14	$ 10	$ 2.45	$ 1.63	$ 1.40	$ 1.40
V	005	$ 506	73	0.91	6,865	1	0	2		0.17	0.14	0.14	$ 7	$ -	$ 1.15	$ 0.99	$ 0.99
W	004	$ 1,027	76	0.70	8,051	3	0	3			0.14	0.14	$ 14	$ -	$ -	$ 1.93	$ 1.93
W	004	$ 1,107	101	0.70	12,064	2	0	2		0.17	0.14	0.14	$ 11	$ -	$ 1.83	$ 1.57	$ 1.57
								SUM	1.00	1.00	1.00	1.00		$ 8.51	$ 8.66	$ 9.35	$ 9.35
									1.00	1.00	1.00	1.00		$10.55	$10.61	$ 9.59	$ 8.85

Table 89: ATM Machine Lighting Cost per Watt

2019 LED									Weighting				Weighted Cost per Watt			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4	LZ1	LZ2	LZ3	LZ4
Cylindrical - Wall Mounted up/down																
C	003	$ 619	10	0.87	838	2	5	0	0.09	0.09	0.09	0.09	$ 62	$ 5.63	$ 5.63	$ 5.63
M	001	$ 950	8	0.70	900	1	1	0	0.09	0.09	0.09	0.09	$ 119	$ 10.79	$ 10.79	$ 10.79
AO	001	$ 349	13	0.70	931	1	1	0	0.09	0.09	0.09	0.09	$ 27	$ 2.44	$ 2.44	$ 2.44
H	003	$ 434	21	0.81	1,047	1	4	0	0.09	0.09	0.09	0.09	$ 21	$ 1.88	$ 1.88	$ 1.88
AN	001	$ -	24	0.70	1,333	1	3	2	0.09	0.09	0.09	0.09	$ -	$ -	$ -	$ -
F	001	$ 1,056	34	0.70	2,212	2	5	0	0.09	0.09	0.09	0.09	$ 31	$ 2.82	$ 2.82	$ 2.82
C	003	$ 862	29	0.70	2,319	2	5	0	0.09	0.09	0.09	0.09	$ 30	$ 2.75	$ 2.75	$ 2.75
F	001	$ 1,067	42	0.70	3,288	3	5	0	0.09	0.09	0.09	0.09	$ 25	$ 2.31	$ 2.31	$ 2.31
BA	001	$ -	34	0.70	3,800				0.09	0.09	0.09	0.09	$ -	$ -	$ -	$ -
F	001	$ 1,352	57	0.70	4,607	3	5	0	0.09	0.09	0.09	0.09	$ 24	$ 2.16	$ 2.16	$ 2.16
AF	004	$ 1,214	76	0.70	4,884	1	5	1	0.09	0.09	0.09	0.09	$ 16	$ 1.46	$ 1.46	$ 1.46
								SUM	1.00	1.00	1.00	1.00	$ 355	$ 32.24	$ 32.24	$ 32.24
Downlight																
J	001	$ 561	10	0.70	647	1	0	0	0.04	0.04	0.04	0.04	$ 56	$ 2.44	$ 2.25	$ 2.25
K	001	$ 220	13	0.70	780	1	1	0	0.04	0.04	0.04	0.04	$ 17	$ 0.74	$ 0.68	$ 0.68
J	001	$ 561	14	0.70	884	1	0	0	0.04	0.04	0.04	0.04	$ 40	$ 1.74	$ 1.60	$ 1.60
P	001	$ 208	14	0.89	1,066	1	1	0	0.04	0.04	0.04	0.04	$ 15	$ 0.65	$ 0.60	$ 0.60
K	001	$ 286	22	0.70	1,170	2	1	0	0.04	0.04	0.04	0.04	$ 13	$ 0.57	$ 0.52	$ 0.52
K	001	$ 272	22	0.70	1,426	2	1	0	0.04	0.04	0.04	0.04	$ 12	$ 0.54	$ 0.49	$ 0.49
K	002	$ 236	19	0.70	1,461	2	0	0	0.04	0.04	0.04	0.04	$ 13	$ 0.56	$ 0.51	$ 0.51
K	002	$ 236	23	0.70	1,860	2	0	0	0.04	0.04	0.04	0.04	$ 10	$ 0.44	$ 0.41	$ 0.41
P	001	$ 237	36	0.89	1,995	2	1	0	0.04	0.04	0.04	0.04	$ 7	$ 0.29	$ 0.26	$ 0.26
C	005	$ 94	21	0.70	1,914	2	0	0	0.04	0.04	0.04	0.04	$ 4	$ 0.19	$ 0.18	$ 0.18
P	001	$ 237	35	0.89	2,130	2	1	0	0.04	0.04	0.04	0.04	$ 7	$ 0.29	$ 0.27	$ 0.27
C	005	$ 112	28	0.70	2,203	2	0	0	0.04	0.04	0.04	0.04	$ 4	$ 0.18	$ 0.16	$ 0.16
K	002	$ 251	30	0.70	2,521	2	0	0	0.04	0.04	0.04	0.04	$ 9	$ 0.37	$ 0.34	$ 0.34
P	001	$ 257	41	0.89	2,621	3	1	0	0.04	0.04	0.04	0.04	$ 6	$ 0.28	$ 0.25	$ 0.25
K	002	$ 266	37	0.70	2,917	3	0	0	0.04	0.04	0.04	0.04	$ 7	$ 0.32	$ 0.29	$ 0.29
K	002	$ 310	48	0.70	3,029	3	0	0	0.04	0.04	0.04	0.04	$ 6	$ 0.28	$ 0.26	$ 0.26
P	001	$ 256	44	0.89	3,184	3	1	0	0.04	0.04	0.04	0.04	$ 6	$ 0.25	$ 0.23	$ 0.23
C	005	$ 112	42	0.70	3,300	3	0	0	0.04	0.04	0.04	0.04	$ 3	$ 0.12	$ 0.11	$ 0.11
K	002	$ 295	48	0.70	3,839	3	0	0	0.04	0.04	0.04	0.04	$ 6	$ 0.27	$ 0.25	$ 0.25
K	002	$ 310	47	0.70	4,234	3	0	0	0.04	0.04	0.04	0.04	$ 7	$ 0.29	$ 0.26	$ 0.26
K	002	$ 324	49	0.70	4,982	3	0	0	0.04	0.04	0.04	0.04	$ 7	$ 0.29	$ 0.27	$ 0.27
K	002	$ 427	75	0.70	6,168	3	0	0	0.04	0.04	0.04	0.04	$ 6	$ 0.25	$ 0.23	$ 0.23
AR	002	$ 585	57	0.70	5,716	3	1	1	0.04	0.04	0.04	0.04	$ 10	$ 0.45	$ 0.41	$ 0.41
C	005	$ 175	115	0.70	7,816	4	0	0		0.04	0.04	0.04	$ 2	$ -	$ 0.06	$ 0.06
K	002	$ 530	115	0.70	11,296	3	0	0		0.04	0.04	0.04	$ 5	$ -	$ 0.18	$ 0.18
								SUM	1.00	1.00	1.00	1.00	$ 277	$ 11.77	$ 11.07	$ 11.07
Recessed Linear																
AB	002	$ 424	18	0.70	1,371	1	0	1	0.03	0.03	0.03	0.03	$ 24	$ 0.76	$ 0.76	$ 0.74
AB	002	$ 424	38	0.70	2,560	1	0	1	0.03	0.03	0.03	0.03	$ 11	$ 0.36	$ 0.36	$ 0.35
AB	001	$ 151	39	0.70	3,088	1	0	1	0.03	0.03	0.03	0.03	$ 4	$ 0.13	$ 0.13	$ 0.12
AV	001	$ 549	30	0.95	2,068	1	0	1	0.03	0.03	0.03	0.03	$ 19	$ 0.60	$ 0.60	$ 0.58
AV	001	$ 549	39	0.95	2,756	1	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.45	$ 0.45	$ 0.44
AV	001	$ 549	24	0.95	3,444	1	0	1	0.03	0.03	0.03	0.03	$ 23	$ 0.73	$ 0.73	$ 0.70
AW	001	$ 610	22	0.70	2,000	1	0	1	0.03	0.03	0.03	0.03	$ 28	$ 0.89	$ 0.89	$ 0.87
AW	001	$ 610	33	0.70	3,000	1	0	1	0.03	0.03	0.03	0.03	$ 18	$ 0.59	$ 0.59	$ 0.57
AW	001	$ 610	44	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.44	$ 0.44	$ 0.43
Y	001	$ 631	14	0.70	1,056	1	0	1	0.03	0.03	0.03	0.03	$ 44	$ 1.41	$ 1.41	$ 1.37
Y	001	$ 631	18	0.70	1,328	1	0	1	0.03	0.03	0.03	0.03	$ 34	$ 1.11	$ 1.11	$ 1.07
Y	001	$ 631	28	0.70	2,004	1	0	1	0.03	0.03	0.03	0.03	$ 22	$ 0.72	$ 0.72	$ 0.69
Y	001	$ 631	37	0.70	2,580	1	0	1	0.03	0.03	0.03	0.03	$ 17	$ 0.55	$ 0.55	$ 0.54
AA	001	$ 440	42	0.70	2,050	1	1	0	0.03	0.03	0.03	0.03	$ 11	$ 0.34	$ 0.34	$ 0.33
AZ	001	$ 329	12	0.70	580	0	1	0	0.03	0.03	0.03	0.03	$ 27	$ 0.86	$ 0.86	$ 0.83
AZ	001	$ 376	30	0.70	1,520	0	1	0	0.03	0.03	0.03	0.03	$ 12	$ 0.40	$ 0.40	$ 0.39
Z	002	$ 574	23	0.70	2,000	1	0	1	0.03	0.03	0.03	0.03	$ 25	$ 0.81	$ 0.81	$ 0.78
Z	002	$ 574	36	0.70	3,000	1	0	1	0.03	0.03	0.03	0.03	$ 16	$ 0.52	$ 0.52	$ 0.51
Z	002	$ 574	49	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 12	$ 0.38	$ 0.38	$ 0.37
Z	001	$ 599	31	0.70	2,914	1	0	1	0.03	0.03	0.03	0.03	$ 19	$ 0.63	$ 0.63	$ 0.61
BE	001	$ 160	10	0.70	1,236	0	1	0	0.03	0.03	0.03	0.03	$ 17	$ 0.54	$ 0.54	$ 0.52
BE	001	$ 245	18	0.70	1,696	0	1	0	0.03	0.03	0.03	0.03	$ 14	$ 0.45	$ 0.45	$ 0.43
BE	001	$ 329	26	0.70	2,308	0	1	0	0.03	0.03	0.03	0.03	$ 12	$ 0.40	$ 0.40	$ 0.39
AX	001	$ 589	19	0.70	1,008	1	2	1	0.03	0.03	0.03	0.03	$ 31	$ 1.01	$ 1.01	$ 0.98
AX	001	$ 589	35	0.70	1,876	1	2	1	0.03	0.03	0.03	0.03	$ 17	$ 0.55	$ 0.55	$ 0.53
AY	001	$ 574	8	0.70	1,400	1	2	1	0.03	0.03	0.03	0.03	$ 72	$ 2.31	$ 2.31	$ 2.24
AY	001	$ 574	12	0.70	2,200	1	2	1	0.03	0.03	0.03	0.03	$ 49	$ 1.60	$ 1.60	$ 1.55
AY	001	$ 574	19	0.70	3,200	1	3	1	0.03	0.03	0.03	0.03	$ 30	$ 0.96	$ 0.96	$ 0.93
AY	001	$ 574	24	0.70	4,000	1	3	1	0.03	0.03	0.03	0.03	$ 24	$ 0.77	$ 0.77	$ 0.75
AY	001	$ 574	30	0.70	4,800	2	3	1	0.03	0.03	0.03	0.03	$ 19	$ 0.62	$ 0.62	$ 0.60
AY	001	$ 574	65	0.70	8,800	2	3	1			0.03	0.03	$ 9	$ -	$ -	$ 0.28
Z	001	$ 599	42	0.70	3,885	2	2	1	0.03	0.03	0.03	0.03	$ 14	$ 0.46	$ 0.46	$ 0.44
								SUM	1.00	1.00	1.00	1.00	$ 701	$ 22.34	$ 22.34	$ 21.91

Table 90: ATM Machine Lighting Cost per Watt, continued

2019 LED									Weighting					Weighted Cost per Watt			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4		LZ1	LZ2	LZ3	LZ4
Surface Mounted Downlight																	
AC	001	$ 99	20	0.70	1,813	1	0	1	0.13	0.13	0.11	0.11		$ 5	$ 0.61	$ 0.61	$ 0.54	$ 0.54
BB	001	$ 793	19	0.70	1,509	1	0	0	0.13	0.13	0.11	0.11		$ 42	$ 5.22	$ 5.22	$ 4.64	$ 4.64
Q	002	$ 61	14	0.70	1,081	1	1	0	0.13	0.13	0.11	0.11		$ 5	$ 0.57	$ 0.57	$ 0.50	$ 0.50
T	001	$ 272	24	0.70	3,055	2	3	2	0.13	0.13	0.11	0.11		$ 11	$ 1.40	$ 1.40	$ 1.24	$ 1.24
C	006	$ 363	28	0.70	3,293	1	0	1	0.13	0.13	0.11	0.11		$ 13	$ 1.62	$ 1.62	$ 1.44	$ 1.44
AL	002	$ 455	31	0.70	4,210	2	2	1	0.13	0.13	0.11	0.11		$ 15	$ 1.84	$ 1.84	$ 1.63	$ 1.63
T	001	$ 296	38	0.70	4,443	2	3	2	0.13	0.13	0.11	0.11		$ 8	$ 0.97	$ 0.97	$ 0.86	$ 0.86
C	006	$ 398	45	0.70	4,949	3	0	2	0.13	0.13	0.11	0.11		$ 9	$ 1.11	$ 1.11	$ 0.98	$ 0.98
T	001	$ 465	55	0.70	6,959	2	3	2			0.11	0.11		$ 9	$ -	$ -	$ 0.95	$ 0.95
								SUM	1.00	1.00	1.00	1.00		$ 115	$ 13.33	$ 13.33	$ 12.79	$ 12.79
Surface Mounted Linear																	
AB	002	$ 524	18	0.70	1,663	1	0	1	0.03	0.03	0.03	0.03		$ 29	$ 0.91	$ 0.91	$ 0.88	$ 0.88
AB	002	$ 524	38	0.70	3,111	2	0	1	0.03	0.03	0.03	0.03		$ 14	$ 0.43	$ 0.43	$ 0.42	$ 0.42
AB	003	$ 930	38	0.70	1,539	1	1	1	0.03	0.03	0.03	0.03		$ 24	$ 0.76	$ 0.76	$ 0.73	$ 0.73
AV	001	$ 549	30	0.95	2,068	1	0	1	0.03	0.03	0.03	0.03		$ 19	$ 0.58	$ 0.58	$ 0.56	$ 0.56
AV	001	$ 549	39	0.95	2,756	1	0	1	0.03	0.03	0.03	0.03		$ 14	$ 0.44	$ 0.44	$ 0.42	$ 0.42
AV	001	$ 579	24	0.95	3,444	1	0	1	0.03	0.03	0.03	0.03		$ 24	$ 0.74	$ 0.74	$ 0.72	$ 0.72
AW	001	$ 639	22	0.70	2,000	1	0	1	0.03	0.03	0.03	0.03		$ 29	$ 0.91	$ 0.91	$ 0.88	$ 0.88
AW	001	$ 639	33	0.70	3,000	1	0	1	0.03	0.03	0.03	0.03		$ 19	$ 0.60	$ 0.60	$ 0.58	$ 0.58
AW	001	$ 639	44	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03		$ 14	$ 0.45	$ 0.45	$ 0.44	$ 0.44
BC	001	$ 524	16	0.70	1,560	2	0	1	0.03	0.03	0.03	0.03		$ 33	$ 1.02	$ 1.02	$ 0.99	$ 0.99
BC	001	$ 524	32	0.70	3,100	2	0	1	0.03	0.03	0.03	0.03		$ 16	$ 0.51	$ 0.51	$ 0.50	$ 0.50
BC	001	$ 524	41	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03		$ 13	$ 0.40	$ 0.40	$ 0.39	$ 0.39
Y	001	$ 569	14	0.70	1,056	1	0	1	0.03	0.03	0.03	0.03		$ 40	$ 1.23	$ 1.23	$ 1.20	$ 1.20
Y	001	$ 569	18	0.70	1,328	1	0	1	0.03	0.03	0.03	0.03		$ 31	$ 0.97	$ 0.97	$ 0.94	$ 0.94
Y	001	$ 569	28	0.70	2,004	1	0	1	0.03	0.03	0.03	0.03		$ 20	$ 0.63	$ 0.63	$ 0.61	$ 0.61
Y	001	$ 569	37	0.70	2,580	1	0	1	0.03	0.03	0.03	0.03		$ 15	$ 0.48	$ 0.48	$ 0.47	$ 0.47
AZ	001	$ 405	12	0.70	560	0	1	0	0.03	0.03	0.03	0.03		$ 34	$ 1.06	$ 1.06	$ 1.02	$ 1.02
AZ	001	$ 470	30	0.70	1,680	1	1	1	0.03	0.03	0.03	0.03		$ 15	$ 0.48	$ 0.48	$ 0.47	$ 0.47
AZ	001	$ 529	30	0.70	2,480	1	1	1	0.03	0.03	0.03	0.03		$ 17	$ 0.54	$ 0.54	$ 0.53	$ 0.53
Z	002	$ 624	17	0.70	2,000	1	0	1	0.03	0.03	0.03	0.03		$ 38	$ 1.18	$ 1.18	$ 1.15	$ 1.15
Z	002	$ 624	26	0.70	3,000	1	0	1	0.03	0.03	0.03	0.03		$ 24	$ 0.76	$ 0.76	$ 0.74	$ 0.74
Z	002	$ 624	35	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03		$ 18	$ 0.56	$ 0.56	$ 0.54	$ 0.54
BE	001	$ 160	10	0.70	1,236	0	1	0	0.03	0.03	0.03	0.03		$ 17	$ 0.52	$ 0.52	$ 0.50	$ 0.50
BE	001	$ 245	18	0.70	1,696	0	1	0	0.03	0.03	0.03	0.03		$ 14	$ 0.43	$ 0.43	$ 0.42	$ 0.42
BE	001	$ 329	26	0.70	2,308	0	1	0	0.03	0.03	0.03	0.03		$ 12	$ 0.39	$ 0.39	$ 0.38	$ 0.38
AX	001	$ 589	19	0.70	1,008	0	2	1	0.03	0.03	0.03	0.03		$ 31	$ 0.98	$ 0.98	$ 0.95	$ 0.95
AX	001	$ 589	35	0.70	1,876	1	2	1	0.03	0.03	0.03	0.03		$ 17	$ 0.53	$ 0.53	$ 0.51	$ 0.51
AY	001	$ 524	8	0.70	1,400	1	2	1	0.03	0.03	0.03	0.03		$ 66	$ 2.05	$ 2.05	$ 1.99	$ 1.99
AY	001	$ 524	12	0.70	2,200	1	2	1	0.03	0.03	0.03	0.03		$ 45	$ 1.41	$ 1.41	$ 1.37	$ 1.37
AY	001	$ 524	19	0.70	3,200	1	3	1	0.03	0.03	0.03	0.03		$ 27	$ 0.85	$ 0.85	$ 0.83	$ 0.83
AY	001	$ 524	24	0.70	4,000	1	3	1	0.03	0.03	0.03	0.03		$ 22	$ 0.68	$ 0.68	$ 0.66	$ 0.66
AY	001	$ 524	30	0.70	4,800	2	3	1	0.03	0.03	0.03	0.03		$ 17	$ 0.55	$ 0.55	$ 0.53	$ 0.53
AY	001	$ 524	65	0.70	8,800	2	3	1			0.03	0.03		$ 8	$ -	$ -	$ 0.24	$ 0.24
								SUM	1.00	1.00	1.00	1.00		$ 777	$ 24.03	$ 24.03	$ 23.55	$ 23.55
Wall Mounted																	
C	001	$ 409	16	0.95	696	0	4	0	0.04	0.04	0.04	0.04		$ 26	$ 1.15	$ 1.15	$ 1.15	$ 1.15
H	002	$ 639	14	0.70	846	0	4	0	0.04	0.04	0.04	0.04		$ 46	$ 1.98	$ 1.98	$ 1.98	$ 1.98
S	001	$ 147	26	0.70	823	1	0	0	0.04	0.04	0.04	0.04		$ 6	$ 0.24	$ 0.24	$ 0.24	$ 0.24
AH	001	$ 815	24	0.70	950	1	3	1	0.04	0.04	0.04	0.04		$ 34	$ 1.48	$ 1.48	$ 1.48	$ 1.48
C	001	$ 409	16	0.95	1,084	0	4	0	0.04	0.04	0.04	0.04		$ 26	$ 1.15	$ 1.15	$ 1.15	$ 1.15
S	002	$ 162	18	0.70	1,189	1	1	0	0.04	0.04	0.04	0.04		$ 9	$ 0.39	$ 0.39	$ 0.39	$ 0.39
C	001	$ 409	16	0.95	1,214	0	4	0	0.04	0.04	0.04	0.04		$ 26	$ 1.15	$ 1.15	$ 1.15	$ 1.15
H	001	$ 1,125	17	0.81	1,216	1	1	0	0.04	0.04	0.04	0.04		$ 66	$ 2.88	$ 2.88	$ 2.88	$ 2.88
AF	001	$ 809	40	0.70	1,290	1	1	1	0.04	0.04	0.04	0.04		$ 20	$ 0.87	$ 0.87	$ 0.87	$ 0.87
V	005	$ 381	13	0.91	1,415	0	0	1	0.04	0.04	0.04	0.04		$ 29	$ 1.28	$ 1.28	$ 1.28	$ 1.28
V	004	$ 408	12	0.90	1,494	0	0	0	0.04	0.04	0.04	0.04		$ 34	$ 1.48	$ 1.48	$ 1.48	$ 1.48
B	004	$ 1,719	88	0.70	3,003	1	3	0	0.04	0.04	0.04	0.04		$ 20	$ 0.85	$ 0.85	$ 0.85	$ 0.85
V	005	$ 381	19	0.91	1,957	1	0	1	0.04	0.04	0.04	0.04		$ 20	$ 0.87	$ 0.87	$ 0.87	$ 0.87
V	005	$ 381	19	0.91	2,031	1	0	1	0.04	0.04	0.04	0.04		$ 20	$ 0.87	$ 0.87	$ 0.87	$ 0.87
AE	001	$ 163	27	0.70	2,075	1	1	0	0.04	0.04	0.04	0.04		$ 6	$ 0.26	$ 0.26	$ 0.26	$ 0.26
AF	002	$ 368	20	0.70	2,054	1	1	1	0.04	0.04	0.04	0.04		$ 19	$ 0.82	$ 0.82	$ 0.82	$ 0.82
V	005	$ 381	26	0.91	2,623	1	0	1	0.04	0.04	0.04	0.04		$ 15	$ 0.64	$ 0.64	$ 0.64	$ 0.64
AG	001	$ 518	36	0.70	2,603	1	0	1	0.04	0.04	0.04	0.04		$ 14	$ 0.63	$ 0.63	$ 0.63	$ 0.63
V	004	$ 449	25	0.90	3,163	1	0	1	0.04	0.04	0.04	0.04		$ 18	$ 0.78	$ 0.78	$ 0.78	$ 0.78
V	005	$ 506	35	0.91	3,912	1	0	2	0.04	0.04	0.04	0.04		$ 14	$ 0.63	$ 0.63	$ 0.63	$ 0.63
V	004	$ 490	50	0.90	6,025	1	0	1	0.04	0.04	0.04	0.04		$ 10	$ 0.43	$ 0.43	$ 0.43	$ 0.43
B	004	$ 707	52	0.70	4,390	1	0	0	0.04	0.04	0.04	0.04		$ 14	$ 0.59	$ 0.59	$ 0.59	$ 0.59
V	004	$ 490	50	0.90	6,025	1	0	1	0.04	0.04	0.04	0.04		$ 10	$ 0.43	$ 0.43	$ 0.43	$ 0.43
								SUM	1.00	1.00	1.00	1.00		$ 502	$ 21.84	$ 21.84	$ 21.84	$ 21.84
									1	1	1	1		$ 20.92	$ 20.81	$ 20.57	$ 20.57

Table 91: Outdoor Sales Frontage Cost per Watt

2019 LED									Weighting				Weighted Cost per Watt				
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4		LZ1	LZ2	LZ3	LZ4
Area																	
W	003	$ 1,061	51	0.84	5,229	3	0	2	0.50	0.20	0.11	0.09	$ 21	$10.40	$ 4.16	$ 2.31	$ 1.89
A	001	$ 1,450	95	0.84	7,312	2	0	2		0.20	0.11	0.09	$ 15	$ -	$ 3.05	$ 1.70	$ 1.39
A	001	$ 1,450	95	0.84	7,572	3	0	2		0.20	0.11	0.09	$ 15	$ -	$ 3.05	$ 1.70	$ 1.39
W	004	$ 1,063	96	0.89	10,231	3	0	2		0.20	0.11	0.09	$ 11	$ -	$ 2.21	$ 1.23	$ 1.01
C	009	$ 863	124	0.95	14,200	2	0	3			0.11	0.09	$ 7	$ -	$ -	$ 0.77	$ 0.63
V	002	$ 1,074	125	0.91	13,999	3	0	1	0.50	0.20	0.11	0.09	$ 9	$ 4.29	$ 1.72	$ 0.95	$ 0.78
C	008	$ 1,544	149	0.96	18,132	3	0	3			0.11	0.09	$ 10	$ -	$ -	$ 1.15	$ 0.94
W	005	$ 960	183	0.88	18,162	3	0	3			0.11	0.09	$ 5	$ -	$ -	$ 0.58	$ 0.48
V	002	$ 1,081	163	0.91	17,683	3	0	3			0.11	0.09	$ 7	$ -	$ -	$ 0.74	$ 0.60
C	009	$ 1,114	210	0.90	23,769	3	0	4				0.09	$ 5	$ -	$ -	$ -	$ 0.48
V	002	$ 1,159	241	0.91	24,870	3	0	4				0.09	$ 5	$ -	$ -	$ -	$ 0.44
C	009	$ 1,384	448	0.90	45,673	3	0	5					$ 3	$ -	$ -	$ -	$ -
V	003	$ 1,603	448	0.91	45,686	4	0	5					$ 4	$ -	$ -	$ -	$ -
								SUM	1.00	1.00	1.00	1.00		$14.69	$14.20	$11.13	$10.03
Flood																	
AT	001	$ 571	70	0.93	7,389	-	-	-		1.00	0.25	0.13	$ 8	$ -	$ 8.16	$ 2.04	$ 1.02
AL	001	$ 256	64	0.87	9,275	-	-	-			0.25	0.13	$ 4	$ -	$ -	$ 1.00	$ 0.50
AT	002	$ 953	90	0.92	10,699	-	-	-			0.25	0.13	$ 11	$ -	$ -	$ 2.65	$ 1.32
C	007	$ 1,305	99	0.70	11,100	-	-	-			0.25	0.13	$ 13	$ -	$ -	$ 3.30	$ 1.65
AT	002	$ 1,017	135	0.92	13,709	-	-	-				0.13	$ 8	$ -	$ -	$ -	$ 0.94
AT	002	$ 1,079	175	0.92	17,615	-	-	-				0.13	$ 6	$ -	$ -	$ -	$ 0.77
W	001	$ 1,039	213	0.96	20,138	-	-	-				0.13	$ 5	$ -	$ -	$ -	$ 0.61
V	001	$ 690	244	0.96	28,237	-	-	-				0.13	$ 3	$ -	$ -	$ -	$ 0.35
								SUM	0.00	1.00	1.00	1.00		$ -	$ 8.16	$ 8.98	$ 7.17
									0.50	1.00	1.00	1.00		$ 7.35	$11.18	$10.06	$ 8.60

Table 92: Hardscape Ornamental Lighting Cost per Watt

2019 LED									Weighting				Weighted Cost per Watt				
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4		LZ1	LZ2	LZ3	LZ4
Area																	
N	001	$ 22	1	0.70	90	0	1	0	0.05	0.04	0.04	0.04	$ 23	$ 1.09	$ 0.96	$ 0.96	$ 0.96
R	001	$ 45	1	0.70	42	0	3	1	0.05	0.04	0.04	0.04	$ 45	$ 2.14	$ 1.87	$ 1.87	$ 1.87
R	001	$ 45	3	0.70	256	0	3	1	0.05	0.04	0.04	0.04	$ 15	$ 0.71	$ 0.62	$ 0.62	$ 0.62
O	001	$ 806	13	0.70	925	1	0	0	0.05	0.04	0.04	0.04	$ 61	$ 2.89	$ 2.52	$ 2.52	$ 2.52
B	002	$ 1,381	25	0.93	1,170	1	2	1	0.05	0.04	0.04	0.04	$ 55	$ 2.63	$ 2.30	$ 2.30	$ 2.30
B	002	$ 1,381	25	0.93	1,216	1	1	1	0.05	0.04	0.04	0.04	$ 55	$ 2.63	$ 2.30	$ 2.30	$ 2.30
B	002	$ 1,381	25	0.93	1,735	1	0	1	0.05	0.04	0.04	0.04	$ 55	$ 2.63	$ 2.30	$ 2.30	$ 2.30
A	002	$ 1,553	21	0.83	2,051	1	0	1	0.05	0.04	0.04	0.04	$ 74	$ 3.52	$ 3.08	$ 3.08	$ 3.08
A	002	$ 1,553	21	0.83	2,189	1	0	1	0.05	0.04	0.04	0.04	$ 74	$ 3.52	$ 3.08	$ 3.08	$ 3.08
A	002	$ 1,553	21	0.83	2,114	1	0	1	0.05	0.04	0.04	0.04	$ 74	$ 3.52	$ 3.08	$ 3.08	$ 3.08
A	002	$ 1,553	30	0.83	2,760	1	0	1	0.05	0.04	0.04	0.04	$ 52	$ 2.47	$ 2.16	$ 2.16	$ 2.16
B	002	$ 1,381	25	0.93	1,830	1	0	1	0.05	0.04	0.04	0.04	$ 55	$ 2.63	$ 2.30	$ 2.30	$ 2.30
W	002	$ 1,970	22	0.84	2,117	1	0	1	0.05	0.04	0.04	0.04	$ 90	$ 4.26	$ 3.73	$ 3.73	$ 3.73
BD	001	$ 1,434	36	0.92	2,221	1	0	1	0.05	0.04	0.04	0.04	$ 40	$ 1.90	$ 1.66	$ 1.66	$ 1.66
W	003	$ 1,071	30	0.84	3,126	1	0	1	0.05	0.04	0.04	0.04	$ 36	$ 1.70	$ 1.49	$ 1.49	$ 1.49
BD	001	$ 1,434	52	0.92	3,178	1	0	1	0.05	0.04	0.04	0.04	$ 28	$ 1.31	$ 1.15	$ 1.15	$ 1.15
AF	003	$ 1,776	48	0.70	4,247	1	0	1	0.05	0.04	0.04	0.04	$ 37	$ 1.76	$ 1.54	$ 1.54	$ 1.54
A	001	$ 1,379	22	0.84	1,888	1	0	1	0.05	0.04	0.04	0.04	$ 63	$ 2.98	$ 2.61	$ 2.61	$ 2.61
A	001	$ 1,379	51	0.84	4,431	2	0	2	0.05	0.04	0.04	0.04	$ 27	$ 1.29	$ 1.13	$ 1.13	$ 1.13
A	001	$ 1,379	51	0.84	4,348	1	0	1	0.05	0.04	0.04	0.04	$ 27	$ 1.29	$ 1.13	$ 1.13	$ 1.13
W	003	$ 1,061	51	0.84	5,229	3	0	2	0.05	0.04	0.04	0.04	$ 21	$ 0.99	$ 0.87	$ 0.87	$ 0.87
A	001	$ 1,450	95	0.84	7,312	2	0	2		0.04	0.04	0.04	$ 15	$ -	$ 0.64	$ 0.64	$ 0.64
A	001	$ 1,450	95	0.84	7,572	3	0	2		0.04	0.04	0.04	$ 15	$ -	$ 0.64	$ 0.64	$ 0.64
W	004	$ 1,063	96	0.89	10,231	3	0	2		0.04	0.04	0.04	$ 11	$ -	$ 0.46	$ 0.46	$ 0.46
								SUM	1.00	1.00	1.00	1.00		$47.87	$43.62	$43.62	$43.62
									1.00	1.00	1.00	1.00		$47.87	$43.62	$43.62	$43.62

Table 93: Building Facades Cost per Watt

2019 LED									Weighting					Weighted Cost per Watt			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4		LZ1	LZ2	LZ3	LZ4
Cylindrical - Wall Mounted up/down																	
C	003	$ 619	10	0.87	838	2	5	0	0.10	0.10	0.10	0.10	$ 62	$ 6.19	$ 6.19	$ 6.19	$ 6.19
M	001	$ 950	8	0.70	900	1	1	0	0.10	0.10	0.10	0.10	$ 119	$11.87	$11.87	$11.87	$11.87
AO	001	$ 349	13	0.70	931	1	1	0	0.10	0.10	0.10	0.10	$ 27	$ 2.69	$ 2.69	$ 2.69	$ 2.69
H	003	$ 434	21	0.81	1,047	1	4	0	0.10	0.10	0.10	0.10	$ 21	$ 2.07	$ 2.07	$ 2.07	$ 2.07
AN	001	$ -	24	0.70	1,333	1	3	2	0.10	0.10	0.10	0.10	$ -	$ -	$ -	$ -	$ -
F	001	$ 1,056	34	0.70	2,212	2	5	0	0.10	0.10	0.10	0.10	$ 31	$ 3.10	$ 3.10	$ 3.10	$ 3.10
C	003	$ 862	29	0.70	2,319	2	5	0	0.10	0.10	0.10	0.10	$ 30	$ 3.02	$ 3.02	$ 3.02	$ 3.02
F	001	$ 1,067	42	0.70	3,288	3	5	0	0.10	0.10	0.10	0.10	$ 25	$ 2.54	$ 2.54	$ 2.54	$ 2.54
BA	001	$ -	34	0.70	3,800	na	na	na	0.10	0.10	0.10	0.10	$ -	$ -	$ -	$ -	$ -
F	001	$ 1,352	57	0.70	4,607	3	5	0	0.10	0.10	0.10	0.10	$ 24	$ 2.37	$ 2.37	$ 2.37	$ 2.37
AF	004	$ 1,214	76	0.70	4,884	1	5	1	0.10	0.10	0.10	0.10	$ 16	$ 1.61	$ 1.61	$ 1.61	$ 1.61
								SUM	1.00	1.00	1.00	1.00		$33.86	$33.86	$33.86	$33.86
Ground Mounted Floodlight																	
U	001	$ 3,053	104	0.70	5,833	-	-	-	0.50	0.33	0.25	0.17	$ 29	$14.68	$ 9.79	$ 7.34	$ 4.89
AS	001	$ 2,302	60	0.70	4,088	-	-	-	0.50	0.33	0.25	0.17	$ 38	$19.18	$12.79	$ 9.59	$ 6.39
U	001	$ 2,760	156	0.70	10,602	-	-	-			0.25	0.17	$ 18	$ -	$ -	$ 4.42	$ 2.95
AM	001	$ 2,307	150	0.70	8,899	-	-	-		0.33	0.25	0.17	$ 15	$ -	$ 5.13	$ 3.85	$ 2.56
AD	001	$ 3,917	200	0.70	12,163	-	-	-				0.17	$ 20	$ -	$ -	$ -	$ 3.26
AU	001	$ 4,198	122	0.70	14,040	-	-	-				0.17	$ 34	$ -	$ -	$ -	$ 5.74
								SUM	1.00	1.00	1.00	1.00		$33.86	$27.70	$25.20	$25.79
Wall Mounted																	
C	001	$ 409	16	0.95	696	0	4	0	0.04	0.04	0.04	0.04	$ 26	$ 1.15	$ 1.10	$ 1.10	$ 1.10
H	002	$ 639	14	0.70	846	0	4	0	0.04	0.04	0.04	0.04	$ 46	$ 1.98	$ 1.90	$ 1.90	$ 1.90
S	001	$ 147	26	0.70	823	1	0	0	0.04	0.04	0.04	0.04	$ 6	$ 0.24	$ 0.23	$ 0.23	$ 0.23
AH	001	$ 815	24	0.70	950	1	3	1	0.04	0.04	0.04	0.04	$ 34	$ 1.48	$ 1.41	$ 1.41	$ 1.41
C	001	$ 409	16	0.95	1,084	0	4	0	0.04	0.04	0.04	0.04	$ 26	$ 1.15	$ 1.10	$ 1.10	$ 1.10
S	002	$ 162	18	0.70	1,189	1	1	0	0.04	0.04	0.04	0.04	$ 9	$ 0.39	$ 0.38	$ 0.38	$ 0.38
C	001	$ 409	16	0.95	1,214	0	4	0	0.04	0.04	0.04	0.04	$ 26	$ 1.15	$ 1.10	$ 1.10	$ 1.10
H	001	$ 1,125	17	0.81	1,216	1	1	0	0.04	0.04	0.04	0.04	$ 66	$ 2.88	$ 2.76	$ 2.76	$ 2.76
AF	001	$ 809	40	0.70	1,290	1	1	1	0.04	0.04	0.04	0.04	$ 20	$ 0.87	$ 0.83	$ 0.83	$ 0.83
V	005	$ 381	13	0.91	1,415	0	0	1	0.04	0.04	0.04	0.04	$ 29	$ 1.28	$ 1.22	$ 1.22	$ 1.22
V	004	$ 408	12	0.90	1,494	0	0	0	0.04	0.04	0.04	0.04	$ 34	$ 1.48	$ 1.42	$ 1.42	$ 1.42
B	004	$ 1,719	88	0.70	3,003	1	3	0	0.04	0.04	0.04	0.04	$ 20	$ 0.85	$ 0.82	$ 0.82	$ 0.82
V	005	$ 381	19	0.91	1,957	1	0	1	0.04	0.04	0.04	0.04	$ 20	$ 0.87	$ 0.84	$ 0.84	$ 0.84
V	005	$ 381	19	0.91	2,031	1	0	1	0.04	0.04	0.04	0.04	$ 20	$ 0.87	$ 0.84	$ 0.84	$ 0.84
AE	001	$ 163	27	0.70	2,075	1	1	0	0.04	0.04	0.04	0.04	$ 6	$ 0.26	$ 0.25	$ 0.25	$ 0.25
AF	002	$ 368	20	0.70	2,054	1	1	1	0.04	0.04	0.04	0.04	$ 19	$ 0.82	$ 0.78	$ 0.78	$ 0.78
V	005	$ 381	26	0.91	2,623	1	0	1	0.04	0.04	0.04	0.04	$ 15	$ 0.64	$ 0.61	$ 0.61	$ 0.61
AG	001	$ 518	36	0.70	2,603	1	0	1	0.04	0.04	0.04	0.04	$ 14	$ 0.63	$ 0.60	$ 0.60	$ 0.60
V	004	$ 449	25	0.90	3,163	1	0	1	0.04	0.04	0.04	0.04	$ 18	$ 0.78	$ 0.75	$ 0.75	$ 0.75
V	005	$ 506	35	0.91	3,912	1	0	2	0.04	0.04	0.04	0.04	$ 14	$ 0.63	$ 0.60	$ 0.60	$ 0.60
V	004	$ 490	50	0.90	6,025	1	0	1	0.04	0.04	0.04	0.04	$ 10	$ 0.43	$ 0.41	$ 0.41	$ 0.41
B	004	$ 707	52	0.70	4,390	1	0	0	0.04	0.04	0.04	0.04	$ 14	$ 0.59	$ 0.57	$ 0.57	$ 0.57
V	004	$ 490	50	0.90	6,025	1	0	1	0.04	0.04	0.04	0.04	$ 10	$ 0.43	$ 0.41	$ 0.41	$ 0.41
V	005	$ 506	73	0.91	6,865	1	0	2		0.04	0.04	0.04	$ 7	$ -	$ 0.29	$ 0.29	$ 0.29
								SUM	1.00	1.00	1.00	1.00		$ 1.00	$ 2.00	$ 3.00	$ 4.00
									1.00	1.00	1.00	1.00		$22.91	$21.19	$20.69	$21.22

Table 94: Outdoor Sales Lots Cost per Watt

2019 LED									Weighting					Weighted Cost per Watt			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4		LZ1	LZ2	LZ3	LZ4
Area																	
W	003	$ 1,061	51	0.84	5,229	3	0	2	0.06	0.06	0.05	0.05	$ 21	$ 1.30	$ 1.22	$ 1.09	$ 0.95
A	001	$ 1,450	95	0.84	7,312	2	0	2	0.06	0.06	0.05	0.05	$ 15	$ 0.95	$ 0.90	$ 0.80	$ 0.69
A	001	$ 1,450	95	0.84	7,572	3	0	2	0.06	0.06	0.05	0.05	$ 15	$ 0.95	$ 0.90	$ 0.80	$ 0.69
W	004	$ 1,063	96	0.89	10,231	3	0	2	0.06	0.06	0.05	0.05	$ 11	$ 0.69	$ 0.65	$ 0.58	$ 0.50
C	009	$ 863	124	0.95	14,200	2	0	3	0.06	0.06	0.05	0.05	$ 7	$ 0.44	$ 0.41	$ 0.37	$ 0.32
V	002	$ 1,074	125	0.91	13,999	3	0	1	0.06	0.06	0.05	0.05	$ 9	$ 0.54	$ 0.51	$ 0.45	$ 0.39
C	008	$ 1,544	149	0.96	18,132	3	0	3	0.06	0.06	0.05	0.05	$ 10	$ 0.65	$ 0.61	$ 0.55	$ 0.47
W	005	$ 960	183	0.88	18,162	3	0	3	0.06	0.06	0.05	0.05	$ 5	$ 0.33	$ 0.31	$ 0.28	$ 0.24
V	002	$ 1,081	163	0.91	17,683	3	0	3	0.06	0.06	0.05	0.05	$ 7	$ 0.41	$ 0.39	$ 0.35	$ 0.30
C	009	$ 1,114	210	0.90	23,769	3	0	4	0.06	0.06	0.05	0.05	$ 5	$ 0.33	$ 0.31	$ 0.28	$ 0.24
V	002	$ 1,159	241	0.91	24,870	3	0	4	0.06	0.06	0.05	0.05	$ 5	$ 0.30	$ 0.28	$ 0.25	$ 0.22
C	009	$ 1,384	448	0.90	45,673	3	0	5	0.06	0.06	0.05	0.05	$ 3	$ 0.19	$ 0.18	$ 0.16	$ 0.14
V	003	$ 1,603	448	0.91	45,686	4	0	5	0.06	0.06	0.05	0.05	$ 4	$ 0.22	$ 0.21	$ 0.19	$ 0.16
								SUM	0.81	0.76	0.68	0.59		$ 7.31	$ 6.88	$ 6.16	$ 5.32
Flood																	
AT	001	$ 571	70	0.93	7,389	na	na	na	0.06	0.06	0.05	0.05	$ 8	$ 0.51	$ 0.48	$ 0.43	$ 0.37
AL	001	$ 256	64	0.87	9,275	na	na	na	0.06	0.06	0.05	0.05	$ 4	$ 0.25	$ 0.24	$ 0.21	$ 0.18
AT	002	$ 953	90	0.92	10,699	na	na	na	0.06	0.06	0.05	0.05	$ 11	$ 0.66	$ 0.62	$ 0.56	$ 0.48
C	007	$ 1,305	99	0.70	11,100	na	na	na	0.06	0.06	0.05	0.05	$ 13	$ 0.82	$ 0.78	$ 0.69	$ 0.60
AT	002	$ 1,017	135	0.92	13,709	na	na	na	0.06	0.06	0.05	0.05	$ 8	$ 0.47	$ 0.44	$ 0.40	$ 0.34
AT	002	$ 1,079	175	0.92	17,615	na	na	na	0.06	0.06	0.05	0.05	$ 6	$ 0.39	$ 0.36	$ 0.32	$ 0.28
W	001	$ 1,039	213	0.96	20,138	na	na	na	0.06	0.06	0.05	0.05	$ 5	$ 0.30	$ 0.29	$ 0.26	$ 0.22
V	001	$ 690	244	0.96	28,237	na	na	na	0.06	0.06	0.05	0.05	$ 3	$ 0.18	$ 0.17	$ 0.15	$ 0.13
								SUM	0.50	0.47	0.42	0.36		$ 3.58	$ 3.37	$ 3.02	$ 2.61
Wall Mounted																	
V	005	$ 506	35	0.91	3,912	1	0	2	0.06	0.06	0.05	0.05	$ 14	$ 0.90	$ 0.85	$ 0.76	$ 0.66
V	004	$ 490	50	0.90	6,025	1	0	1	0.06	0.06	0.05	0.05	$ 10	$ 0.61	$ 0.58	$ 0.52	$ 0.45
W	007	$ -	52	0.99	6,076	1	0	2	0.06	0.06	0.05	0.05	$ -	$ -	$ -	$ -	$ -
V	004	$ 490	50	0.90	6,025	1	0	1	0.06	0.06	0.05	0.05	$ 10	$ 0.61	$ 0.58	$ 0.52	$ 0.45
V	005	$ 506	73	0.91	6,865	1	0	2	0.06	0.06	0.05	0.05	$ 7	$ 0.43	$ 0.41	$ 0.36	$ 0.31
W	004	$ 1,027	76	0.70	8,051	3	0	3	0.06	0.06	0.05	0.05	$ 14	$ 0.84	$ 0.79	$ 0.71	$ 0.61
W	004	$ 1,107	101	0.70	12,064	2	0	2	0.06	0.06	0.05	0.05	$ 11	$ 0.68	$ 0.64	$ 0.58	$ 0.50
								SUM	0.44	0.41	0.37	0.32		$ 4.09	$ 3.85	$ 3.44	$ 2.98
									0.58	0.55	0.49	0.42		$ 5.00	$ 4.70	$ 4.21	$ 3.63

Table 95: Vehicle Service Station Hardscape Cost per Watt

2019 LED									Weighting				Weighted Cost per Watt				
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4		LZ1	LZ2	LZ3	LZ4
Area																	
W	003	$ 1,061	51	0.84	5,229	3	0	2	0.50	0.20	0.11	0.09	$ 21	$ 10.40	$ 4.16	$ 2.31	$ 1.89
A	001	$ 1,450	95	0.84	7,312	2	0	2		0.20	0.11	0.09	$ 15	$ -	$ 3.05	$ 1.70	$ 1.39
A	001	$ 1,450	95	0.84	7,572	3	0	2		0.20	0.11	0.09	$ 15	$ -	$ 3.05	$ 1.70	$ 1.39
W	004	$ 1,063	96	0.89	10,231	3	0	2		0.20	0.11	0.09	$ 11	$ -	$ 2.21	$ 1.23	$ 1.01
C	009	$ 863	124	0.95	14,200	2	0	3			0.11	0.09	$ 7	$ -	$ -	$ 0.77	$ 0.63
V	002	$ 1,074	125	0.91	13,999	3	0	1	0.50	0.20	0.11	0.09	$ 9	$ 4.29	$ 1.72	$ 0.95	$ 0.78
C	008	$ 1,544	149	0.96	18,132	3	0	3			0.11	0.09	$ 10	$ -	$ -	$ 1.15	$ 0.94
W	005	$ 960	183	0.88	18,162	3	0	3			0.11	0.09	$ 5	$ -	$ -	$ 0.58	$ 0.48
V	002	$ 1,081	163	0.91	17,683	3	0	3			0.11	0.09	$ 7	$ -	$ -	$ 0.74	$ 0.60
C	009	$ 1,114	210	0.90	23,769	3	0	4				0.09	$ 5	$ -	$ -	$ -	$ 0.48
V	002	$ 1,159	241	0.91	24,870	3	0	4				0.09	$ 5	$ -	$ -	$ -	$ 0.44
								SUM	1.00	1.00	1.00	1.00		$ 14.69	$14.20	$11.13	$10.03
Ground Mounted Floodlight																	
AT	001	$ 571	70	0.93	7,389	na	na	na		1.00	0.25	0.13	$ 8	$ -	$ 8.16	$ 2.04	$ 1.02
AL	001	$ 256	64	0.87	9,275	na	na	na			0.25	0.13	$ 4	$ -	$ -	$ 1.00	$ 0.50
AT	002	$ 953	90	0.92	10,699	na	na	na			0.25	0.13	$ 11	$ -	$ -	$ 2.65	$ 1.32
C	007	$ 1,305	99	0.70	11,100	na	na	na			0.25	0.13	$ 13	$ -	$ -	$ 3.30	$ 1.65
AT	002	$ 1,017	135	0.92	13,709	na	na	na				0.13	$ 8	$ -	$ -	$ -	$ 0.94
AT	002	$ 1,079	175	0.92	17,615	na	na	na				0.13	$ 6	$ -	$ -	$ -	$ 0.77
W	001	$ 1,039	213	0.96	20,138	na	na	na				0.13	$ 5	$ -	$ -	$ -	$ 0.61
V	001	$ 690	244	0.96	28,237	na	na	na				0.13	$ 3	$ -	$ -	$ -	$ 0.35
								SUM	0.00	1.00	1.00	1.00		$ -	$ 8.16	$ 8.98	$ 7.17
Wall Mounted																	
V	005	$ 381	19	0.91	2,031	1	0	1	0.10	0.08	0.08	0.08	$ 20	$ 2.01	$ 1.67	$ 1.54	$ 1.54
AE	001	$ 163	27	0.70	2,075	1	1	0	0.10	0.08	0.08	0.08	$ 6	$ 0.60	$ 0.50	$ 0.46	$ 0.46
AF	002	$ 368	20	0.70	2,054	1	1	1	0.10	0.08	0.08	0.08	$ 19	$ 1.88	$ 1.56	$ 1.44	$ 1.44
V	005	$ 381	26	0.91	2,623	1	0	1	0.10	0.08	0.08	0.08	$ 15	$ 1.47	$ 1.22	$ 1.13	$ 1.13
AG	001	$ 518	36	0.70	2,603	1	0	1	0.10	0.08	0.08	0.08	$ 14	$ 1.44	$ 1.20	$ 1.11	$ 1.11
V	004	$ 449	25	0.90	3,163	1	0	1	0.10	0.08	0.08	0.08	$ 18	$ 1.80	$ 1.50	$ 1.38	$ 1.38
V	005	$ 506	35	0.91	3,912	1	0	2	0.10	0.08	0.08	0.08	$ 14	$ 1.44	$ 1.20	$ 1.11	$ 1.11
V	004	$ 490	50	0.90	6,025	1	0	1	0.10	0.08	0.08	0.08	$ 10	$ 0.98	$ 0.82	$ 0.75	$ 0.75
B	004	$ 707	52	0.70	4,390	1	0	0	0.10	0.08	0.08	0.08	$ 14	$ 1.36	$ 1.13	$ 1.05	$ 1.05
V	004	$ 490	50	0.90	6,025	1	0	1	0.10	0.08	0.08	0.08	$ 10	$ 0.98	$ 0.82	$ 0.75	$ 0.75
V	005	$ 506	73	0.91	6,865	1	0	2		0.08	0.08	0.08	$ 7	$ -	$ 0.58	$ 0.53	$ 0.53
W	004	$ 1,027	76	0.70	8,051	3	0	3			0.08	0.08	$ 14	$ -	$ -	$ 1.04	$ 1.04
W	004	$ 1,107	101	0.70	12,064	2	0	2		0.08	0.08	0.08	$ 11	$ -	$ 0.91	$ 0.84	$ 0.84
								SUM	1.00	1.00	1.00	1.00		$ 13.96	$13.12	$13.15	$13.15
									0.67	1.00	1.00	1.00		$ 9.55	$11.83	$11.09	$10.12

Table 96: Vehicle Service Station Canopies Cost per Watt

2019 LED									Weighting				Weighted Cost per Watt			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4	LZ1	LZ2	LZ3	LZ4
Downlight																
K	002	$ 236	23	0.70	1,860	2	0	0	0.06	0.06	0.06	0.06	$ 10	$ 0.60	$ 0.57	$ 0.57	$ 0.57
P	001	$ 237	36	0.89	1,995	2	1	0	0.06	0.06	0.06	0.06	$ 7	$ 0.39	$ 0.37	$ 0.37	$ 0.37
C	005	$ 94	21	0.70	1,914	2	0	0	0.06	0.06	0.06	0.06	$ 4	$ 0.26	$ 0.25	$ 0.25	$ 0.25
P	001	$ 237	35	0.89	2,130	2	1	0	0.06	0.06	0.06	0.06	$ 7	$ 0.40	$ 0.37	$ 0.37	$ 0.37
C	005	$ 112	28	0.70	2,203	2	0	0	0.06	0.06	0.06	0.06	$ 4	$ 0.24	$ 0.23	$ 0.23	$ 0.23
K	002	$ 251	30	0.70	2,521	2	0	0	0.06	0.06	0.06	0.06	$ 9	$ 0.50	$ 0.47	$ 0.47	$ 0.47
P	001	$ 257	41	0.89	2,621	3	1	0	0.06	0.06	0.06	0.06	$ 6	$ 0.37	$ 0.35	$ 0.35	$ 0.35
K	002	$ 266	37	0.70	2,917	3	0	0	0.06	0.06	0.06	0.06	$ 7	$ 0.43	$ 0.40	$ 0.40	$ 0.40
K	002	$ 310	48	0.70	3,029	3	0	0	0.06	0.06	0.06	0.06	$ 6	$ 0.38	$ 0.36	$ 0.36	$ 0.36
P	001	$ 256	44	0.89	3,184	3	1	0	0.06	0.06	0.06	0.06	$ 6	$ 0.34	$ 0.32	$ 0.32	$ 0.32
C	005	$ 112	42	0.70	3,300	3	0	0	0.06	0.06	0.06	0.06	$ 3	$ 0.16	$ 0.15	$ 0.15	$ 0.15
K	002	$ 295	48	0.70	3,839	3	0	0	0.06	0.06	0.06	0.06	$ 6	$ 0.36	$ 0.34	$ 0.34	$ 0.34
K	002	$ 310	47	0.70	4,234	3	0	0	0.06	0.06	0.06	0.06	$ 7	$ 0.39	$ 0.37	$ 0.37	$ 0.37
K	002	$ 324	49	0.70	4,982	3	0	0	0.06	0.06	0.06	0.06	$ 7	$ 0.39	$ 0.37	$ 0.37	$ 0.37
K	002	$ 427	75	0.70	6,168	3	0	0	0.06	0.06	0.06	0.06	$ 6	$ 0.34	$ 0.32	$ 0.32	$ 0.32
AR	002	$ 585	57	0.70	5,716	3	1	1	0.06	0.06	0.06	0.06	$ 10	$ 0.60	$ 0.57	$ 0.57	$ 0.57
C	005	$ 175	115	0.70	7,816	4	0	0	0.06	0.06	0.06	0.06	$ 2	$ 0.09	$ 0.08	$ 0.08	$ 0.08
K	002	$ 530	115	0.70	11,296	3	0	0		0.06	0.06	0.06	$ 5	$ -	$ 0.26	$ 0.26	$ 0.26
								SUM	1.00	1.00	1.00	1.00		$ 6.23	$ 6.14	$ 6.14	$ 6.14
Surface Mounted Downlight																
AC	001	$ 99	20	0.70	1,813	1	0	1	0.13	0.11	0.11	0.11	$ 5	$ 0.61	$ 0.54	$ 0.54	$ 0.54
BB	001	$ 793	19	0.70	1,509	1	0	0	0.13	0.11	0.11	0.11	$ 42	$ 5.22	$ 4.64	$ 4.64	$ 4.64
Q	002	$ 61	14	0.70	1,081	1	1	0	0.13	0.11	0.11	0.11	$ 5	$ 0.57	$ 0.50	$ 0.50	$ 0.50
T	001	$ 272	24	0.70	3,055	2	3	2	0.13	0.11	0.11	0.11	$ 11	$ 1.40	$ 1.24	$ 1.24	$ 1.24
C	006	$ 363	28	0.70	3,293	1	0	1	0.13	0.11	0.11	0.11	$ 13	$ 1.62	$ 1.44	$ 1.44	$ 1.44
AL	002	$ 455	31	0.70	4,210	2	2	1	0.13	0.11	0.11	0.11	$ 15	$ 1.84	$ 1.63	$ 1.63	$ 1.63
T	001	$ 296	38	0.70	4,443	2	3	2	0.13	0.11	0.11	0.11	$ 8	$ 0.97	$ 0.86	$ 0.86	$ 0.86
C	006	$ 398	45	0.70	4,949	3	0	2	0.13	0.11	0.11	0.11	$ 9	$ 1.11	$ 0.98	$ 0.98	$ 0.98
T	001	$ 465	55	0.70	6,959	2	3	2		0.11	0.11	0.11	$ 9	$ -	$ 0.95	$ 0.95	$ 0.95
								SUM	1.00	1.00	1.00	1.00		$13.33	$12.79	$12.79	$12.79
									0.56	0.56	0.56	0.56		$ 3.42	$ 3.34	$ 3.34	$ 3.34

Table 97: Sales Canopies Cost per Watt

2019 LED									Weighting				Weighted Cost per Watt				
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4		LZ1	LZ2	LZ3	LZ4
Downlight																	
J	001	$ 561	10	0.70	647	1	0	0	0.04	0.04	0.04	0.04	$ 56	$ 2.44	$ 2.25	$ 2.25	$ 2.25
K	001	$ 220	13	0.70	780	1	1	0	0.04	0.04	0.04	0.04	$ 17	$ 0.74	$ 0.68	$ 0.68	$ 0.68
J	001	$ 561	14	0.70	884	1	0	0	0.04	0.04	0.04	0.04	$ 40	$ 1.74	$ 1.60	$ 1.60	$ 1.60
P	001	$ 208	14	0.89	1,066	1	1	0	0.04	0.04	0.04	0.04	$ 15	$ 0.65	$ 0.60	$ 0.60	$ 0.60
K	001	$ 286	22	0.70	1,170	2	1	0	0.04	0.04	0.04	0.04	$ 13	$ 0.57	$ 0.52	$ 0.52	$ 0.52
K	001	$ 272	22	0.70	1,426	2	1	0	0.04	0.04	0.04	0.04	$ 12	$ 0.54	$ 0.49	$ 0.49	$ 0.49
K	002	$ 236	19	0.70	1,461	2	0	0	0.04	0.04	0.04	0.04	$ 13	$ 0.56	$ 0.51	$ 0.51	$ 0.51
K	002	$ 236	23	0.70	1,860	2	0	0	0.04	0.04	0.04	0.04	$ 10	$ 0.44	$ 0.41	$ 0.41	$ 0.41
P	001	$ 237	36	0.89	1,995	2	1	0	0.04	0.04	0.04	0.04	$ 7	$ 0.29	$ 0.26	$ 0.26	$ 0.26
C	005	$ 94	21	0.70	1,914	2	0	0	0.04	0.04	0.04	0.04	$ 4	$ 0.19	$ 0.18	$ 0.18	$ 0.18
P	001	$ 237	35	0.89	2,130	2	1	0	0.04	0.04	0.04	0.04	$ 7	$ 0.29	$ 0.27	$ 0.27	$ 0.27
C	005	$ 112	28	0.70	2,203	2	0	0	0.04	0.04	0.04	0.04	$ 4	$ 0.18	$ 0.16	$ 0.16	$ 0.16
K	002	$ 251	30	0.70	2,521	2	0	0	0.04	0.04	0.04	0.04	$ 9	$ 0.37	$ 0.34	$ 0.34	$ 0.34
P	001	$ 257	41	0.89	2,621	3	1	0	0.04	0.04	0.04	0.04	$ 6	$ 0.28	$ 0.25	$ 0.25	$ 0.25
K	002	$ 266	37	0.70	2,917	3	0	0	0.04	0.04	0.04	0.04	$ 7	$ 0.32	$ 0.29	$ 0.29	$ 0.29
K	002	$ 310	48	0.70	3,029	3	0	0	0.04	0.04	0.04	0.04	$ 6	$ 0.28	$ 0.26	$ 0.26	$ 0.26
P	001	$ 256	44	0.89	3,184	3	1	0	0.04	0.04	0.04	0.04	$ 6	$ 0.25	$ 0.23	$ 0.23	$ 0.23
C	005	$ 112	42	0.70	3,300	3	0	0	0.04	0.04	0.04	0.04	$ 3	$ 0.12	$ 0.11	$ 0.11	$ 0.11
K	002	$ 295	48	0.70	3,839	3	0	0	0.04	0.04	0.04	0.04	$ 6	$ 0.27	$ 0.25	$ 0.25	$ 0.25
K	002	$ 310	47	0.70	4,234	3	0	0	0.04	0.04	0.04	0.04	$ 7	$ 0.29	$ 0.26	$ 0.26	$ 0.26
K	002	$ 324	49	0.70	4,982	3	0	0	0.04	0.04	0.04	0.04	$ 7	$ 0.29	$ 0.27	$ 0.27	$ 0.27
K	002	$ 427	75	0.70	6,168	3	0	0	0.04	0.04	0.04	0.04	$ 6	$ 0.25	$ 0.23	$ 0.23	$ 0.23
AR	002	$ 585	57	0.70	5,716	3	1	1	0.04	0.04	0.04	0.04	$ 10	$ 0.45	$ 0.41	$ 0.41	$ 0.41
C	005	$ 175	115	0.70	7,816	4	0	0		0.04	0.04	0.04	$ 2	$ -	$ 0.06	$ 0.06	$ 0.06
K	002	$ 530	115	0.70	11,296	3	0	0		0.04	0.04	0.04	$ 5	$ -	$ 0.18	$ 0.18	$ 0.18
								SUM	1.00	1.00	1.00	1.00		$11.77	$11.07	$11.07	$11.07
Recessed Linear																	
AB	002	$ 424	18	0.70	1,371	1	0	1	0.03	0.03	0.03	0.03	$ 24	$ 0.76	$ 0.76	$ 0.74	$ 0.74
AB	002	$ 424	38	0.70	2,560	1	0	1	0.03	0.03	0.03	0.03	$ 11	$ 0.36	$ 0.36	$ 0.35	$ 0.35
AB	001	$ 151	39	0.70	3,088	1	0	1	0.03	0.03	0.03	0.03	$ 4	$ 0.13	$ 0.13	$ 0.12	$ 0.12
AV	001	$ 549	30	0.95	2,068	1	0	1	0.03	0.03	0.03	0.03	$ 19	$ 0.60	$ 0.60	$ 0.58	$ 0.58
AV	001	$ 549	39	0.95	2,756	1	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.45	$ 0.45	$ 0.44	$ 0.44
AV	001	$ 549	24	0.95	3,444	1	0	1	0.03	0.03	0.03	0.03	$ 23	$ 0.73	$ 0.73	$ 0.70	$ 0.70
AW	001	$ 610	22	0.70	2,000	1	0	1	0.03	0.03	0.03	0.03	$ 28	$ 0.89	$ 0.89	$ 0.87	$ 0.87
AW	001	$ 610	33	0.70	3,000	1	0	1	0.03	0.03	0.03	0.03	$ 18	$ 0.59	$ 0.59	$ 0.57	$ 0.57
AW	001	$ 610	44	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.44	$ 0.44	$ 0.43	$ 0.43
Y	001	$ 631	14	0.70	1,056	1	0	1	0.03	0.03	0.03	0.03	$ 44	$ 1.41	$ 1.41	$ 1.37	$ 1.37
Y	001	$ 631	18	0.70	1,328	1	0	1	0.03	0.03	0.03	0.03	$ 34	$ 1.11	$ 1.11	$ 1.07	$ 1.07
Y	001	$ 631	28	0.70	2,004	1	0	1	0.03	0.03	0.03	0.03	$ 22	$ 0.72	$ 0.72	$ 0.69	$ 0.69
Y	001	$ 631	37	0.70	2,580	1	0	1	0.03	0.03	0.03	0.03	$ 17	$ 0.55	$ 0.55	$ 0.54	$ 0.54
AA	001	$ 440	42	0.70	2,050	1	1	0	0.03	0.03	0.03	0.03	$ 11	$ 0.34	$ 0.34	$ 0.33	$ 0.33
AZ	001	$ 329	12	0.70	580	0	1	0	0.03	0.03	0.03	0.03	$ 27	$ 0.86	$ 0.86	$ 0.83	$ 0.83
AZ	001	$ 376	30	0.70	1,520	0	1	0	0.03	0.03	0.03	0.03	$ 12	$ 0.40	$ 0.40	$ 0.39	$ 0.39
Z	002	$ 574	23	0.70	2,000	1	0	1	0.03	0.03	0.03	0.03	$ 25	$ 0.81	$ 0.81	$ 0.78	$ 0.78
Z	002	$ 574	36	0.70	3,000	1	0	1	0.03	0.03	0.03	0.03	$ 16	$ 0.52	$ 0.52	$ 0.51	$ 0.51
Z	002	$ 574	49	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 12	$ 0.38	$ 0.38	$ 0.37	$ 0.37
Z	001	$ 599	31	0.70	2,914	1	0	1	0.03	0.03	0.03	0.03	$ 19	$ 0.63	$ 0.63	$ 0.61	$ 0.61
BE	001	$ 160	10	0.70	1,236	0	1	0	0.03	0.03	0.03	0.03	$ 17	$ 0.54	$ 0.54	$ 0.52	$ 0.52
BE	001	$ 245	18	0.70	1,696	0	1	0	0.03	0.03	0.03	0.03	$ 14	$ 0.45	$ 0.45	$ 0.43	$ 0.43
BE	001	$ 329	26	0.70	2,308	0	1	0	0.03	0.03	0.03	0.03	$ 12	$ 0.40	$ 0.40	$ 0.39	$ 0.39
AX	001	$ 589	19	0.70	1,008	1	2	1	0.03	0.03	0.03	0.03	$ 31	$ 1.01	$ 1.01	$ 0.98	$ 0.98
AX	001	$ 589	35	0.70	1,876	1	2	1	0.03	0.03	0.03	0.03	$ 17	$ 0.55	$ 0.55	$ 0.53	$ 0.53
AY	001	$ 574	8	0.70	1,400	1	2	1	0.03	0.03	0.03	0.03	$ 72	$ 2.31	$ 2.31	$ 2.24	$ 2.24
AY	001	$ 574	12	0.70	2,200	1	2	1	0.03	0.03	0.03	0.03	$ 49	$ 1.60	$ 1.60	$ 1.55	$ 1.55
AY	001	$ 574	19	0.70	3,200	1	3	1	0.03	0.03	0.03	0.03	$ 30	$ 0.96	$ 0.96	$ 0.93	$ 0.93
AY	001	$ 574	24	0.70	4,000	1	3	1	0.03	0.03	0.03	0.03	$ 24	$ 0.77	$ 0.77	$ 0.75	$ 0.75
AY	001	$ 574	30	0.70	4,800	2	3	1	0.03	0.03	0.03	0.03	$ 19	$ 0.62	$ 0.62	$ 0.60	$ 0.60
AY	001	$ 574	65	0.70	8,800	2	3	1			0.03	0.03	$ 9	$ -	$ -	$ 0.28	$ 0.28
Z	001	$ 599	42	0.70	3,885	2	2	1	0.03	0.03	0.03	0.03	$ 14	$ 0.46	$ 0.46	$ 0.44	$ 0.44
								SUM	1.00	1.00	1.00	1.00		$22.34	$22.34	$21.91	$21.91

Table 98: Sales Canopies Cost per Watt, continued

2019 LED									Weighting					Weighted Cost per Watt			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4		LZ1	LZ2	LZ3	LZ4
Surface Mounted Downlight																	
AC	001	$ 99	20	0.70	1,813	1	0	1	0.13	0.13	0.11	0.11	$ 5	$ 0.61	$ 0.61	$ 0.54	$ 0.54
BB	001	$ 793	19	0.70	1,509	1	0	0	0.13	0.13	0.11	0.11	$ 42	$ 5.22	$ 5.22	$ 4.64	$ 4.64
Q	002	$ 61	14	0.70	1,081	1	1	0	0.13	0.13	0.11	0.11	$ 5	$ 0.57	$ 0.57	$ 0.50	$ 0.50
T	001	$ 272	24	0.70	3,055	2	3	2	0.13	0.13	0.11	0.11	$ 11	$ 1.40	$ 1.40	$ 1.24	$ 1.24
C	006	$ 363	28	0.70	3,293	1	0	1	0.13	0.13	0.11	0.11	$ 13	$ 1.62	$ 1.62	$ 1.44	$ 1.44
AL	002	$ 455	31	0.70	4,210	2	2	1	0.13	0.13	0.11	0.11	$ 15	$ 1.84	$ 1.84	$ 1.63	$ 1.63
T	001	$ 296	38	0.70	4,443	2	3	2	0.13	0.13	0.11	0.11	$ 8	$ 0.97	$ 0.97	$ 0.86	$ 0.86
C	006	$ 398	45	0.70	4,949	3	0	2	0.13	0.13	0.11	0.11	$ 9	$ 1.11	$ 1.11	$ 0.98	$ 0.98
T	001	$ 465	55	0.70	6,959	2	3	2			0.11	0.11	$ 9	$ -	$ -	$ 0.95	$ 0.95
								SUM	1.00	1.00	1.00	1.00		$13.33	$13.33	$12.79	$12.79
Surface Mounted Linear																	
AB	002	$ 524	18	0.70	1,663	1	0	1	0.03	0.03	0.03	0.03	$ 29	$ 0.91	$ 0.91	$ 0.88	$ 0.88
AB	002	$ 524	38	0.70	3,111	2	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.43	$ 0.43	$ 0.42	$ 0.42
AB	003	$ 930	38	0.70	1,539	1	1	1	0.03	0.03	0.03	0.03	$ 24	$ 0.76	$ 0.76	$ 0.73	$ 0.73
AV	001	$ 549	30	0.95	2,068	1	0	1	0.03	0.03	0.03	0.03	$ 19	$ 0.58	$ 0.58	$ 0.56	$ 0.56
AV	001	$ 549	39	0.95	2,756	1	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.44	$ 0.44	$ 0.42	$ 0.42
AV	001	$ 579	24	0.95	3,444	1	0	1	0.03	0.03	0.03	0.03	$ 24	$ 0.74	$ 0.74	$ 0.72	$ 0.72
AW	001	$ 639	22	0.70	2,000	1	0	1	0.03	0.03	0.03	0.03	$ 29	$ 0.91	$ 0.91	$ 0.88	$ 0.88
AW	001	$ 639	33	0.70	3,000	1	0	1	0.03	0.03	0.03	0.03	$ 19	$ 0.60	$ 0.60	$ 0.58	$ 0.58
AW	001	$ 639	44	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.45	$ 0.45	$ 0.44	$ 0.44
BC	001	$ 524	16	0.70	1,560	2	0	1	0.03	0.03	0.03	0.03	$ 33	$ 1.02	$ 1.02	$ 0.99	$ 0.99
BC	001	$ 524	32	0.70	3,100	2	0	1	0.03	0.03	0.03	0.03	$ 16	$ 0.51	$ 0.51	$ 0.50	$ 0.50
BC	001	$ 524	41	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 13	$ 0.40	$ 0.40	$ 0.39	$ 0.39
Y	001	$ 569	14	0.70	1,056	1	0	1	0.03	0.03	0.03	0.03	$ 40	$ 1.23	$ 1.23	$ 1.20	$ 1.20
Y	001	$ 569	18	0.70	1,328	1	0	1	0.03	0.03	0.03	0.03	$ 31	$ 0.97	$ 0.97	$ 0.94	$ 0.94
Y	001	$ 569	28	0.70	2,004	1	0	1	0.03	0.03	0.03	0.03	$ 20	$ 0.63	$ 0.63	$ 0.61	$ 0.61
Y	001	$ 569	37	0.70	2,580	1	0	1	0.03	0.03	0.03	0.03	$ 15	$ 0.48	$ 0.48	$ 0.47	$ 0.47
AZ	001	$ 405	12	0.70	560	0	1	0	0.03	0.03	0.03	0.03	$ 34	$ 1.06	$ 1.06	$ 1.02	$ 1.02
AZ	001	$ 470	30	0.70	1,680	1	1	1	0.03	0.03	0.03	0.03	$ 15	$ 0.48	$ 0.48	$ 0.47	$ 0.47
AZ	001	$ 529	30	0.70	2,480	1	1	1	0.03	0.03	0.03	0.03	$ 17	$ 0.54	$ 0.54	$ 0.53	$ 0.53
Z	002	$ 624	17	0.70	2,000	1	0	1	0.03	0.03	0.03	0.03	$ 38	$ 1.18	$ 1.18	$ 1.15	$ 1.15
Z	002	$ 624	26	0.70	3,000	1	0	1	0.03	0.03	0.03	0.03	$ 24	$ 0.76	$ 0.76	$ 0.74	$ 0.74
Z	002	$ 624	35	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 18	$ 0.56	$ 0.56	$ 0.54	$ 0.54
BE	001	$ 160	10	0.70	1,236	0	1	0	0.03	0.03	0.03	0.03	$ 17	$ 0.52	$ 0.52	$ 0.50	$ 0.50
BE	001	$ 245	18	0.70	1,696	0	1	0	0.03	0.03	0.03	0.03	$ 14	$ 0.43	$ 0.43	$ 0.42	$ 0.42
BE	001	$ 329	26	0.70	2,308	0	1	0	0.03	0.03	0.03	0.03	$ 12	$ 0.39	$ 0.39	$ 0.38	$ 0.38
AX	001	$ 589	19	0.70	1,008	0	2	1	0.03	0.03	0.03	0.03	$ 31	$ 0.98	$ 0.98	$ 0.95	$ 0.95
AX	001	$ 589	35	0.70	1,876	1	2	1	0.03	0.03	0.03	0.03	$ 17	$ 0.53	$ 0.53	$ 0.51	$ 0.51
AY	001	$ 524	8	0.70	1,400	1	2	1	0.03	0.03	0.03	0.03	$ 66	$ 2.05	$ 2.05	$ 1.99	$ 1.99
AY	001	$ 524	12	0.70	2,200	1	2	1	0.03	0.03	0.03	0.03	$ 45	$ 1.41	$ 1.41	$ 1.37	$ 1.37
AY	001	$ 524	19	0.70	3,200	1	3	1	0.03	0.03	0.03	0.03	$ 27	$ 0.85	$ 0.85	$ 0.83	$ 0.83
AY	001	$ 524	24	0.70	4,000	1	3	1	0.03	0.03	0.03	0.03	$ 22	$ 0.68	$ 0.68	$ 0.66	$ 0.66
AY	001	$ 524	30	0.70	4,800	2	3	1	0.03	0.03	0.03	0.03	$ 17	$ 0.55	$ 0.55	$ 0.53	$ 0.53
AY	001	$ 524	65	0.70	8,800	2	3	1			0.03	0.03	$ 8	$ -	$ -	$ 0.24	$ 0.24
								SUM	1.00	1.00	1.00	1.00		$24.03	$24.03	$23.55	$23.55
Wall Mounted																	
C	001	$ 409	16	0.95	696	0	4	0	0.06	0.06	0.06	0.06	$ 26	$ 1.47	$ 1.47	$ 1.47	$ 1.47
H	002	$ 639	14	0.70	846	0	4	0	0.06	0.06	0.06	0.06	$ 46	$ 2.54	$ 2.54	$ 2.54	$ 2.54
S	001	$ 147	26	0.70	823	1	0	0	0.06	0.06	0.06	0.06	$ 6	$ 0.31	$ 0.31	$ 0.31	$ 0.31
AH	001	$ 815	24	0.70	950	1	3	1	0.06	0.06	0.06	0.06	$ 34	$ 1.89	$ 1.89	$ 1.89	$ 1.89
C	001	$ 409	16	0.95	1,084	0	4	0	0.06	0.06	0.06	0.06	$ 26	$ 1.47	$ 1.47	$ 1.47	$ 1.47
S	002	$ 162	18	0.70	1,189	1	1	0	0.06	0.06	0.06	0.06	$ 9	$ 0.50	$ 0.50	$ 0.50	$ 0.50
C	001	$ 409	16	0.95	1,214	0	4	0	0.06	0.06	0.06	0.06	$ 26	$ 1.47	$ 1.47	$ 1.47	$ 1.47
H	001	$ 1,125	17	0.81	1,216	1	1	0	0.06	0.06	0.06	0.06	$ 66	$ 3.68	$ 3.68	$ 3.68	$ 3.68
AF	001	$ 809	40	0.70	1,290	1	1	1	0.06	0.06	0.06	0.06	$ 20	$ 1.11	$ 1.11	$ 1.11	$ 1.11
V	005	$ 381	13	0.91	1,415	0	0	1	0.06	0.06	0.06	0.06	$ 29	$ 1.63	$ 1.63	$ 1.63	$ 1.63
V	004	$ 408	12	0.90	1,494	0	0	0	0.06	0.06	0.06	0.06	$ 34	$ 1.89	$ 1.89	$ 1.89	$ 1.89
B	004	$ 1,719	88	0.70	3,003	1	3	0	0.06	0.06	0.06	0.06	$ 20	$ 1.09	$ 1.09	$ 1.09	$ 1.09
V	005	$ 381	19	0.91	1,957	1	0	1	0.06	0.06	0.06	0.06	$ 20	$ 1.11	$ 1.11	$ 1.11	$ 1.11
V	005	$ 381	19	0.91	2,031	1	0	1	0.06	0.06	0.06	0.06	$ 20	$ 1.11	$ 1.11	$ 1.11	$ 1.11
AE	001	$ 163	27	0.70	2,075	1	1	0	0.06	0.06	0.06	0.06	$ 6	$ 0.34	$ 0.34	$ 0.34	$ 0.34
AF	002	$ 368	20	0.70	2,054	1	1	1	0.06	0.06	0.06	0.06	$ 19	$ 1.04	$ 1.04	$ 1.04	$ 1.04
V	004	$ 449	25	0.90	3,163	1	0	1	0.06	0.06	0.06	0.06	$ 18	$ 1.00	$ 1.00	$ 1.00	$ 1.00
V	004	$ 490	50	0.90	6,025	1	0	1	0.06	0.06	0.06	0.06	$ 10	$ 0.54	$ 0.54	$ 0.54	$ 0.54
								SUM	1.00	1.00	1.00	1.00		$24.18	$24.18	$24.18	$24.18
									1.00	1.00	1.00	1.00		$19.13	$18.99	$18.70	$18.70

Table 99: Non-sales Canopies and Tunnels Cost per Watt

2019 LED									Weighting				Weighted Cost per Watt			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4	LZ1	LZ2	LZ3	LZ4
Downlight																
J	001	$ 561	10	0.70	647	1	0	0	0.04	0.04	0.04	0.04	$ 56	$ 2.44	$ 2.25	$ 2.25	$ 2.25
K	001	$ 220	13	0.70	780	1	1	0	0.04	0.04	0.04	0.04	$ 17	$ 0.74	$ 0.68	$ 0.68	$ 0.68
J	001	$ 561	14	0.70	884	1	0	0	0.04	0.04	0.04	0.04	$ 40	$ 1.74	$ 1.60	$ 1.60	$ 1.60
P	001	$ 208	14	0.89	1,066	1	1	0	0.04	0.04	0.04	0.04	$ 15	$ 0.65	$ 0.60	$ 0.60	$ 0.60
K	001	$ 286	22	0.70	1,170	2	1	0	0.04	0.04	0.04	0.04	$ 13	$ 0.57	$ 0.52	$ 0.52	$ 0.52
K	001	$ 272	22	0.70	1,426	2	1	0	0.04	0.04	0.04	0.04	$ 12	$ 0.54	$ 0.49	$ 0.49	$ 0.49
K	002	$ 236	19	0.70	1,461	2	0	0	0.04	0.04	0.04	0.04	$ 13	$ 0.56	$ 0.51	$ 0.51	$ 0.51
K	002	$ 236	23	0.70	1,860	2	0	0	0.04	0.04	0.04	0.04	$ 10	$ 0.44	$ 0.41	$ 0.41	$ 0.41
P	001	$ 237	36	0.89	1,995	2	1	0	0.04	0.04	0.04	0.04	$ 7	$ 0.29	$ 0.26	$ 0.26	$ 0.26
C	005	$ 94	21	0.70	1,914	2	0	0	0.04	0.04	0.04	0.04	$ 4	$ 0.19	$ 0.18	$ 0.18	$ 0.18
P	001	$ 237	35	0.89	2,130	2	1	0	0.04	0.04	0.04	0.04	$ 7	$ 0.29	$ 0.27	$ 0.27	$ 0.27
C	005	$ 112	28	0.70	2,203	2	0	0	0.04	0.04	0.04	0.04	$ 4	$ 0.18	$ 0.16	$ 0.16	$ 0.16
K	002	$ 251	30	0.70	2,521	2	0	0	0.04	0.04	0.04	0.04	$ 9	$ 0.37	$ 0.34	$ 0.34	$ 0.34
P	001	$ 257	41	0.89	2,621	3	1	0	0.04	0.04	0.04	0.04	$ 6	$ 0.28	$ 0.25	$ 0.25	$ 0.25
K	002	$ 266	37	0.70	2,917	3	0	0	0.04	0.04	0.04	0.04	$ 7	$ 0.32	$ 0.29	$ 0.29	$ 0.29
K	002	$ 310	48	0.70	3,029	3	0	0	0.04	0.04	0.04	0.04	$ 6	$ 0.28	$ 0.26	$ 0.26	$ 0.26
P	001	$ 256	44	0.89	3,184	3	1	0	0.04	0.04	0.04	0.04	$ 6	$ 0.25	$ 0.23	$ 0.23	$ 0.23
C	005	$ 112	42	0.70	3,300	3	0	0	0.04	0.04	0.04	0.04	$ 3	$ 0.12	$ 0.11	$ 0.11	$ 0.11
K	002	$ 295	48	0.70	3,839	3	0	0	0.04	0.04	0.04	0.04	$ 6	$ 0.27	$ 0.25	$ 0.25	$ 0.25
K	002	$ 310	47	0.70	4,234	3	0	0	0.04	0.04	0.04	0.04	$ 7	$ 0.29	$ 0.26	$ 0.26	$ 0.26
K	002	$ 324	49	0.70	4,982	3	0	0	0.04	0.04	0.04	0.04	$ 7	$ 0.29	$ 0.27	$ 0.27	$ 0.27
K	002	$ 427	75	0.70	6,168	3	0	0	0.04	0.04	0.04	0.04	$ 6	$ 0.25	$ 0.23	$ 0.23	$ 0.23
AR	002	$ 585	57	0.70	5,716	3	1	1	0.04	0.04	0.04	0.04	$ 10	$ 0.45	$ 0.41	$ 0.41	$ 0.41
C	005	$ 175	115	0.70	7,816	4	0	0		0.04	0.04	0.04	$ 2	$ -	$ 0.06	$ 0.06	$ 0.06
K	002	$ 530	115	0.70	11,296	3	0	0		0.04	0.04	0.04	$ 5	$ -	$ 0.18	$ 0.18	$ 0.18
								SUM	1.00	1.00	1.00	1.00		$11.77	$11.07	$11.07	$11.07
Recessed Linear																
AB	002	$ 424	18	0.70	1,371	1	0	1	0.03	0.03	0.03	0.03	$ 24	$ 0.76	$ 0.76	$ 0.74	$ 0.74
AB	002	$ 424	38	0.70	2,560	1	0	1	0.03	0.03	0.03	0.03	$ 11	$ 0.36	$ 0.36	$ 0.35	$ 0.35
AB	001	$ 151	39	0.70	3,088	1	0	1	0.03	0.03	0.03	0.03	$ 4	$ 0.13	$ 0.13	$ 0.12	$ 0.12
AV	001	$ 549	30	0.95	2,068	1	0	1	0.03	0.03	0.03	0.03	$ 19	$ 0.60	$ 0.60	$ 0.58	$ 0.58
AV	001	$ 549	39	0.95	2,756	1	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.45	$ 0.45	$ 0.44	$ 0.44
AV	001	$ 549	24	0.95	3,444	1	0	1	0.03	0.03	0.03	0.03	$ 23	$ 0.73	$ 0.73	$ 0.70	$ 0.70
AW	001	$ 610	22	0.70	2,000	1	0	1	0.03	0.03	0.03	0.03	$ 28	$ 0.89	$ 0.89	$ 0.87	$ 0.87
AW	001	$ 610	33	0.70	3,000	1	0	1	0.03	0.03	0.03	0.03	$ 18	$ 0.59	$ 0.59	$ 0.57	$ 0.57
AW	001	$ 610	44	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.44	$ 0.44	$ 0.43	$ 0.43
Y	001	$ 631	14	0.70	1,056	1	0	1	0.03	0.03	0.03	0.03	$ 44	$ 1.41	$ 1.41	$ 1.37	$ 1.37
Y	001	$ 631	18	0.70	1,328	1	0	1	0.03	0.03	0.03	0.03	$ 34	$ 1.11	$ 1.11	$ 1.07	$ 1.07
Y	001	$ 631	28	0.70	2,004	1	0	1	0.03	0.03	0.03	0.03	$ 22	$ 0.72	$ 0.72	$ 0.69	$ 0.69
Y	001	$ 631	37	0.70	2,580	1	0	1	0.03	0.03	0.03	0.03	$ 17	$ 0.55	$ 0.55	$ 0.54	$ 0.54
AA	001	$ 440	42	0.70	2,050	1	1	0	0.03	0.03	0.03	0.03	$ 11	$ 0.34	$ 0.34	$ 0.33	$ 0.33
AZ	001	$ 329	12	0.70	580	0	1	0	0.03	0.03	0.03	0.03	$ 27	$ 0.86	$ 0.86	$ 0.83	$ 0.83
AZ	001	$ 376	30	0.70	1,520	0	1	0	0.03	0.03	0.03	0.03	$ 12	$ 0.40	$ 0.40	$ 0.39	$ 0.39
Z	002	$ 574	23	0.70	2,000	1	0	1	0.03	0.03	0.03	0.03	$ 25	$ 0.81	$ 0.81	$ 0.78	$ 0.78
Z	002	$ 574	36	0.70	3,000	1	0	1	0.03	0.03	0.03	0.03	$ 16	$ 0.52	$ 0.52	$ 0.51	$ 0.51
Z	002	$ 574	49	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 12	$ 0.38	$ 0.38	$ 0.37	$ 0.37
Z	001	$ 599	31	0.70	2,914	1	0	1	0.03	0.03	0.03	0.03	$ 19	$ 0.63	$ 0.63	$ 0.61	$ 0.61
BE	001	$ 160	10	0.70	1,236	0	1	0	0.03	0.03	0.03	0.03	$ 17	$ 0.54	$ 0.54	$ 0.52	$ 0.52
BE	001	$ 245	18	0.70	1,696	0	1	0	0.03	0.03	0.03	0.03	$ 14	$ 0.45	$ 0.45	$ 0.43	$ 0.43
BE	001	$ 329	26	0.70	2,308	0	1	0	0.03	0.03	0.03	0.03	$ 12	$ 0.40	$ 0.40	$ 0.39	$ 0.39
AX	001	$ 589	19	0.70	1,008	1	2	1	0.03	0.03	0.03	0.03	$ 31	$ 1.01	$ 1.01	$ 0.98	$ 0.98
AX	001	$ 589	35	0.70	1,876	1	2	1	0.03	0.03	0.03	0.03	$ 17	$ 0.55	$ 0.55	$ 0.53	$ 0.53
AY	001	$ 574	8	0.70	1,400	1	2	1	0.03	0.03	0.03	0.03	$ 72	$ 2.31	$ 2.31	$ 2.24	$ 2.24
AY	001	$ 574	12	0.70	2,200	1	2	1	0.03	0.03	0.03	0.03	$ 49	$ 1.60	$ 1.60	$ 1.55	$ 1.55
AY	001	$ 574	19	0.70	3,200	1	3	1	0.03	0.03	0.03	0.03	$ 30	$ 0.96	$ 0.96	$ 0.93	$ 0.93
AY	001	$ 574	24	0.70	4,000	1	3	1	0.03	0.03	0.03	0.03	$ 24	$ 0.77	$ 0.77	$ 0.75	$ 0.75
AY	001	$ 574	30	0.70	4,800	2	3	1	0.03	0.03	0.03	0.03	$ 19	$ 0.62	$ 0.62	$ 0.60	$ 0.60
AY	001	$ 574	65	0.70	8,800	2	3	1			0.03	0.03	$ 9	$ -	$ -	$ 0.28	$ 0.28
Z	001	$ 599	42	0.70	3,885	2	2	1	0.03	0.03	0.03	0.03	$ 14	$ 0.46	$ 0.46	$ 0.44	$ 0.44
								SUM	1.00	1.00	1.00	1.00		$22.34	$22.34	$21.91	$21.91

Table 100: Non-sales Canopies and Tunnels Cost per Watt, continued

2019 LED									Weighting					Weighted Cost per Watt			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4		LZ1	LZ2	LZ3	LZ4
Surface Mounted Downlight																	
AC	001	$ 99	20	0.70	1,813	1	0	1	0.13	0.13	0.11	0.11	$ 5	$ 0.61	$ 0.61	$ 0.54	$ 0.54
BB	001	$ 793	19	0.70	1,509	1	0	0	0.13	0.13	0.11	0.11	$ 42	$ 5.22	$ 5.22	$ 4.64	$ 4.64
Q	002	$ 61	14	0.70	1,081	1	1	0	0.13	0.13	0.11	0.11	$ 5	$ 0.57	$ 0.57	$ 0.50	$ 0.50
T	001	$ 272	24	0.70	3,055	2	3	2	0.13	0.13	0.11	0.11	$ 11	$ 1.40	$ 1.40	$ 1.24	$ 1.24
C	006	$ 363	28	0.70	3,293	1	0	1	0.13	0.13	0.11	0.11	$ 13	$ 1.62	$ 1.62	$ 1.44	$ 1.44
AL	002	$ 455	31	0.70	4,210	2	2	1	0.13	0.13	0.11	0.11	$ 15	$ 1.84	$ 1.84	$ 1.63	$ 1.63
T	001	$ 296	38	0.70	4,443	2	3	2	0.13	0.13	0.11	0.11	$ 8	$ 0.97	$ 0.97	$ 0.86	$ 0.86
C	006	$ 398	45	0.70	4,949	3	0	2	0.13	0.13	0.11	0.11	$ 9	$ 1.11	$ 1.11	$ 0.98	$ 0.98
T	001	$ 465	55	0.70	6,959	2	3	2			0.11	0.11	$ 9	$ -	$ -	$ 0.95	$ 0.95
								SUM	1.00	1.00	1.00	1.00		$13.33	$13.33	$12.79	$12.79
Surface Mounted Linear																	
AB	002	$ 524	18	0.70	1,663	1	0	1	0.03	0.03	0.03	0.03	$ 29	$ 0.91	$ 0.91	$ 0.88	$ 0.88
AB	002	$ 524	38	0.70	3,111	2	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.43	$ 0.43	$ 0.42	$ 0.42
AB	003	$ 930	38	0.70	1,539	1	1	1	0.03	0.03	0.03	0.03	$ 24	$ 0.76	$ 0.76	$ 0.73	$ 0.73
AV	001	$ 549	30	0.95	2,068	1	0	1	0.03	0.03	0.03	0.03	$ 19	$ 0.58	$ 0.58	$ 0.56	$ 0.56
AV	001	$ 549	39	0.95	2,756	1	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.44	$ 0.44	$ 0.42	$ 0.42
AV	001	$ 579	24	0.95	3,444	1	0	1	0.03	0.03	0.03	0.03	$ 24	$ 0.74	$ 0.74	$ 0.72	$ 0.72
AW	001	$ 639	22	0.70	2,000	1	0	1	0.03	0.03	0.03	0.03	$ 29	$ 0.91	$ 0.91	$ 0.88	$ 0.88
AW	001	$ 639	33	0.70	3,000	1	0	1	0.03	0.03	0.03	0.03	$ 19	$ 0.60	$ 0.60	$ 0.58	$ 0.58
AW	001	$ 639	44	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.45	$ 0.45	$ 0.44	$ 0.44
BC	001	$ 524	16	0.70	1,560	2	0	1	0.03	0.03	0.03	0.03	$ 33	$ 1.02	$ 1.02	$ 0.99	$ 0.99
BC	001	$ 524	32	0.70	3,100	2	0	1	0.03	0.03	0.03	0.03	$ 16	$ 0.51	$ 0.51	$ 0.50	$ 0.50
BC	001	$ 524	41	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 13	$ 0.40	$ 0.40	$ 0.39	$ 0.39
Y	001	$ 569	14	0.70	1,056	1	0	1	0.03	0.03	0.03	0.03	$ 40	$ 1.23	$ 1.23	$ 1.20	$ 1.20
Y	001	$ 569	18	0.70	1,328	1	0	1	0.03	0.03	0.03	0.03	$ 31	$ 0.97	$ 0.97	$ 0.94	$ 0.94
Y	001	$ 569	28	0.70	2,004	1	0	1	0.03	0.03	0.03	0.03	$ 20	$ 0.63	$ 0.63	$ 0.61	$ 0.61
Y	001	$ 569	37	0.70	2,580	1	0	1	0.03	0.03	0.03	0.03	$ 15	$ 0.48	$ 0.48	$ 0.47	$ 0.47
AZ	001	$ 405	12	0.70	560	0	1	0	0.03	0.03	0.03	0.03	$ 34	$ 1.06	$ 1.06	$ 1.02	$ 1.02
AZ	001	$ 470	30	0.70	1,680	1	1	1	0.03	0.03	0.03	0.03	$ 15	$ 0.48	$ 0.48	$ 0.47	$ 0.47
AZ	001	$ 529	30	0.70	2,480	1	1	1	0.03	0.03	0.03	0.03	$ 17	$ 0.54	$ 0.54	$ 0.53	$ 0.53
Z	002	$ 624	17	0.70	2,000	1	0	1	0.03	0.03	0.03	0.03	$ 38	$ 1.18	$ 1.18	$ 1.15	$ 1.15
Z	002	$ 624	26	0.70	3,000	1	0	1	0.03	0.03	0.03	0.03	$ 24	$ 0.76	$ 0.76	$ 0.74	$ 0.74
Z	002	$ 624	35	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 18	$ 0.56	$ 0.56	$ 0.54	$ 0.54
BE	001	$ 160	10	0.70	1,236	0	1	0	0.03	0.03	0.03	0.03	$ 17	$ 0.52	$ 0.52	$ 0.50	$ 0.50
BE	001	$ 245	18	0.70	1,696	0	1	0	0.03	0.03	0.03	0.03	$ 14	$ 0.43	$ 0.43	$ 0.42	$ 0.42
BE	001	$ 329	26	0.70	2,308	0	1	0	0.03	0.03	0.03	0.03	$ 12	$ 0.39	$ 0.39	$ 0.38	$ 0.38
AX	001	$ 589	19	0.70	1,008	0	2	1	0.03	0.03	0.03	0.03	$ 31	$ 0.98	$ 0.98	$ 0.95	$ 0.95
AX	001	$ 589	35	0.70	1,876	1	2	1	0.03	0.03	0.03	0.03	$ 17	$ 0.53	$ 0.53	$ 0.51	$ 0.51
AY	001	$ 524	8	0.70	1,400	1	2	1	0.03	0.03	0.03	0.03	$ 66	$ 2.05	$ 2.05	$ 1.99	$ 1.99
AY	001	$ 524	12	0.70	2,200	1	2	1	0.03	0.03	0.03	0.03	$ 45	$ 1.41	$ 1.41	$ 1.37	$ 1.37
AY	001	$ 524	19	0.70	3,200	1	3	1	0.03	0.03	0.03	0.03	$ 27	$ 0.85	$ 0.85	$ 0.83	$ 0.83
AY	001	$ 524	24	0.70	4,000	1	3	1	0.03	0.03	0.03	0.03	$ 22	$ 0.68	$ 0.68	$ 0.66	$ 0.66
AY	001	$ 524	30	0.70	4,800	2	3	1	0.03	0.03	0.03	0.03	$ 17	$ 0.55	$ 0.55	$ 0.53	$ 0.53
AY	001	$ 524	65	0.70	8,800	2	3	1			0.03	0.03	$ 8	$ -	$ -	$ 0.24	$ 0.24
								SUM	1.00	1.00	1.00	1.00		$24.03	$24.03	$23.55	$23.55
Wall Mounted																	
C	001	$ 409	16	0.95	696	0	4	0	0.06	0.06	0.06	0.06	$ 26	$ 1.47	$ 1.47	$ 1.47	$ 1.47
H	002	$ 639	14	0.70	846	0	4	0	0.06	0.06	0.06	0.06	$ 46	$ 2.54	$ 2.54	$ 2.54	$ 2.54
S	001	$ 147	26	0.70	823	1	0	0	0.06	0.06	0.06	0.06	$ 6	$ 0.31	$ 0.31	$ 0.31	$ 0.31
AH	001	$ 815	24	0.70	950	1	3	1	0.06	0.06	0.06	0.06	$ 34	$ 1.89	$ 1.89	$ 1.89	$ 1.89
C	001	$ 409	16	0.95	1,084	0	4	0	0.06	0.06	0.06	0.06	$ 26	$ 1.47	$ 1.47	$ 1.47	$ 1.47
S	002	$ 162	18	0.70	1,189	1	1	0	0.06	0.06	0.06	0.06	$ 9	$ 0.50	$ 0.50	$ 0.50	$ 0.50
C	001	$ 409	16	0.95	1,214	0	4	0	0.06	0.06	0.06	0.06	$ 26	$ 1.47	$ 1.47	$ 1.47	$ 1.47
H	001	$ 1,125	17	0.81	1,216	1	1	0	0.06	0.06	0.06	0.06	$ 66	$ 3.68	$ 3.68	$ 3.68	$ 3.68
AF	001	$ 809	40	0.70	1,290	1	1	1	0.06	0.06	0.06	0.06	$ 20	$ 1.11	$ 1.11	$ 1.11	$ 1.11
V	005	$ 381	13	0.91	1,415	0	0	1	0.06	0.06	0.06	0.06	$ 29	$ 1.63	$ 1.63	$ 1.63	$ 1.63
V	004	$ 408	12	0.90	1,494	0	0	0	0.06	0.06	0.06	0.06	$ 34	$ 1.89	$ 1.89	$ 1.89	$ 1.89
B	004	$ 1,719	88	0.70	3,003	1	3	0	0.06	0.06	0.06	0.06	$ 20	$ 1.09	$ 1.09	$ 1.09	$ 1.09
V	005	$ 381	19	0.91	1,957	1	0	1	0.06	0.06	0.06	0.06	$ 20	$ 1.11	$ 1.11	$ 1.11	$ 1.11
V	005	$ 381	19	0.91	2,031	1	0	1	0.06	0.06	0.06	0.06	$ 20	$ 1.11	$ 1.11	$ 1.11	$ 1.11
AE	001	$ 163	27	0.70	2,075	1	1	0	0.06	0.06	0.06	0.06	$ 6	$ 0.34	$ 0.34	$ 0.34	$ 0.34
AF	002	$ 368	20	0.70	2,054	1	1	1	0.06	0.06	0.06	0.06	$ 19	$ 1.04	$ 1.04	$ 1.04	$ 1.04
V	004	$ 449	25	0.90	3,163	1	0	1	0.06	0.06	0.06	0.06	$ 18	$ 1.00	$ 1.00	$ 1.00	$ 1.00
V	004	$ 490	50	0.90	6,025	1	0	1	0.06	0.06	0.06	0.06	$ 10	$ 0.54	$ 0.54	$ 0.54	$ 0.54
								SUM	1.00	1.00	1.00	1.00		$24.18	$24.18	$24.18	$24.18
									1.00	1.00	1.00	1.00		$19.13	$18.99	$18.70	$18.70

Table 101: Guard Stations Cost per Watt

2019 LED									Weighting					Weighted Cost per Watt			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4		LZ1	LZ2	LZ3	LZ4
Area																	
AF	003	$ 1,776	48	0.70	4,247	1	0	1	0.33	0.17	0.10	0.08	$ 37	$ 12.33	$ 6.17	$ 3.70	$ 3.08
W	003	$ 1,061	51	0.84	5,229	3	0	2	0.33	0.17	0.10	0.08	$ 21	$ 6.93	$ 3.47	$ 2.08	$ 1.73
A	001	$ 1,450	95	0.84	7,312	2	0	2		0.17	0.10	0.08	$ 15	$ -	$ 2.54	$ 1.53	$ 1.27
A	001	$ 1,450	95	0.84	7,572	3	0	2		0.17	0.10	0.08	$ 15	$ -	$ 2.54	$ 1.53	$ 1.27
W	004	$ 1,063	96	0.89	10,231	3	0	2		0.17	0.10	0.08	$ 11	$ -	$ 1.85	$ 1.11	$ 0.92
C	009	$ 863	124	0.95	14,200	2	0	3			0.10	0.08	$ 7	$ -	$ -	$ 0.70	$ 0.58
V	002	$ 1,074	125	0.91	13,999	3	0	1	0.33	0.17	0.10	0.08	$ 9	$ 2.86	$ 1.43	$ 0.86	$ 0.72
C	008	$ 1,544	149	0.96	18,132	3	0	3			0.10	0.08	$ 10	$ -	$ -	$ 1.04	$ 0.86
W	005	$ 960	183	0.88	18,162	3	0	3			0.10	0.08	$ 5	$ -	$ -	$ 0.52	$ 0.44
V	002	$ 1,081	163	0.91	17,683	3	0	3			0.10	0.08	$ 7	$ -	$ -	$ 0.66	$ 0.55
C	009	$ 1,114	210	0.90	23,769	3	0	4				0.08	$ 5	$ -	$ -	$ -	$ 0.44
V	002	$ 1,159	241	0.91	24,870	3	0	4				0.08	$ 5	$ -	$ -	$ -	$ 0.40
C	009	$ 1,384	448	0.90	45,673	3	0	5					$ 3	$ -	$ -	$ -	$ -
V	003	$ 1,603	448	0.91	45,686	4	0	5					$ 4	$ -	$ -	$ -	$ -
								SUM	1.00	1.00	1.00	1.00		$ 22.13	$ 18.00	$ 13.72	$ 12.27
Ground Mounted Floodlight																	
AT	001	$ 571	70	0.93	7,389	na	na	na		0.50	0.25	0.13	$ 8	$ -	$ 4.08	$ 2.04	$ 1.02
AL	001	$ 256	64	0.87	9,275	na	na	na		0.50	0.25	0.13	$ 4	$ -	$ 2.00	$ 1.00	$ 0.50
AT	002	$ 953	90	0.92	10,699	na	na	na			0.25	0.13	$ 11	$ -	$ -	$ 2.65	$ 1.32
C	007	$ 1,305	99	0.70	11,100	na	na	na			0.25	0.13	$ 13	$ -	$ -	$ 3.30	$ 1.65
AT	002	$ 1,017	135	0.92	13,709	na	na	na				0.13	$ 8	$ -	$ -	$ -	$ 0.94
AT	002	$ 1,079	175	0.92	17,615	na	na	na				0.13	$ 6	$ -	$ -	$ -	$ 0.77
W	001	$ 1,039	213	0.96	20,138	na	na	na				0.13	$ 5	$ -	$ -	$ -	$ 0.61
V	001	$ 690	244	0.96	28,237	na	na	na				0.13	$ 3	$ -	$ -	$ -	$ 0.35
								SUM	0.00	1.00	1.00	1.00		$ -	$ 6.08	$ 8.98	$ 7.17
Wall Mounted																	
C	001	$ 409	16	0.95	696	0	4	0	0.04	0.04	0.04	0.04	$ 26	$ 1.15	$ 1.06	$ 1.02	$ 1.02
H	002	$ 639	14	0.70	846	0	4	0	0.04	0.04	0.04	0.04	$ 46	$ 1.98	$ 1.83	$ 1.76	$ 1.76
S	001	$ 147	26	0.70	823	1	0	0	0.04	0.04	0.04	0.04	$ 6	$ 0.24	$ 0.22	$ 0.22	$ 0.22
AH	001	$ 815	24	0.70	950	1	3	1	0.04	0.04	0.04	0.04	$ 34	$ 1.48	$ 1.36	$ 1.31	$ 1.31
C	001	$ 409	16	0.95	1,084	0	4	0	0.04	0.04	0.04	0.04	$ 26	$ 1.15	$ 1.06	$ 1.02	$ 1.02
S	002	$ 162	18	0.70	1,189	1	1	0	0.04	0.04	0.04	0.04	$ 9	$ 0.39	$ 0.36	$ 0.35	$ 0.35
C	001	$ 409	16	0.95	1,214	0	4	0	0.04	0.04	0.04	0.04	$ 26	$ 1.15	$ 1.06	$ 1.02	$ 1.02
H	001	$ 1,125	17	0.81	1,216	1	1	0	0.04	0.04	0.04	0.04	$ 66	$ 2.88	$ 2.65	$ 2.55	$ 2.55
AF	001	$ 809	40	0.70	1,290	1	1	1	0.04	0.04	0.04	0.04	$ 20	$ 0.87	$ 0.80	$ 0.77	$ 0.77
V	005	$ 381	13	0.91	1,415	0	0	1	0.04	0.04	0.04	0.04	$ 29	$ 1.28	$ 1.17	$ 1.13	$ 1.13
V	004	$ 408	12	0.90	1,494	0	0	0	0.04	0.04	0.04	0.04	$ 34	$ 1.48	$ 1.36	$ 1.31	$ 1.31
B	004	$ 1,719	88	0.70	3,003	1	3	0	0.04	0.04	0.04	0.04	$ 20	$ 0.85	$ 0.79	$ 0.75	$ 0.75
V	005	$ 381	19	0.91	1,957	1	0	1	0.04	0.04	0.04	0.04	$ 20	$ 0.87	$ 0.80	$ 0.77	$ 0.77
V	005	$ 381	19	0.91	2,031	1	0	1	0.04	0.04	0.04	0.04	$ 20	$ 0.87	$ 0.80	$ 0.77	$ 0.77
AE	001	$ 163	27	0.70	2,075	1	1	0	0.04	0.04	0.04	0.04	$ 6	$ 0.26	$ 0.24	$ 0.23	$ 0.23
AF	002	$ 368	20	0.70	2,054	1	1	1	0.04	0.04	0.04	0.04	$ 19	$ 0.82	$ 0.75	$ 0.72	$ 0.72
V	005	$ 381	26	0.91	2,623	1	0	1	0.04	0.04	0.04	0.04	$ 15	$ 0.64	$ 0.59	$ 0.56	$ 0.56
AG	001	$ 518	36	0.70	2,603	1	0	1	0.04	0.04	0.04	0.04	$ 14	$ 0.63	$ 0.58	$ 0.55	$ 0.55
V	004	$ 449	25	0.90	3,163	1	0	1	0.04	0.04	0.04	0.04	$ 18	$ 0.78	$ 0.72	$ 0.69	$ 0.69
V	005	$ 506	35	0.91	3,912	1	0	2	0.04	0.04	0.04	0.04	$ 14	$ 0.63	$ 0.58	$ 0.56	$ 0.56
V	004	$ 490	50	0.90	6,025	1	0	1	0.04	0.04	0.04	0.04	$ 10	$ 0.43	$ 0.39	$ 0.38	$ 0.38
B	004	$ 707	52	0.70	4,390	1	0	0	0.04	0.04	0.04	0.04	$ 14	$ 0.59	$ 0.54	$ 0.52	$ 0.52
V	004	$ 490	50	0.90	6,025	1	0	1	0.04	0.04	0.04	0.04	$ 10	$ 0.43	$ 0.39	$ 0.38	$ 0.38
V	005	$ 506	73	0.91	6,865	1	0	2		0.04	0.04	0.04	$ 7	$ -	$ 0.28	$ 0.27	$ 0.27
W	004	$ 1,027	76	0.70	8,051	3	0	3			0.04	0.04	$ 14	$ -	$ -	$ 0.52	$ 0.52
W	004	$ 1,107	101	0.70	12,064	2	0	2		0.04	0.04	0.04	$ 11	$ -	$ 0.44	$ 0.42	$ 0.42
								SUM	1.00	1.00	1.00	1.00		$ 21.84	$ 20.80	$ 20.52	$ 20.52
									0.67	1.00	1.00	1.00		$ 14.65	$ 14.96	$ 14.41	$ 13.32

Table 102: Student Pick-up / Drop-off Zone Cost per Watt

2019 LED									Weighting					Weighted Cost per Watt			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4		LZ1	LZ2	LZ3	LZ4
Area Light																	
B	002	$ 1,381	25	0.93	1,170	1	2	1	0.06	0.05	0.05	0.05	$ 55	$ 3.25	$ 2.76	$ 2.76	$ 2.76
B	002	$ 1,381	25	0.93	1,216	1	1	1	0.06	0.05	0.05	0.05	$ 55	$ 3.25	$ 2.76	$ 2.76	$ 2.76
B	002	$ 1,381	25	0.93	1,735	1	0	1	0.06	0.05	0.05	0.05	$ 55	$ 3.25	$ 2.76	$ 2.76	$ 2.76
A	002	$ 1,553	21	0.83	2,051	1	0	1	0.06	0.05	0.05	0.05	$ 74	$ 4.35	$ 3.70	$ 3.70	$ 3.70
A	002	$ 1,553	21	0.83	2,189	1	0	1	0.06	0.05	0.05	0.05	$ 74	$ 4.35	$ 3.70	$ 3.70	$ 3.70
A	002	$ 1,553	21	0.83	2,114	1	0	1	0.06	0.05	0.05	0.05	$ 74	$ 4.35	$ 3.70	$ 3.70	$ 3.70
A	002	$ 1,553	30	0.83	2,760	1	0	1	0.06	0.05	0.05	0.05	$ 52	$ 3.05	$ 2.59	$ 2.59	$ 2.59
B	002	$ 1,381	25	0.93	1,830	1	0	1	0.06	0.05	0.05	0.05	$ 55	$ 3.25	$ 2.76	$ 2.76	$ 2.76
W	002	$ 1,970	22	0.84	2,117	1	0	1	0.06	0.05	0.05	0.05	$ 90	$ 5.27	$ 4.48	$ 4.48	$ 4.48
BD	001	$ 1,434	36	0.92	2,221	1	0	1	0.06	0.05	0.05	0.05	$ 40	$ 2.34	$ 1.99	$ 1.99	$ 1.99
W	003	$ 1,071	30	0.84	3,126	1	0	1	0.06	0.05	0.05	0.05	$ 36	$ 2.10	$ 1.78	$ 1.78	$ 1.78
BD	001	$ 1,434	52	0.92	3,178	1	0	1	0.06	0.05	0.05	0.05	$ 28	$ 1.62	$ 1.38	$ 1.38	$ 1.38
AF	003	$ 1,776	48	0.70	4,247	1	0	1	0.06	0.05	0.05	0.05	$ 37	$ 2.18	$ 1.85	$ 1.85	$ 1.85
A	001	$ 1,379	22	0.84	1,888	1	0	1	0.06	0.05	0.05	0.05	$ 63	$ 3.69	$ 3.13	$ 3.13	$ 3.13
A	001	$ 1,379	51	0.84	4,431	2	0	2	0.06	0.05	0.05	0.05	$ 27	$ 1.59	$ 1.35	$ 1.35	$ 1.35
A	001	$ 1,379	51	0.84	4,348	1	0	1	0.06	0.05	0.05	0.05	$ 27	$ 1.59	$ 1.35	$ 1.35	$ 1.35
W	003	$ 1,061	51	0.84	5,229	3	0	2	0.06	0.05	0.05	0.05	$ 21	$ 1.22	$ 1.04	$ 1.04	$ 1.04
A	001	$ 1,450	95	0.84	7,312	2	0	2		0.05	0.05	0.05	$ 15	$ -	$ 0.76	$ 0.76	$ 0.76
A	001	$ 1,450	95	0.84	7,572	3	0	2		0.05	0.05	0.05	$ 15	$ -	$ 0.76	$ 0.76	$ 0.76
W	004	$ 1,063	96	0.89	10,231	3	0	2		0.05	0.05	0.05	$ 11	$ -	$ 0.55	$ 0.55	$ 0.55
								SUM	1.00	1.00	1.00	1.00		$50.70	$45.17	$45.17	$45.17
Cylindrical - Wall Mounted up/down																	
M	001	$ 950	8	0.70	900	1	1	0	0.33	0.33	0.33	0.33	$ 119	$39.57	$39.57	$39.57	$39.57
AO	001	$ 349	13	0.70	931	1	1	0	0.33	0.33	0.33	0.33	$ 27	$ 8.96	$ 8.96	$ 8.96	$ 8.96
H	003	$ 434	21	0.81	1,047	1	4	0	0.33	0.33	0.33	0.33	$ 21	$ 6.89	$ 6.89	$ 6.89	$ 6.89
								SUM	1.00	1.00	1.00	1.00		$55.43	$55.43	$55.43	$55.43
Downlight																	
J	001	$ 561	10	0.70	647	1	0	0	0.04	0.04	0.04	0.04	$ 56	$ 2.44	$ 2.25	$ 2.25	$ 2.25
K	001	$ 220	13	0.70	780	1	1	0	0.04	0.04	0.04	0.04	$ 17	$ 0.74	$ 0.68	$ 0.68	$ 0.68
J	001	$ 561	14	0.70	884	1	0	0	0.04	0.04	0.04	0.04	$ 40	$ 1.74	$ 1.60	$ 1.60	$ 1.60
P	001	$ 208	14	0.89	1,066	1	1	0	0.04	0.04	0.04	0.04	$ 15	$ 0.65	$ 0.60	$ 0.60	$ 0.60
K	001	$ 286	22	0.70	1,170	2	1	0	0.04	0.04	0.04	0.04	$ 13	$ 0.57	$ 0.52	$ 0.52	$ 0.52
K	001	$ 272	22	0.70	1,426	2	1	0	0.04	0.04	0.04	0.04	$ 12	$ 0.54	$ 0.49	$ 0.49	$ 0.49
K	002	$ 236	19	0.70	1,461	2	0	0	0.04	0.04	0.04	0.04	$ 13	$ 0.56	$ 0.51	$ 0.51	$ 0.51
K	002	$ 236	23	0.70	1,860	2	0	0	0.04	0.04	0.04	0.04	$ 10	$ 0.44	$ 0.41	$ 0.41	$ 0.41
P	001	$ 237	36	0.89	1,995	2	1	0	0.04	0.04	0.04	0.04	$ 7	$ 0.29	$ 0.26	$ 0.26	$ 0.26
C	005	$ 94	21	0.70	1,914	2	0	0	0.04	0.04	0.04	0.04	$ 4	$ 0.19	$ 0.18	$ 0.18	$ 0.18
P	001	$ 237	35	0.89	2,130	2	1	0	0.04	0.04	0.04	0.04	$ 7	$ 0.29	$ 0.27	$ 0.27	$ 0.27
C	005	$ 112	28	0.70	2,203	2	0	0	0.04	0.04	0.04	0.04	$ 4	$ 0.18	$ 0.16	$ 0.16	$ 0.16
K	002	$ 251	30	0.70	2,521	2	0	0	0.04	0.04	0.04	0.04	$ 9	$ 0.37	$ 0.34	$ 0.34	$ 0.34
P	001	$ 257	41	0.89	2,621	3	1	0	0.04	0.04	0.04	0.04	$ 6	$ 0.28	$ 0.25	$ 0.25	$ 0.25
K	002	$ 266	37	0.70	2,917	3	0	0	0.04	0.04	0.04	0.04	$ 7	$ 0.32	$ 0.29	$ 0.29	$ 0.29
K	002	$ 310	48	0.70	3,029	3	0	0	0.04	0.04	0.04	0.04	$ 6	$ 0.28	$ 0.26	$ 0.26	$ 0.26
P	001	$ 256	44	0.89	3,184	3	1	0	0.04	0.04	0.04	0.04	$ 6	$ 0.25	$ 0.23	$ 0.23	$ 0.23
C	005	$ 112	42	0.70	3,300	3	0	0	0.04	0.04	0.04	0.04	$ 3	$ 0.12	$ 0.11	$ 0.11	$ 0.11
K	002	$ 295	48	0.70	3,839	3	0	0	0.04	0.04	0.04	0.04	$ 6	$ 0.27	$ 0.25	$ 0.25	$ 0.25
K	002	$ 310	47	0.70	4,234	3	0	0	0.04	0.04	0.04	0.04	$ 7	$ 0.29	$ 0.26	$ 0.26	$ 0.26
K	002	$ 324	49	0.70	4,982	3	0	0	0.04	0.04	0.04	0.04	$ 7	$ 0.29	$ 0.27	$ 0.27	$ 0.27
K	002	$ 427	75	0.70	6,168	3	0	0	0.04	0.04	0.04	0.04	$ 6	$ 0.25	$ 0.23	$ 0.23	$ 0.23
AR	002	$ 585	57	0.70	5,716	3	1	1	0.04	0.04	0.04	0.04	$ 10	$ 0.45	$ 0.41	$ 0.41	$ 0.41
C	005	$ 175	115	0.70	7,816	4	0	0		0.04	0.04	0.04	$ 2	$ -	$ 0.06	$ 0.06	$ 0.06
K	002	$ 530	115	0.70	11,296	3	0	0		0.04	0.04	0.04	$ 5	$ -	$ 0.18	$ 0.18	$ 0.18
								SUM	1.00	1.00	1.00	1.00		$11.77	$11.07	$11.07	$11.07
Flood																	
AT	001	$ 571	70	0.93	7,389					0.50	0.25	0.17	$ 8	$ -	$ 4.08	$ 2.04	$ 1.36
AL	001	$ 256	64	0.87	9,275					0.50	0.25	0.17	$ 4	$ -	$ 2.00	$ 1.00	$ 0.67
AT	002	$ 953	90	0.92	10,699						0.25	0.17	$ 11	$ -	$ -	$ 2.65	$ 1.77
C	007	$ 1,305	99	0.70	11,100						0.25	0.17	$ 13	$ -	$ -	$ 3.30	$ 2.20
AT	002	$ 1,017	135	0.92	13,709							0.17	$ 8	$ -	$ -	$ -	$ 1.26
AT	002	$ 1,079	175	0.92	17,615							0.17	$ 6	$ -	$ -	$ -	$ 1.03
								SUM	0.00	1.00	1.00	1.00		$ -	$ 6.08	$ 8.98	$ 8.27

Table 103: Student Pick-up / Drop-off Zone, continued

2019 LED									Weighting					Weighted Cost per Watt			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4		LZ1	LZ2	LZ3	LZ4
Recessed Linear																	
AB	002	$ 424	18	0.70	1,371	1	0	1	0.03	0.03	0.03	0.03	$ 24	$ 0.76	$ 0.76	$ 0.74	$ 0.74
AB	002	$ 424	38	0.70	2,560	1	0	1	0.03	0.03	0.03	0.03	$ 11	$ 0.36	$ 0.36	$ 0.35	$ 0.35
AB	001	$ 151	39	0.70	3,088	1	0	1	0.03	0.03	0.03	0.03	$ 4	$ 0.13	$ 0.13	$ 0.12	$ 0.12
AV	001	$ 549	30	0.95	2,068	1	0	1	0.03	0.03	0.03	0.03	$ 19	$ 0.60	$ 0.60	$ 0.58	$ 0.58
AV	001	$ 549	39	0.95	2,756	1	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.45	$ 0.45	$ 0.44	$ 0.44
AV	001	$ 549	24	0.95	3,444	1	0	1	0.03	0.03	0.03	0.03	$ 23	$ 0.73	$ 0.73	$ 0.70	$ 0.70
AW	001	$ 610	22	0.70	2,000	1	0	1	0.03	0.03	0.03	0.03	$ 28	$ 0.89	$ 0.89	$ 0.87	$ 0.87
AW	001	$ 610	33	0.70	3,000	1	0	1	0.03	0.03	0.03	0.03	$ 18	$ 0.59	$ 0.59	$ 0.57	$ 0.57
AW	001	$ 610	44	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.44	$ 0.44	$ 0.43	$ 0.43
Y	001	$ 631	14	0.70	1,056	1	0	1	0.03	0.03	0.03	0.03	$ 44	$ 1.41	$ 1.41	$ 1.37	$ 1.37
Y	001	$ 631	18	0.70	1,328	1	0	1	0.03	0.03	0.03	0.03	$ 34	$ 1.11	$ 1.11	$ 1.07	$ 1.07
Y	001	$ 631	28	0.70	2,004	1	0	1	0.03	0.03	0.03	0.03	$ 22	$ 0.72	$ 0.72	$ 0.69	$ 0.69
Y	001	$ 631	37	0.70	2,580	1	0	1	0.03	0.03	0.03	0.03	$ 17	$ 0.55	$ 0.55	$ 0.54	$ 0.54
AA	001	$ 440	42	0.70	2,050	1	1	0	0.03	0.03	0.03	0.03	$ 11	$ 0.34	$ 0.34	$ 0.33	$ 0.33
AZ	001	$ 329	12	0.70	580	0	1	0	0.03	0.03	0.03	0.03	$ 27	$ 0.86	$ 0.86	$ 0.83	$ 0.83
AZ	001	$ 376	30	0.70	1,520	0	1	0	0.03	0.03	0.03	0.03	$ 12	$ 0.40	$ 0.40	$ 0.39	$ 0.39
Z	002	$ 574	23	0.70	2,000	1	0	1	0.03	0.03	0.03	0.03	$ 25	$ 0.81	$ 0.81	$ 0.78	$ 0.78
Z	002	$ 574	36	0.70	3,000	1	0	1	0.03	0.03	0.03	0.03	$ 16	$ 0.52	$ 0.52	$ 0.51	$ 0.51
Z	002	$ 574	49	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 12	$ 0.38	$ 0.38	$ 0.37	$ 0.37
Z	001	$ 599	31	0.70	2,914	1	0	1	0.03	0.03	0.03	0.03	$ 19	$ 0.63	$ 0.63	$ 0.61	$ 0.61
BE	001	$ 160	10	0.70	1,236	0	1	0	0.03	0.03	0.03	0.03	$ 17	$ 0.54	$ 0.54	$ 0.52	$ 0.52
BE	001	$ 245	18	0.70	1,696	0	1	0	0.03	0.03	0.03	0.03	$ 14	$ 0.45	$ 0.45	$ 0.43	$ 0.43
BE	001	$ 329	26	0.70	2,308	0	1	0	0.03	0.03	0.03	0.03	$ 12	$ 0.40	$ 0.40	$ 0.39	$ 0.39
AX	001	$ 589	19	0.70	1,008	1	2	1	0.03	0.03	0.03	0.03	$ 31	$ 1.01	$ 1.01	$ 0.98	$ 0.98
AX	001	$ 589	35	0.70	1,876	1	2	1	0.03	0.03	0.03	0.03	$ 17	$ 0.55	$ 0.55	$ 0.53	$ 0.53
AY	001	$ 574	8	0.70	1,400	1	2	1	0.03	0.03	0.03	0.03	$ 72	$ 2.31	$ 2.31	$ 2.24	$ 2.24
AY	001	$ 574	12	0.70	2,200	1	2	1	0.03	0.03	0.03	0.03	$ 49	$ 1.60	$ 1.60	$ 1.55	$ 1.55
AY	001	$ 574	19	0.70	3,200	1	3	1	0.03	0.03	0.03	0.03	$ 30	$ 0.96	$ 0.96	$ 0.93	$ 0.93
AY	001	$ 574	24	0.70	4,000	1	3	1	0.03	0.03	0.03	0.03	$ 24	$ 0.77	$ 0.77	$ 0.75	$ 0.75
AY	001	$ 574	30	0.70	4,800	2	3	1	0.03	0.03	0.03	0.03	$ 19	$ 0.62	$ 0.62	$ 0.60	$ 0.60
AY	001	$ 574	65	0.70	8,800	2	3	1			0.03	0.03	$ 9	$ -	$ -	$ 0.28	$ 0.28
Z	001	$ 599	42	0.70	3,885	2	2	1	0.03	0.03	0.03	0.03	$ 14	$ 0.46	$ 0.46	$ 0.44	$ 0.44
								SUM	1.00	1.00	1.00	1.00		$22.34	$22.34	$21.91	$21.91
Surface Mounted Linear																	
AB	002	$ 524	18	0.70	1,663	1	0	1	0.03	0.03	0.03	0.03	$ 29	$ 0.91	$ 0.91	$ 0.88	$ 0.88
AB	002	$ 524	38	0.70	3,111	2	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.43	$ 0.43	$ 0.42	$ 0.42
AB	003	$ 930	38	0.70	1,539	1	1	1	0.03	0.03	0.03	0.03	$ 24	$ 0.76	$ 0.76	$ 0.73	$ 0.73
AV	001	$ 549	30	0.95	2,068	1	0	1	0.03	0.03	0.03	0.03	$ 19	$ 0.58	$ 0.58	$ 0.56	$ 0.56
AV	001	$ 549	39	0.95	2,756	1	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.44	$ 0.44	$ 0.42	$ 0.42
AV	001	$ 579	24	0.95	3,444	1	0	1	0.03	0.03	0.03	0.03	$ 24	$ 0.74	$ 0.74	$ 0.72	$ 0.72
AW	001	$ 639	22	0.70	2,000	1	0	1	0.03	0.03	0.03	0.03	$ 29	$ 0.91	$ 0.91	$ 0.88	$ 0.88
AW	001	$ 639	33	0.70	3,000	1	0	1	0.03	0.03	0.03	0.03	$ 19	$ 0.60	$ 0.60	$ 0.58	$ 0.58
AW	001	$ 639	44	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.45	$ 0.45	$ 0.44	$ 0.44
BC	001	$ 524	16	0.70	1,560	2	0	1	0.03	0.03	0.03	0.03	$ 33	$ 1.02	$ 1.02	$ 0.99	$ 0.99
BC	001	$ 524	32	0.70	3,100	2	0	1	0.03	0.03	0.03	0.03	$ 16	$ 0.51	$ 0.51	$ 0.50	$ 0.50
BC	001	$ 524	41	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 13	$ 0.40	$ 0.40	$ 0.39	$ 0.39
Y	001	$ 569	14	0.70	1,056	1	0	1	0.03	0.03	0.03	0.03	$ 40	$ 1.23	$ 1.23	$ 1.20	$ 1.20
Y	001	$ 569	18	0.70	1,328	1	0	1	0.03	0.03	0.03	0.03	$ 31	$ 0.97	$ 0.97	$ 0.94	$ 0.94
Y	001	$ 569	28	0.70	2,004	1	0	1	0.03	0.03	0.03	0.03	$ 20	$ 0.63	$ 0.63	$ 0.61	$ 0.61
Y	001	$ 569	37	0.70	2,580	1	0	1	0.03	0.03	0.03	0.03	$ 15	$ 0.48	$ 0.48	$ 0.47	$ 0.47
AZ	001	$ 405	12	0.70	560	0	1	0	0.03	0.03	0.03	0.03	$ 34	$ 1.06	$ 1.06	$ 1.02	$ 1.02
AZ	001	$ 470	30	0.70	1,680	1	1	1	0.03	0.03	0.03	0.03	$ 15	$ 0.48	$ 0.48	$ 0.47	$ 0.47
AZ	001	$ 529	30	0.70	2,480	1	1	1	0.03	0.03	0.03	0.03	$ 17	$ 0.54	$ 0.54	$ 0.53	$ 0.53
Z	002	$ 624	17	0.70	2,000	1	0	1	0.03	0.03	0.03	0.03	$ 38	$ 1.18	$ 1.18	$ 1.15	$ 1.15
Z	002	$ 624	26	0.70	3,000	1	0	1	0.03	0.03	0.03	0.03	$ 24	$ 0.76	$ 0.76	$ 0.74	$ 0.74
Z	002	$ 624	35	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 18	$ 0.56	$ 0.56	$ 0.54	$ 0.54
BE	001	$ 160	10	0.70	1,236	0	1	0	0.03	0.03	0.03	0.03	$ 17	$ 0.52	$ 0.52	$ 0.50	$ 0.50
BE	001	$ 245	18	0.70	1,696	0	1	0	0.03	0.03	0.03	0.03	$ 14	$ 0.43	$ 0.43	$ 0.42	$ 0.42
BE	001	$ 329	26	0.70	2,308	0	1	0	0.03	0.03	0.03	0.03	$ 12	$ 0.39	$ 0.39	$ 0.38	$ 0.38
AX	001	$ 589	19	0.70	1,008	0	2	1	0.03	0.03	0.03	0.03	$ 31	$ 0.98	$ 0.98	$ 0.95	$ 0.95
AX	001	$ 589	35	0.70	1,876	1	2	1	0.03	0.03	0.03	0.03	$ 17	$ 0.53	$ 0.53	$ 0.51	$ 0.51
AY	001	$ 524	8	0.70	1,400	1	2	1	0.03	0.03	0.03	0.03	$ 66	$ 2.05	$ 2.05	$ 1.99	$ 1.99
AY	001	$ 524	12	0.70	2,200	1	2	1	0.03	0.03	0.03	0.03	$ 45	$ 1.41	$ 1.41	$ 1.37	$ 1.37
AY	001	$ 524	19	0.70	3,200	1	3	1	0.03	0.03	0.03	0.03	$ 27	$ 0.85	$ 0.85	$ 0.83	$ 0.83
AY	001	$ 524	24	0.70	4,000	1	3	1	0.03	0.03	0.03	0.03	$ 22	$ 0.68	$ 0.68	$ 0.66	$ 0.66
AY	001	$ 524	30	0.70	4,800	2	3	1	0.03	0.03	0.03	0.03	$ 17	$ 0.55	$ 0.55	$ 0.53	$ 0.53
AY	001	$ 524	65	0.70	8,800	2	3	1			0.03	0.03	$ 8	$ -	$ -	$ 0.24	$ 0.24
								SUM	1.00	1.00	1.00	1.00		$24.03	$24.03	$23.55	$23.55

Table 104: Student Pick-up / Drop-off Zone, continued

2019 LED									Weighting					Weighted Cost per Watt			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4		LZ1	LZ2	LZ3	LZ4
Wall Mounted																	
C	001	$ 409	16	0.95	696	0	4	0	0.04	0.04	0.04	0.04	$ 26	$ 1.15	$ 1.06	$ 1.02	$ 1.02
H	002	$ 639	14	0.70	846	0	4	0	0.04	0.04	0.04	0.04	$ 46	$ 1.98	$ 1.83	$ 1.76	$ 1.76
S	001	$ 147	26	0.70	823	1	0	0	0.04	0.04	0.04	0.04	$ 6	$ 0.24	$ 0.22	$ 0.22	$ 0.22
AH	001	$ 815	24	0.70	950	1	3	1	0.04	0.04	0.04	0.04	$ 34	$ 1.48	$ 1.36	$ 1.31	$ 1.31
C	001	$ 409	16	0.95	1,084	0	4	0	0.04	0.04	0.04	0.04	$ 26	$ 1.15	$ 1.06	$ 1.02	$ 1.02
S	002	$ 162	18	0.70	1,189	1	1	0	0.04	0.04	0.04	0.04	$ 9	$ 0.39	$ 0.36	$ 0.35	$ 0.35
C	001	$ 409	16	0.95	1,214	0	4	0	0.04	0.04	0.04	0.04	$ 26	$ 1.15	$ 1.06	$ 1.02	$ 1.02
H	001	$ 1,125	17	0.81	1,216	1	1	0	0.04	0.04	0.04	0.04	$ 66	$ 2.88	$ 2.65	$ 2.55	$ 2.55
AF	001	$ 809	40	0.70	1,290	1	1	1	0.04	0.04	0.04	0.04	$ 20	$ 0.87	$ 0.80	$ 0.77	$ 0.77
V	005	$ 381	13	0.91	1,415	0	0	1	0.04	0.04	0.04	0.04	$ 29	$ 1.28	$ 1.17	$ 1.13	$ 1.13
V	004	$ 408	12	0.90	1,494	0	0	0	0.04	0.04	0.04	0.04	$ 34	$ 1.48	$ 1.36	$ 1.31	$ 1.31
B	004	$ 1,719	88	0.70	3,003	1	3	0	0.04	0.04	0.04	0.04	$ 20	$ 0.85	$ 0.79	$ 0.75	$ 0.75
V	005	$ 381	19	0.91	1,957	1	0	1	0.04	0.04	0.04	0.04	$ 20	$ 0.87	$ 0.80	$ 0.77	$ 0.77
V	005	$ 381	19	0.91	2,031	1	0	1	0.04	0.04	0.04	0.04	$ 20	$ 0.87	$ 0.80	$ 0.77	$ 0.77
AE	001	$ 163	27	0.70	2,075	1	1	0	0.04	0.04	0.04	0.04	$ 6	$ 0.26	$ 0.24	$ 0.23	$ 0.23
AF	002	$ 368	20	0.70	2,054	1	1	1	0.04	0.04	0.04	0.04	$ 19	$ 0.82	$ 0.75	$ 0.72	$ 0.72
V	005	$ 381	26	0.91	2,623	1	0	1	0.04	0.04	0.04	0.04	$ 15	$ 0.64	$ 0.59	$ 0.56	$ 0.56
AG	001	$ 518	36	0.70	2,603	1	0	1	0.04	0.04	0.04	0.04	$ 14	$ 0.63	$ 0.58	$ 0.55	$ 0.55
V	004	$ 449	25	0.90	3,163	1	0	1	0.04	0.04	0.04	0.04	$ 18	$ 0.78	$ 0.72	$ 0.69	$ 0.69
V	005	$ 506	35	0.91	3,912	1	0	2	0.04	0.04	0.04	0.04	$ 14	$ 0.63	$ 0.58	$ 0.56	$ 0.56
V	004	$ 490	50	0.90	6,025	1	0	1	0.04	0.04	0.04	0.04	$ 10	$ 0.43	$ 0.39	$ 0.38	$ 0.38
B	004	$ 707	52	0.70	4,390	1	0	0	0.04	0.04	0.04	0.04	$ 14	$ 0.59	$ 0.54	$ 0.52	$ 0.52
V	004	$ 490	50	0.90	6,025	1	0	1	0.04	0.04	0.04	0.04	$ 10	$ 0.43	$ 0.39	$ 0.38	$ 0.38
V	005	$ 506	73	0.91	6,865	1	0	2		0.04	0.04	0.04	$ 7	$ -	$ 0.28	$ 0.27	$ 0.27
W	004	$ 1,027	76	0.70	8,051	3	0	3			0.04	0.04	$ 14	$ -	$ -	$ 0.52	$ 0.52
W	004	$ 1,107	101	0.70	12,064	2	0	2		0.04	0.04	0.04	$ 11	$ -	$ 0.44	$ 0.42	$ 0.42
								SUM	1.00	1.00	1.00	1.00		$21.84	$20.80	$20.52	$20.52
									1.00	1.00	1.00	1.00		$55.43	$55.43	$55.43	$55.43

Table 105: Outdoor Dining Cost per Watt

2019 LED									Weighting					Weighted Cost per Watt			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4		LZ1	LZ2	LZ3	LZ4
Area Light																	
N	001	$ 22	1	0.70	90	0	1	0	0.05	0.04	0.04	0.04	$ 23	$ 1.09	$ 1.00	$ 1.00	$ 1.00
R	001	$ 45	1	0.70	42	0	3	1	0.05	0.04	0.04	0.04	$ 45	$ 2.14	$ 1.95	$ 1.95	$ 1.95
R	001	$ 45	3	0.70	256	0	3	1	0.05	0.04	0.04	0.04	$ 15	$ 0.71	$ 0.65	$ 0.65	$ 0.65
O	001	$ 806	13	0.70	925	1	0	0	0.05	0.04	0.04	0.04	$ 61	$ 2.89	$ 2.63	$ 2.63	$ 2.63
B	002	$ 1,381	25	0.93	1,170	1	2	1	0.05	0.04	0.04	0.04	$ 55	$ 2.63	$ 2.40	$ 2.40	$ 2.40
B	002	$ 1,381	25	0.93	1,216	1	1	1	0.05	0.04	0.04	0.04	$ 55	$ 2.63	$ 2.40	$ 2.40	$ 2.40
B	002	$ 1,381	25	0.93	1,735	1	0	1	0.05	0.04	0.04	0.04	$ 55	$ 2.63	$ 2.40	$ 2.40	$ 2.40
A	002	$ 1,553	21	0.83	2,051	1	0	1	0.05	0.04	0.04	0.04	$ 74	$ 3.52	$ 3.22	$ 3.22	$ 3.22
A	002	$ 1,553	21	0.83	2,189	1	0	1	0.05	0.04	0.04	0.04	$ 74	$ 3.52	$ 3.22	$ 3.22	$ 3.22
A	002	$ 1,553	21	0.83	2,114	1	0	1	0.05	0.04	0.04	0.04	$ 74	$ 3.52	$ 3.22	$ 3.22	$ 3.22
A	002	$ 1,553	30	0.83	2,760	1	0	1	0.05	0.04	0.04	0.04	$ 52	$ 2.47	$ 2.25	$ 2.25	$ 2.25
B	002	$ 1,381	25	0.93	1,830	1	0	1	0.05	0.04	0.04	0.04	$ 55	$ 2.63	$ 2.40	$ 2.40	$ 2.40
W	002	$ 1,970	22	0.84	2,117	1	0	1	0.05	0.04	0.04	0.04	$ 90	$ 4.26	$ 3.89	$ 3.89	$ 3.89
BD	001	$ 1,434	36	0.92	2,221	1	0	1	0.05	0.04	0.04	0.04	$ 40	$ 1.90	$ 1.73	$ 1.73	$ 1.73
W	003	$ 1,071	30	0.84	3,126	1	0	1	0.05	0.04	0.04	0.04	$ 36	$ 1.70	$ 1.55	$ 1.55	$ 1.55
BD	001	$ 1,434	52	0.92	3,178	1	0	1	0.05	0.04	0.04	0.04	$ 28	$ 1.31	$ 1.20	$ 1.20	$ 1.20
AF	003	$ 1,776	48	0.70	4,247	1	0	1	0.05	0.04	0.04	0.04	$ 37	$ 1.76	$ 1.61	$ 1.61	$ 1.61
A	001	$ 1,379	22	0.84	1,888	1	0	1	0.05	0.04	0.04	0.04	$ 63	$ 2.98	$ 2.72	$ 2.72	$ 2.72
A	001	$ 1,379	51	0.84	4,431	2	0	2	0.05	0.04	0.04	0.04	$ 27	$ 1.29	$ 1.18	$ 1.18	$ 1.18
A	001	$ 1,379	51	0.84	4,348	1	0	1	0.05	0.04	0.04	0.04	$ 27	$ 1.29	$ 1.18	$ 1.18	$ 1.18
W	003	$ 1,061	51	0.84	5,229	3	0	2	0.05	0.04	0.04	0.04	$ 21	$ 0.99	$ 0.90	$ 0.90	$ 0.90
A	001	$ 1,450	95	0.84	7,312	2	0	2		0.04	0.04	0.04	$ 15	$ -	$ 0.66	$ 0.66	$ 0.66
A	001	$ 1,450	95	0.84	7,572	3	0	2		0.04	0.04	0.04	$ 15	$ -	$ 0.66	$ 0.66	$ 0.66
								SUM	1.00	1.00	1.00	1.00		$47.87	$45.04	$45.04	$45.04
Cylindrical - Wall Mounted up/down																	
M	001	$ 950	8	0.70	900	1	1	0	0.33	0.33	0.33	0.33	$ 119	$39.57	$39.57	$39.57	$39.57
AO	001	$ 349	13	0.70	931	1	1	0	0.33	0.33	0.33	0.33	$ 27	$ 8.96	$ 8.96	$ 8.96	$ 8.96
H	003	$ 434	21	0.81	1,047	1	4	0	0.33	0.33	0.33	0.33	$ 21	$ 6.89	$ 6.89	$ 6.89	$ 6.89
								SUM	1.00	1.00	1.00	1.00		$55.43	$55.43	$55.43	$55.43
Surface Mounted Downlight																	
AC	001	$ 99	20	0.70	1,813	1	0	1	0.25	0.25	0.25	0.25	$ 5	$ 1.22	$ 1.22	$ 1.22	$ 1.22
BB	001	$ 793	19	0.70	1,509	1	0	0	0.25	0.25	0.25	0.25	$ 42	$10.43	$10.43	$10.43	$10.43
Q	002	$ 61	14	0.70	1,081	1	1	0	0.25	0.25	0.25	0.25	$ 5	$ 1.13	$ 1.13	$ 1.13	$ 1.13
T	001	$ 272	24	0.70	3,055	2	3	2	0.25	0.25	0.25	0.25	$ 11	$ 2.80	$ 2.80	$ 2.80	$ 2.80
								SUM	1.00	1.00	1.00	1.00		$15.58	$15.58	$15.58	$15.58
Surface Mounted Linear																	
AB	002	$ 524	18	0.70	1,663	1	0	1	0.03	0.03	0.03	0.03	$ 29	$ 0.91	$ 0.91	$ 0.88	$ 0.88
AB	002	$ 524	38	0.70	3,111	2	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.43	$ 0.43	$ 0.42	$ 0.42
AB	003	$ 930	38	0.70	1,539	1	1	1	0.03	0.03	0.03	0.03	$ 24	$ 0.76	$ 0.76	$ 0.73	$ 0.73
AV	001	$ 549	30	0.95	2,068	1	0	1	0.03	0.03	0.03	0.03	$ 19	$ 0.58	$ 0.58	$ 0.56	$ 0.56
AV	001	$ 549	39	0.95	2,756	1	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.44	$ 0.44	$ 0.42	$ 0.42
AV	001	$ 579	24	0.95	3,444	1	0	1	0.03	0.03	0.03	0.03	$ 24	$ 0.74	$ 0.74	$ 0.72	$ 0.72
AW	001	$ 639	22	0.70	2,000	1	0	1	0.03	0.03	0.03	0.03	$ 29	$ 0.91	$ 0.91	$ 0.88	$ 0.88
AW	001	$ 639	33	0.70	3,000	1	0	1	0.03	0.03	0.03	0.03	$ 19	$ 0.60	$ 0.60	$ 0.58	$ 0.58
AW	001	$ 639	44	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 14	$ 0.45	$ 0.45	$ 0.44	$ 0.44
BC	001	$ 524	16	0.70	1,560	2	0	1	0.03	0.03	0.03	0.03	$ 33	$ 1.02	$ 1.02	$ 0.99	$ 0.99
BC	001	$ 524	32	0.70	3,100	2	0	1	0.03	0.03	0.03	0.03	$ 16	$ 0.51	$ 0.51	$ 0.50	$ 0.50
BC	001	$ 524	41	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 13	$ 0.40	$ 0.40	$ 0.39	$ 0.39
Y	001	$ 569	14	0.70	1,056	1	0	1	0.03	0.03	0.03	0.03	$ 40	$ 1.23	$ 1.23	$ 1.20	$ 1.20
Y	001	$ 569	18	0.70	1,328	1	0	1	0.03	0.03	0.03	0.03	$ 31	$ 0.97	$ 0.97	$ 0.94	$ 0.94
Y	001	$ 569	28	0.70	2,004	1	0	1	0.03	0.03	0.03	0.03	$ 20	$ 0.63	$ 0.63	$ 0.61	$ 0.61
Y	001	$ 569	37	0.70	2,580	1	0	1	0.03	0.03	0.03	0.03	$ 15	$ 0.48	$ 0.48	$ 0.47	$ 0.47
AZ	001	$ 405	12	0.70	560	0	1	0	0.03	0.03	0.03	0.03	$ 34	$ 1.06	$ 1.06	$ 1.02	$ 1.02
AZ	001	$ 470	30	0.70	1,680	1	1	1	0.03	0.03	0.03	0.03	$ 15	$ 0.48	$ 0.48	$ 0.47	$ 0.47
AZ	001	$ 529	30	0.70	2,480	1	1	1	0.03	0.03	0.03	0.03	$ 17	$ 0.54	$ 0.54	$ 0.53	$ 0.53
Z	002	$ 624	17	0.70	2,000	1	0	1	0.03	0.03	0.03	0.03	$ 38	$ 1.18	$ 1.18	$ 1.15	$ 1.15
Z	002	$ 624	26	0.70	3,000	1	0	1	0.03	0.03	0.03	0.03	$ 24	$ 0.76	$ 0.76	$ 0.74	$ 0.74
Z	002	$ 624	35	0.70	4,000	2	0	1	0.03	0.03	0.03	0.03	$ 18	$ 0.56	$ 0.56	$ 0.54	$ 0.54
BE	001	$ 160	10	0.70	1,236	0	1	0	0.03	0.03	0.03	0.03	$ 17	$ 0.52	$ 0.52	$ 0.50	$ 0.50
BE	001	$ 245	18	0.70	1,696	0	1	0	0.03	0.03	0.03	0.03	$ 14	$ 0.43	$ 0.43	$ 0.42	$ 0.42
BE	001	$ 329	26	0.70	2,308	0	1	0	0.03	0.03	0.03	0.03	$ 12	$ 0.39	$ 0.39	$ 0.38	$ 0.38
AX	001	$ 589	19	0.70	1,008	0	2	1	0.03	0.03	0.03	0.03	$ 31	$ 0.98	$ 0.98	$ 0.95	$ 0.95
AX	001	$ 589	35	0.70	1,876	1	2	1	0.03	0.03	0.03	0.03	$ 17	$ 0.53	$ 0.53	$ 0.51	$ 0.51
AY	001	$ 524	8	0.70	1,400	1	2	1	0.03	0.03	0.03	0.03	$ 66	$ 2.05	$ 2.05	$ 1.99	$ 1.99
AY	001	$ 524	12	0.70	2,200	1	2	1	0.03	0.03	0.03	0.03	$ 45	$ 1.41	$ 1.41	$ 1.37	$ 1.37
AY	001	$ 524	19	0.70	3,200	1	3	1	0.03	0.03	0.03	0.03	$ 27	$ 0.85	$ 0.85	$ 0.83	$ 0.83
AY	001	$ 524	24	0.70	4,000	1	3	1	0.03	0.03	0.03	0.03	$ 22	$ 0.68	$ 0.68	$ 0.66	$ 0.66
AY	001	$ 524	30	0.70	4,800	2	3	1	0.03	0.03	0.03	0.03	$ 17	$ 0.55	$ 0.55	$ 0.53	$ 0.53
AY	001	$ 524	65	0.70	8,800	2	3	1			0.03	0.03	$ 8	$ -	$ -	$ 0.24	$ 0.24
								SUM	1.00	1.00	1.00	1.00		$24.03	$24.03	$23.55	$23.55

Table 106: Outdoor Dining Cost per Watt, continued

2019 LED									Weighting					Weighted Cost per Watt			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	B	U	G	LZ1	LZ2	LZ3	LZ4		LZ1	LZ2	LZ3	LZ4
Wall Mounted																	
C	001	$ 409	16	0.95	696	0	4	0	0.06	0.06	0.06	0.06	$ 26	$ 1.65	$ 1.65	$ 1.65	$ 1.65
H	002	$ 639	14	0.70	846	0	4	0	0.06	0.06	0.06	0.06	$ 46	$ 2.85	$ 2.85	$ 2.85	$ 2.85
S	001	$ 147	26	0.70	823	1	0	0	0.06	0.06	0.06	0.06	$ 6	$ 0.35	$ 0.35	$ 0.35	$ 0.35
AH	001	$ 815	24	0.70	950	1	3	1	0.06	0.06	0.06	0.06	$ 34	$ 2.12	$ 2.12	$ 2.12	$ 2.12
C	001	$ 409	16	0.95	1,084	0	4	0	0.06	0.06	0.06	0.06	$ 26	$ 1.65	$ 1.65	$ 1.65	$ 1.65
S	002	$ 162	18	0.70	1,189	1	1	0	0.06	0.06	0.06	0.06	$ 9	$ 0.56	$ 0.56	$ 0.56	$ 0.56
C	001	$ 409	16	0.95	1,214	0	4	0	0.06	0.06	0.06	0.06	$ 26	$ 1.65	$ 1.65	$ 1.65	$ 1.65
H	001	$ 1,125	17	0.81	1,216	1	1	0	0.06	0.06	0.06	0.06	$ 66	$ 4.14	$ 4.14	$ 4.14	$ 4.14
AF	001	$ 809	40	0.70	1,290	1	1	1	0.06	0.06	0.06	0.06	$ 20	$ 1.25	$ 1.25	$ 1.25	$ 1.25
V	005	$ 381	13	0.91	1,415	0	0	1	0.06	0.06	0.06	0.06	$ 29	$ 1.83	$ 1.83	$ 1.83	$ 1.83
V	004	$ 408	12	0.90	1,494	0	0	0	0.06	0.06	0.06	0.06	$ 34	$ 2.13	$ 2.13	$ 2.13	$ 2.13
B	004	$ 1,719	88	0.70	3,003	1	3	0	0.06	0.06	0.06	0.06	$ 20	$ 1.23	$ 1.23	$ 1.23	$ 1.23
V	005	$ 381	19	0.91	1,957	1	0	1	0.06	0.06	0.06	0.06	$ 20	$ 1.25	$ 1.25	$ 1.25	$ 1.25
V	005	$ 381	19	0.91	2,031	1	0	1	0.06	0.06	0.06	0.06	$ 20	$ 1.25	$ 1.25	$ 1.25	$ 1.25
AE	001	$ 163	27	0.70	2,075	1	1	0	0.06	0.06	0.06	0.06	$ 6	$ 0.38	$ 0.38	$ 0.38	$ 0.38
AF	002	$ 368	20	0.70	2,054	1	1	1	0.06	0.06	0.06	0.06	$ 19	$ 1.17	$ 1.17	$ 1.17	$ 1.17
								SUM	1.00	1.00	1.00	1.00		$25.47	$25.47	$25.47	$25.47
									1.00	1.00	1.00	1.00		$55.43	$55.43	$55.43	$55.43

Table 107: Special Security Lighting for Retail Parking and Pedestrian Hardscape Cost per Watt

2019 LED											Weighting					Weighted Cost per Watt			
Luminaire Manufacturer Letter	Luminaire Product Number	2019 Luminaire Cost	2019 System Watts	LED L70 lifetime hours (LLD)	Initial Luminaire Lumens	Maintained Luminaire Lumens	Lumens per Watt (LPW)	B	U	G	LZ1	LZ2	LZ3	LZ4		LZ1	LZ2	LZ3	LZ4
Area Light																			
B	002	$ 1,381	25	0.93	1,170	1,088	44	1	2	1	0.06	0.05	0.05	0.05	$ 55	$ 3.25	$ 2.63	$ 2.51	$ 2.51
B	002	$ 1,381	25	0.93	1,216	1,131	45	1	1	1	0.06	0.05	0.05	0.05	$ 55	$ 3.25	$ 2.63	$ 2.51	$ 2.51
B	002	$ 1,381	25	0.93	1,735	1,614	65	1	0	1	0.06	0.05	0.05	0.05	$ 55	$ 3.25	$ 2.63	$ 2.51	$ 2.51
A	002	$ 1,553	21	0.83	2,051	1,702	81	1	0	1	0.06	0.05	0.05	0.05	$ 74	$ 4.35	$ 3.52	$ 3.36	$ 3.36
A	002	$ 1,553	21	0.83	2,189	1,817	87	1	0	1	0.06	0.05	0.05	0.05	$ 74	$ 4.35	$ 3.52	$ 3.36	$ 3.36
A	002	$ 1,553	21	0.83	2,114	1,755	84	1	0	1	0.06	0.05	0.05	0.05	$ 74	$ 4.35	$ 3.52	$ 3.36	$ 3.36
A	002	$ 1,553	30	0.83	2,760	2,291	76	1	0	1	0.06	0.05	0.05	0.05	$ 52	$ 3.05	$ 2.47	$ 2.35	$ 2.35
B	002	$ 1,381	25	0.93	1,830	1,702	68	1	0	1	0.06	0.05	0.05	0.05	$ 55	$ 3.25	$ 2.63	$ 2.51	$ 2.51
W	002	$ 1,970	22	0.84	2,117	1,778	81	1	0	1	0.06	0.05	0.05	0.05	$ 90	$ 5.27	$ 4.26	$ 4.07	$ 4.07
BD	001	$ 1,434	36	0.92	2,221	2,043	57	1	0	1	0.06	0.05	0.05	0.05	$ 40	$ 2.34	$ 1.90	$ 1.81	$ 1.81
W	003	$ 1,071	30	0.84	3,126	2,626	88	1	0	1	0.06	0.05	0.05	0.05	$ 36	$ 2.10	$ 1.70	$ 1.62	$ 1.62
BD	001	$ 1,434	52	0.92	3,178	2,924	56	1	0	1	0.06	0.05	0.05	0.05	$ 28	$ 1.62	$ 1.31	$ 1.25	$ 1.25
AF	003	$ 1,776	48	0.70	4,247	2,973	62	1	0	1	0.06	0.05	0.05	0.05	$ 37	$ 2.18	$ 1.76	$ 1.68	$ 1.68
A	001	$ 1,379	22	0.84	1,888	1,586	72	1	0	1	0.06	0.05	0.05	0.05	$ 63	$ 3.69	$ 2.98	$ 2.85	$ 2.85
A	001	$ 1,379	51	0.84	4,431	3,722	73	2	0	2	0.06	0.05	0.05	0.05	$ 27	$ 1.59	$ 1.29	$ 1.23	$ 1.23
A	001	$ 1,379	51	0.84	4,348	3,652	72	1	0	1	0.06	0.05	0.05	0.05	$ 27	$ 1.59	$ 1.29	$ 1.23	$ 1.23
W	003	$ 1,061	51	0.84	5,229	4,392	86	3	0	2	0.06	0.05	0.05	0.05	$ 21	$ 1.22	$ 0.99	$ 0.95	$ 0.95
A	001	$ 1,450	95	0.84	7,312	6,142	65	2	0	2		0.05	0.05	0.05	$ 15	$ -	$ 0.73	$ 0.69	$ 0.69
A	001	$ 1,450	95	0.84	7,572	6,360	67	3	0	2		0.05	0.05	0.05	$ 15	$ -	$ 0.73	$ 0.69	$ 0.69
W	004	$ 1,063	96	0.89	10,231	9,106	95	3	0	2		0.05	0.05	0.05	$ 11	$ -	$ 0.53	$ 0.50	$ 0.50
C	009	$ 863	124	0.95	14,200	13,490	109	2	0	3			0.05	0.05	$ 7	$ -	$ -	$ 0.32	$ 0.32
V	002	$ 1,074	125	0.91	13,999	12,683	101	3	0	1		0.05	0.05	0.05	$ 9	$ -	$ 0.41	$ 0.39	$ 0.39
										SUM	1.00	1.00	1.00	1.00		$50.70	$43.43	$41.77	$41.77
Cylindrical - WM u/d																			
M	001	$ 950	8	0.70	900	630	79	1	1	0	0.33	0.33	0.33	0.33	$ 119	$39.57	$39.57	$39.57	$39.57
AO	001	$ 349	13	0.70	931	652	50	1	1	0	0.33	0.33	0.33	0.33	$ 27	$ 8.96	$ 8.96	$ 8.96	$ 8.96
H	003	$ 434	21	0.81	1,047	848	40	1	4	0	0.33	0.33	0.33	0.33	$ 21	$ 6.89	$ 6.89	$ 6.89	$ 6.89
										SUM	1.00	1.00	1.00	1.00		$55.43	$55.43	$55.43	$55.43
Flood																			
AT	001	$ 571	70	0.93	7,389	6,857	98	na	na	na		0.50	0.25	0.17	$ 8	$ -	$ 4.08	$ 2.04	$ 1.36
AL	001	$ 256	64	0.87	9,275	8,069	126	na	na	na		0.50	0.25	0.17	$ 4	$ -	$ 2.00	$ 1.00	$ 0.67
AT	002	$ 953	90	0.92	10,699	9,854	109	na	na	na			0.25	0.17	$ 11	$ -	$ -	$ 2.65	$ 1.77
C	007	$ 1,305	99	0.70	11,100	7,770	78	na	na	na			0.25	0.17	$ 13	$ -	$ -	$ 3.30	$ 2.20
AT	002	$ 1,017	135	0.92	13,709	12,626	94	na	na	na				0.17	$ 8	$ -	$ -	$ -	$ 1.26
AT	002	$ 1,079	175	0.92	17,615	16,223	93	na	na	na				0.17	$ 6	$ -	$ -	$ -	$ 1.03
										SUM	0.00	1.00	1.00	1.00		$ -	$ 6.08	$ 8.98	$ 8.27
Wall Mounted																			
C	001	$ 409	16	0.95	696	661	43	0	4	0	0.04	0.04	0.04	0.04	$ 26	$ 1.15	$ 1.06	$ 1.02	$ 1.02
H	002	$ 639	14	0.70	846	592	42	0	4	0	0.04	0.04	0.04	0.04	$ 46	$ 1.98	$ 1.83	$ 1.76	$ 1.76
S	001	$ 147	26	0.70	823	576	22	1	0	0	0.04	0.04	0.04	0.04	$ 6	$ 0.24	$ 0.22	$ 0.22	$ 0.22
AH	001	$ 815	24	0.70	950	665	28	1	3	1	0.04	0.04	0.04	0.04	$ 34	$ 1.48	$ 1.36	$ 1.31	$ 1.31
C	001	$ 409	16	0.95	1,084	1,030	66	0	4	0	0.04	0.04	0.04	0.04	$ 26	$ 1.15	$ 1.06	$ 1.02	$ 1.02
S	002	$ 162	18	0.70	1,189	832	46	1	1	0	0.04	0.04	0.04	0.04	$ 9	$ 0.39	$ 0.36	$ 0.35	$ 0.35
C	001	$ 409	16	0.95	1,214	1,153	74	0	4	0	0.04	0.04	0.04	0.04	$ 26	$ 1.15	$ 1.06	$ 1.02	$ 1.02
H	001	$ 1,125	17	0.81	1,216	985	58	1	1	0	0.04	0.04	0.04	0.04	$ 66	$ 2.88	$ 2.65	$ 2.55	$ 2.55
AF	001	$ 809	40	0.70	1,290	903	22	1	1	1	0.04	0.04	0.04	0.04	$ 20	$ 0.87	$ 0.80	$ 0.77	$ 0.77
V	005	$ 381	13	0.91	1,415	1,288	99	0	0	1	0.04	0.04	0.04	0.04	$ 29	$ 1.28	$ 1.17	$ 1.13	$ 1.13
V	004	$ 408	12	0.90	1,494	1,345	112	0	0	0	0.04	0.04	0.04	0.04	$ 34	$ 1.48	$ 1.36	$ 1.31	$ 1.31
B	004	$ 1,719	88	0.70	3,003	2,102	24	1	3	0	0.04	0.04	0.04	0.04	$ 20	$ 0.85	$ 0.79	$ 0.75	$ 0.75
V	005	$ 381	19	0.91	1,957	1,781	94	1	0	1	0.04	0.04	0.04	0.04	$ 20	$ 0.87	$ 0.80	$ 0.77	$ 0.77
V	005	$ 381	19	0.91	2,031	1,848	97	1	0	1	0.04	0.04	0.04	0.04	$ 20	$ 0.87	$ 0.80	$ 0.77	$ 0.77
AE	001	$ 163	27	0.70	2,075	1,453	54	1	1	0	0.04	0.04	0.04	0.04	$ 6	$ 0.26	$ 0.24	$ 0.23	$ 0.23
AF	002	$ 368	20	0.70	2,054	1,438	73	1	1	1	0.04	0.04	0.04	0.04	$ 19	$ 0.82	$ 0.75	$ 0.72	$ 0.72
V	005	$ 381	26	0.91	2,623	2,387	92	1	0	1	0.04	0.04	0.04	0.04	$ 15	$ 0.64	$ 0.59	$ 0.56	$ 0.56
AG	001	$ 518	36	0.70	2,603	1,822	51	1	0	1	0.04	0.04	0.04	0.04	$ 14	$ 0.63	$ 0.58	$ 0.55	$ 0.55
V	004	$ 449	25	0.90	3,163	2,847	114	1	0	1	0.04	0.04	0.04	0.04	$ 18	$ 0.78	$ 0.72	$ 0.69	$ 0.69
V	005	$ 506	35	0.91	3,912	3,560	102	1	0	2	0.04	0.04	0.04	0.04	$ 14	$ 0.63	$ 0.58	$ 0.56	$ 0.56
V	004	$ 490	50	0.90	6,025	5,423	108	1	0	1	0.04	0.04	0.04	0.04	$ 10	$ 0.43	$ 0.39	$ 0.38	$ 0.38
B	004	$ 707	52	0.70	4,390	3,073	59	1	0	0	0.04	0.04	0.04	0.04	$ 14	$ 0.59	$ 0.54	$ 0.52	$ 0.52
V	004	$ 490	50	0.90	6,025	5,423	108	1	0	1	0.04	0.04	0.04	0.04	$ 10	$ 0.43	$ 0.39	$ 0.38	$ 0.38
V	005	$ 506	73	0.91	6,865	6,247	86	1	0	2		0.04	0.04	0.04	$ 7	$ -	$ 0.28	$ 0.27	$ 0.27
W	004	$ 1,027	76	0.70	8,051	5,636	74	3	0	3			0.04	0.04	$ 14	$ -	$ -	$ 0.52	$ 0.52
W	004	$ 1,107	101	0.70	12,064	8,445	84	2	0	2		0.04	0.04	0.04	$ 11	$ -	$ 0.44	$ 0.42	$ 0.42
										SUM	1.00	1.00	1.00	1.00		$21.84	$20.80	$20.52	$20.52
							Average:				1.00	1.00	1.00	1.00		$55.43	$55.43	$55.43	$55.43

Appendix K: General Hardscape Lighting Power Allowance Calculations

The General Hardscape lighting levels are taken from the IES RP-8-18 Chapter 17 Addendum 1 Parking Facilities. IES is recommending lower parking lot lighting levels based on recent research by VTTI, which found that lower lighting levels are necessary than previously published. This research also found that task visibility does not change depending on pavement surface type. Due to these findings, the surface classification distinction would be removed from Title 24, Part 6 Table 140.7-A to simplify code compliance.

The general hardscape lighting power allowance calculations are based on 46 different products by 17 different manufacturers that represent typical area luminaires. These products include architectural area lights and post top lights with Type III, Type IV, and Type V distributions. Each luminaire studied was selected to meet the backlight, uplight, and glare (BUG) ratings specified in Title 24, Part 11, Table 5.106.8 (CALGreen). Luminaires installed within two mounting heights have a property line have minimal backlight to reduce light trespass across the adjacent property line.

The luminaire wattage, lumen output, and unit cost can be found in Table 108 below. Low lumen output luminaires were considered for lighting zones with less ambient light (LZ1 and LZ2) and lower luminaire mounting heights. The real design calculation for LZ1 and LZ2 were performed for mounting heights of 10 feet to 35 feet. The LZ3 calculations were performed for mounting heights of 15 feet to 40 feet. The LZ4 calculations were performed for mounting heights of 15 feet to 50 feet. The amount of times each luminaire was studied within each LZ is shown in Table 109.

Table 108: General Hardscape Luminaire Characteristics and Cost

Luminaire ID	Wattage	Lumens	Unit Cost	Cost per Lumen	Cost per Watt
A 01	95	7,312	$ 1,450	$ 0.20	$ 15.26
A 02	21	2,189	$ 1,553	$ 0.71	$ 73.97
A 03	31	2,653	$ 1,379	$ 0.52	$ 44.48
A 04	161	18,928	$ 301	$ 0.02	$ 1.87
AF 03	70	6,096	$ 1,776	$ 0.29	$ 25.37
AQ 02	124	10,128	$ 1,060	$ 0.10	$ 8.58
AQ 02	95	8,070	$ 1,060	$ 0.13	$ 11.22
AQ 03	75	5,948	$ 1,060	$ 0.18	$ 14.13
AQ 04	105	7,541	$ 1,060	$ 0.14	$ 10.14
AT 02	126	11,685	$ 2,090	$ 0.18	$ 16.64
AU 02	43	3,745	$ 1,628	$ 0.43	$ 37.85
AU 03	122	12,727	$ 2,103	$ 0.17	$ 17.24
AU 04	81	7,492	$ 2,007	$ 0.27	$ 24.78
AU 05	81	7,956	$ 2,103	$ 0.26	$ 25.96
B 03	130	11,718	$ 2,332	$ 0.20	$ 17.94
B 05	38	2,226	$ 1,778	$ 0.80	$ 47.04
B 06	130	11,718	$ 2,332	$ 0.20	$ 17.94
BD 01	53	3,127	$ 1,434	$ 0.46	$ 27.20
BF 01	67	4,843	$ 1,731	$ 0.36	$ 25.83
BF 02	45	4,260	$ 1,620	$ 0.38	$ 35.99
BF 02	45	4,187	$ 1,620	$ 0.39	$ 35.99
BF 03	64	4,843	$ 1,591	$ 0.33	$ 25.05
BG 01	54	3,937	$ 1,060	$ 0.27	$ 19.81
BH 01	18	2,190	$ 1,060	$ 0.48	$ 58.89
BH 02	56	6,694	$ 1,060	$ 0.16	$ 18.93
C 04	24	2,061	$ 1,741	$ 0.84	$ 72.53
C 08	25	2,905	$ 686	$ 0.24	$ 27.77
C 09	66	8,175	$ 747	$ 0.09	$ 11.32
C 10	44	4,612	$ 643	$ 0.14	$ 14.60
D 01	186	24,600	$ 742	$ 0.03	$ 3.99
D 02	58	6,200	$ 679	$ 0.11	$ 11.70
D 02	58	5,800	$ 679	$ 0.12	$ 11.70
D 03	35	3,800	$ 762	$ 0.20	$ 21.78
D 04	43	4,800	$ 820	$ 0.17	$ 19.06
E 01	25	3,789	$ 1,187	$ 0.31	$ 46.73
E 02	45	3,905	$ 1,253	$ 0.32	$ 27.85
E 03	38	4,280	$ 662	$ 0.15	$ 17.42
I 02	72	5,126	$ 1,060	$ 0.21	$ 14.72
I 03	72	4,639	$ 1,060	$ 0.23	$ 14.72
I 04	72	6,959	$ 1,060	$ 0.15	$ 14.72
T 02	62	6,455	$ 618	$ 0.10	$ 9.96
V 02	54	6,710	$ 1,074	$ 0.16	$ 19.88
V 03	80	27,301	$ 1,338	$ 0.05	$ 16.72
V 04	50	6,025	$ 490	$ 0.08	$ 9.80
V 06	75	5,398	$ 1,492	$ 0.28	$ 19.89
V 07	35	4,123	$ 570	$ 0.14	$ 16.28
W 02	31	2,881	$ 1,970	$ 0.68	$ 63.55
W 03	30	3,126	$ 1,071	$ 0.34	$ 35.69
W 04	51	5,229	$ 1,061	$ 0.20	$ 20.80
W 05	56	6,044	$ 960	$ 0.16	$ 17.23
W 06	37	3,458	$ 379	$ 0.11	$ 10.29
W 07	28	2,687	$ 379	$ 0.14	$ 13.62

Table 109: General Hardscape Weighting

2019 Weighting						
0.10%	4.95%	4.95%	45.00%	45.00%	0.00%	0.00%
2019 Studied						
LZ1-A	LZ2-A	LZ2-C	LZ3-A	LZ3-C	LZ4-A	LZ4-C
0	0.13	0.13	0.05	0.05	0.04	0.04
0.01	0.02	0.02	0.02	0.02	0	0
0.01	0.05	0.05	0.02	0.02	0	0
0	0	0	0	0	0.06	0.06
0	0	0	0	0	0.01	0.01
0.01	0	0	0	0	0.01	0.01
0.04	0	0	0.03	0.03	0.01	0.01
0	0	0	0.03	0.03	0	0
0	0	0	0.03	0.03	0	0
0	0	0	0	0	0.03	0.03
0	0.02	0.02	0	0	0	0
0	0.02	0.02	0	0	0.04	0.04
0	0.03	0.03	0	0	0.01	0.01
0.04	0.02	0.02	0.02	0.02	0	0
0	0	0	0.05	0.05	0.04	0.04
0.04	0.02	0.02	0	0	0	0
0.03	0.03	0.03	0	0	0.01	0.01
0.01	0.03	0.03	0.02	0.02	0.07	0.07
0	0	0	0.02	0.02	0	0
0	0	0	0.03	0.03	0	0
0	0	0	0.03	0.03	0	0
0	0	0	0.03	0.03	0	0
0	0	0	0.03	0.03	0	0
0	0	0	0.03	0.03	0	0
0	0	0	0.02	0.02	0	0
0.07	0	0	0	0	0.01	0.01
0.18	0.05	0.05	0.07	0.07	0	0
0	0	0	0	0	0.06	0.06
0.06	0.03	0.03	0	0	0.04	0.04
0	0	0	0	0	0.03	0.03
0.01	0	0	0	0	0.06	0.06
0	0.08	0.08	0.07	0.07	0	0
0.08	0.03	0.03	0	0	0.01	0.01
0	0.02	0.02	0	0	0	0
0	0.02	0.02	0	0	0	0
0	0.02	0.02	0	0	0	0
0.06	0.05	0.05	0.02	0.02	0.06	0.06
0	0.02	0.02	0	0	0	0
0.04	0.03	0.03	0	0	0.01	0.01
0	0	0	0.02	0.02	0.06	0.06
0.07	0.02	0.02	0.13	0.13	0.07	0.07
0.04	0.03	0.03	0.1	0.1	0.01	0.01
0	0	0	0	0	0.04	0.04
0	0.05	0.05	0	0	0	0
0	0.02	0.02	0	0	0	0
0.03	0.03	0.03	0.08	0.08	0	0
0	0.02	0.02	0	0	0	0
0.01	0	0	0	0	0.01	0.01
0	0.07	0.07	0.05	0.05	0.03	0.03
0	0.02	0.02	0.02	0.02	0.09	0.09
0.08	0.02	0.02	0	0	0	0
0.04	0.03	0.03	0	0	0	0

2022 Weighting			
0.10%	9.90%	90.00%	0.00%
2022 Studied			
LZ1	LZ2	LZ3	LZ4
0	0.13	0.05	0.04
0.01	0.02	0.02	0
0.01	0.05	0.02	0
0	0	0	0.06
0	0	0	0.01
0.01	0	0	0.01
0.04	0	0.03	0.01
0	0	0.03	0
0	0	0.03	0
0	0	0	0.03
0	0.02	0	0
0	0.02	0	0.04
0	0.03	0	0.01
0.04	0.02	0.02	0
0	0	0.05	0.04
0.04	0.02	0	0
0.03	0.03	0	0.01
0.01	0.03	0.02	0.07
0	0	0.02	0
0	0	0.03	0
0	0	0.03	0
0	0	0.03	0
0	0	0.03	0
0	0	0.03	0
0	0	0.02	0
0.07	0	0	0.01
0.18	0.05	0.07	0
0	0	0	0.06
0.06	0.03	0	0.04
0	0	0	0.03
0.01	0	0	0.06
0	0.08	0.07	0
0.08	0.03	0	0.01
0	0.02	0	0
0	0.02	0	0
0	0.02	0	0
0.06	0.05	0.02	0.06
0	0.02	0	0
0.04	0.03	0	0.01
0	0	0.02	0.06
0.07	0.02	0.13	0.07
0.04	0.03	0.1	0.01
0	0	0	0.04
0	0.05	0	0
0	0.02	0	0
0.03	0.03	0.08	0
0	0.02	0	0
0.01	0	0	0.01
0	0.07	0.05	0.03
0	0.02	0.02	0.09
0.08	0.02	0	0
0.04	0.03	0	0

Luminaire ID
A 01
A 02
A 03
A 04
AF 03
AQ 02
AQ 02
AQ 03
AQ 04
AT 02
AU 02
AU 03
AU 04
AU 05
B 03
B 05
B 06
BD 01
BF 01
BF 02
BF 02
BF 03
BG 01
BH 01
BH 02
C 04
C 08
C 09
C 10
D 01
D 02
D 02
D 03
D 04
E 01
E 02
E 03
I 02
I 03
I 04
T 02
V 02
V 03
V 04
V 06
V 07
W 02
W 03
W 04
W 05
W 06
W 07

The weighting factors listed below in Table 110 and Table 111 were used to determine the statewide luminaire pricing listed Table 112. The statewide weighting factors were multiplied by the unit cost of each luminaire studied to determine the average statewide cost per each lighting zone.

Table 110: 2019 Title 24 Lighting Zone Weighting

LZ1	LZ2	LZ3	LZ4
0.1%	9.9%	90.0%	0.0%

Table 111: 2022 Title 24 Lighting Zone Weighting

LZ1	LZ2	LZ3	LZ4
5.0%	5.0%	90.0%	0.0%

Table 112: General Hardscape Weighted Cost Comparison

Luminaire ID	2022 Studied Cost Per kW. Statewide Results LZ1	LZ2	LZ3	LZ4	2019 Studied Cost Per kW. Statewide Results LZ1	LZ2	LZ3	LZ4
A01	$-	$ 3,502,942	$ 14,268,587	$-	$-	$ 4,490,409	$ 18,171,882	$-
A02	$ 15,537	$ 2,122,313	$ 23,052,937	$-	$ 16,084	$ 2,720,586	$ 29,359,266	$-
A03	$ 9,342	$ 3,828,069	$ 13,860,384	$-	$ 9,671	$ 4,907,188	$ 17,652,011	$-
A04	$-	$-	$-	$-	$-	$-	$-	$-
AF 03	$-	$-	$-	$-	$-	$-	$-	$-
AQ 02	$ 1,801	$-	$-	$-	$ 1,865	$-	$-	$-
AQ 02	$ 7,088	$-	$ 6,991,210	$-	$ 7,317	$-	$ 8,903,715	$-
AQ 03	$-	$-	$ 8,808,924	$-	$-	$-	$ 11,218,681	$-
AQ 04	$-	$-	$ 6,322,194	$-	$-	$-	$ 8,051,685	$-
AT 02	$-	$-	$-	$-	$-	$-	$-	$-
AU 02	$-	$ 1,085,885	$-	$-	$-	$ 1,391,993	$-	$-
AU 03	$-	$ 494,487	$-	$-	$-	$ 633,882	$-	$-
AU 04	$-	$ 1,421,929	$-	$-	$-	$ 1,822,766	$-	$-
AU 05	$ 16,358	$ 744,783	$ 8,089,967	$-	$ 16,933	$ 954,735	$ 10,303,048	$-
B 03	$-	$-	$ 16,771,124	$-	$-	$-	$ 21,359,009	$-
B 05	$ 29,639	$ 1,349,496	$-	$-	$ 30,682	$ 1,729,914	$-	$-
B 06	$ 7,536	$ 1,029,329	$-	$-	$ 7,801	$ 1,319,493	$-	$-
BD 01	$ 5,714	$ 1,560,979	$ 8,477,813	$-	$ 5,915	$ 2,001,013	$ 10,796,992	$-
BF 01	$-	$-	$ 8,049,663	$-	$-	$-	$ 10,251,718	$-
BF 02	$-	$-	$ 22,432,008	$-	$-	$-	$ 28,568,478	$-
BF 02	$-	$-	$ 22,432,008	$-	$-	$-	$ 28,568,478	$-
BF 03	$-	$-	$ 15,614,999	$-	$-	$-	$ 19,886,617	$-
BG 01	$-	$-	$ 12,348,959	$-	$-	$-	$ 15,727,123	$-
BH 01	$-	$-	$ 36,703,851	$-	$-	$-	$ 46,744,505	$-
BH 02	$-	$-	$ 5,898,833	$-	$-	$-	$ 7,512,510	$-
C 04	$ 76,166	$-	$-	$-	$ 78,847	$-	$-	$-
C 08	$ 75,836	$ 2,390,486	$ 34,621,171	$-	$ 78,506	$ 3,064,356	$ 44,092,091	$-
C 09	$-	$-	$-	$-	$-	$-	$-	$-
C 10	$ 12,270	$ 837,998	$-	$-	$ 12,702	$ 1,074,226	$-	$-
D 01	$-	$-	$-	$-	$-	$-	$-	$-
D 02	$ 2,458	$-	$-	$-	$ 2,545	$-	$-	$-
D 02	$-	$ 1,678,814	$ 14,588,455	$-	$-	$ 2,152,066	$ 18,579,253	$-
D 03	$ 27,451	$ 1,249,870	$-	$-	$ 28,417	$ 1,602,204	$-	$-
D 04	$-	$ 546,959	$-	$-	$-	$ 701,145	$-	$-
E 01	$-	$ 1,340,741	$-	$-	$-	$ 1,718,691	$-	$-
E 02	$-	$ 798,974	$-	$-	$-	$ 1,024,201	$-	$-
E 03	$ 14,633	$ 1,499,094	$ 5,427,805	$-	$ 15,148	$ 1,921,683	$ 6,912,628	$-
I 02	$-	$ 422,381	$-	$-	$-	$ 541,449	$-	$-
I 03	$ 9,277	$ 844,763	$-	$-	$ 9,603	$ 1,082,899	$-	$-
I 04	$-	$-	$ 4,587,981	$-	$-	$-	$ 5,843,063	$-
T 02	$ 10,462	$ 285,809	$ 24,836,019	$-	$ 10,830	$ 366,377	$ 31,830,126	$-
V02	$ 12,529	$ 1,140,898	$ 37,177,884	$-	$ 12,970	$ 1,462,513	$ 47,348,215	$-
V03	$-	$-	$-	$-	$-	$-	$-	$-
V04	$-	$ 843,798	$-	$-	$-	$ 1,081,661	$-	$-
V06	$-	$ 570,695	$-	$-	$-	$ 731,572	$-	$-
V07	$ 6,837	$ 933,870	$ 25,359,640	$-	$ 7,077	$ 1,197,124	$ 32,296,988	$-
W 02	$-	$ 1,823,392	$-	$-	$-	$ 2,337,400	$-	$-
W 03	$ 7,495	$-	$-	$-	$ 7,759	$-	$-	$-
W 04	$-	$ 2,386,541	$ 19,442,266	$-	$-	$ 3,059,298	$ 24,760,865	$-
W 05	$-	$ 494,231	$ 5,368,428	$-	$-	$ 633,553	$ 6,837,007	$-
W 06	$ 12,968	$ 295,219	$-	$-	$ 13,424	$ 378,440	$-	$-
W 07	$ 8,583	$ 781,587	$-	$-	$ 8,885	$ 1,001,914	$-	$-

	LZ1	LZ2	LZ3	LZ4	LZ1	LZ2	LZ3	LZ4
Average Statewide Cost on a Fixture	$ 7,115	$ 736,660	$ 7,721,791	$-	$ 7,365	$ 944,322	$ 9,834,153	$-
TOTAL	$ 369,958	$ 38,306,332	$ 401,533,112	$-	$ 382,981	$ 49,104,752	$ 511,375,954	$-

Appendix L: Mapping of IES Criteria

The target illuminance values proposed for the 2022 code cycle are found below. These proposed lighting levels are taken from current IES recommendations and the California Financial Code ATM lighting requirements. The parking lot lighting level criteria was recently revised by IES in the beginning of 2020 to revert back to the lighting levels recommended before 2014. This addendum is reflected in the applied parking lot lighting criteria below.

Table 113: Lighting Criteria Mapping

	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Area Wattage Allowance (AWA); Linear Wattage Allowance (LWA); and Initial Wattage Allowance (IWA)	Not Applicable	RP-8-18 Chapter 17 Parking Facilities, Addendum 1 0.2 Horizontal FC Min, 0.1 Vertical FC Min, 20:1 Max:Min	RP-8-18 Chapter 17 Parking Facilities, Addendum 1 0.2 Horizontal FC Min, 0.1 Vertical FC Min, 20:1 Max:Min	RP-8-18 Chapter 17 Parking Facilities, Addendum 1 0.2 Horizontal FC Min, 0.1 Vertical FC Min, 20:1 Max:Min	RP-8-18 Chapter 17 Parking Facilities, Addendum 1 0.2 Horizontal FC Min, 0.1 Vertical FC Min, 20:1 Max:Min
Building Entrances or Exits. Allowance per door. Luminaires qualifying for this allowance shall be within 20 feet of the door.	Not Applicable	HB10 T22.2 "Non-Covered Entries/Exits - Medium Activity LZ1" 1.0 Horizontal FC Avg, 2:1 Avg:Min 0.4 Vertical FC Avg, 4:1 Avg:Min	HB10 T22.2 "Non-Covered Entries/Exits - Medium Activity LZ2" 1.0 Horizontal FC Avg, 2:1 Avg:Min 0.6 Vertical FC Avg, 4:1 Avg:Min	HB10 T22.2 "Non-Covered Entries/Exits - Medium Activity LZ3" 1.0 Horizontal FC Avg, 2:1 Avg:Min 0.8 Vertical FC Avg, 4:1 Avg:Min	HB10 T22.2 "Non-Covered Entries/Exits - Medium Activity LZ4" 1.0 Horizontal FC Avg, 2:1 Avg:Min 1.0 Vertical FC Avg, 2:1 Avg:Min

	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Primary Entrances to Senior Care Facilities, Police Stations, Hospitals, Fire Stations, and Emergency Vehicle Facilities. Allowance per primary entrance(s) only. Primary entrances shall provide access for the general public and shall not be used exclusively for staff or service personnel. This allowance shall be in addition to the building entrance or exit allowance above. Luminaires qualifying for this allowance shall be within 100 feet of the primary entrance.	Not Applicable	HB10 T22.2 "Building Entries, Porte Cocheres - High Activity for Elderly LZ1" 2.0 Horizontal FC Avg, 2:1 Avg:Min 1.5 Vertical FC Avg, 4:1 Avg:Min	HB10 T22.2 "Building Entries, Porte Cocheres - High Activity for Elderly LZ2" 4.0 Horizontal FC Avg, 2:1 Avg:Min 2.0 Vertical FC Avg, 4:1 Avg:Min	HB10 T22.2 "Building Entries, Porte Cocheres - High Activity for Elderly LZ3" 5.0 Horizontal FC Avg, 2:1 Avg:Min 3.0 Vertical FC Avg, 4:1 Avg:Min	HB10 T22.2 "Building Entries, Porte Cocheres - High Activity for Elderly LZ4" 7.5 Horizontal FC Avg, 2:1 Avg:Min 4.0 Vertical FC Avg, 2:1 Avg:Min
Drive Up Windows. Allowance per customer service location. Luminaires qualifying for this allowance shall be within two mounting heights of the sill of the window.	Not Applicable	HB10 T31.2 "Drive-Up Financial Services - Covered LZ1" 2.0 Horizontal FC Avg, 3:1 Avg:Min 0.8 Vertical FC Avg, 6:1 Avg:Min	HB10 T31.2 "Drive-Up Financial Services - Covered LZ2" 3.0 Horizontal FC Avg, 3:1 Avg:Min 1.0 Vertical FC Avg, 6:1 Avg:Min	HB10 T31.2 "Drive-Up Financial Services - Covered LZ3" 4.0 Horizontal FC Avg, 3:1 Avg:Min 1.5 Vertical FC Avg, 6:1 Avg:Min	HB10 T31.2 "Drive-Up Financial Services - Covered LZ4" 5.0 Horizontal FC Avg, 3:1 Avg:Min 2.0 Vertical FC Avg, 3:1 Avg:Min
Vehicle Service Station Uncovered Fuel Dispenser. Allowance per fueling dispenser. Luminaires qualifying for this allowance shall be within two mounting heights of the dispenser.	Not Applicable	HB10 T34.2 "Service Stations Dispensing Islands - Medium Activity LZ1 5.0 Horizontal FC Avg, 4:1 Avg:Min 5.0 Vertical FC Avg, 8:1 Avg:Min	HB10 T34.2 "Service Stations Dispensing Islands - Medium Activity LZ2" 7.5 Horizontal FC Avg, 4:1 Avg:Min 7.5 Vertical FC Avg, 8:1 Avg:Min	HB10 T34.2 "Service Stations Dispensing Islands - Medium Activity LZ3" 10.0 Horizontal FC Avg, 4:1 Avg:Min 10.0 Vertical FC Avg, 8:1 Avg:Min	HB10 T34.2 "Service Stations Dispensing Islands - Medium Activity LZ4" 15.0 Horizontal FC Avg, 4:1 Avg:Min 15.0 Vertical FC Avg, 4:1 Avg:Min

	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
ATM Machine Lighting. Allowance per ATM machine. Luminaires qualifying for this allowance shall be within 50 feet of the dispenser.	Not Applicable	California Financial Code 13041 10.0 Horizontal FC Min within 5ft 2.0 Horizontal FC Min within 60ft 10.0 Vertical FC Min on machine face	California Financial Code 13041 10.0 Horizontal FC Min within 5ft 2.0 Horizontal FC Min within 60ft 10.0 Vertical FC Min on machine face	California Financial Code 13041 10.0 Horizontal FC Min within 5ft 2.0 Horizontal FC Min within 60ft 10.0 Vertical FC Min on machine face	California Financial Code 13041 10.0 Horizontal FC Min within 5ft 2.0 Horizontal FC Min within 60ft 10.0 Vertical FC Min on machine face
Outdoor Sales Frontage. Allowance for frontage immediately adjacent to the principal viewing location(s) and unobstructed for its viewing length. A corner sales lot may include two adjacent sides provided that a different principal viewing location exists for each side. Luminaires qualifying for this allowance shall be located between the principal viewing location and the frontage outdoor sales area.	Not Applicable	NO ALLOWANCE	HB10 T34.2 "Automotive Sales Front Row - Medium Activity LZ2" 10.0 Horizontal FC Avg, 3:1 Avg:Min 10.0 Vertical FC Avg, 6:1 Avg:Min	HB10 T34.2 "Automotive Sales Front Row - Medium Activity LZ3" 15.0 Horizontal FC Avg, 3:1 Avg:Min 15.0 Vertical FC Avg, 6:1 Avg:Min	HB10 T34.2 "Automotive Sales Front Row - Medium Activity LZ4" 20.0 Horizontal FC Avg, 3:1 Avg:Min 20.0 Vertical FC Avg, 3:1 Avg:Min
Hardscape Ornamental Lighting. Allowance for the total site illuminated hardscape area. Luminaires qualifying for this allowance shall be rated for 100 watts or less as determined in accordance with Section 130(d), and shall be post-top luminaires, lanterns, pendant luminaires, or chandeliers.	Not Applicable	NO ALLOWANCE	HB10 T34.2 "Centers, Outdoor, Plazas and Town Squares - Medium Activity LZ2" 0.2 Horizontal FC Avg, 5:1 Avg:Min 0.1 Vertical FC Avg, 10:1 Avg:Min	HB10 T34.2 "Centers, Outdoor, Plazas and Town Squares - Medium Activity LZ3" 0.4 Horizontal FC Avg, 5:1 Avg:Min 0.2 Vertical FC Avg, 10:1 Avg:Min	HB10 T34.2 "Centers, Outdoor, Plazas and Town Squares - Medium Activity LZ4" 0.6 Horizontal FC Avg, 5:1 Avg:Min 0.2 Vertical FC Avg, 5:1 Avg:Min

	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Building Facades. Only areas of building façade that are illuminated shall qualify for this allowance. Luminaires qualifying for this allowance shall be aimed at the façade and shall be capable of illuminating it without obstruction or interference by permanent building features or other objects.	Not Applicable	NO ALLOWANCE	HB10 T26.2 "Façade Fields - Medium Activity LZ2 Reflectance ≥ 50%" 2 FC AVG	HB10 T26.2 "Façade Fields - Medium Activity LZ3 Reflectance ≥ 50%" 3 FC AVG	HB10 T26.2 "Façade Fields - Medium Activity LZ4 Reflectance ≥ 50%" 4 FC AVG
Outdoor Sales Lots. Allowance for uncovered sales lots used exclusively for the display of vehicles or other merchandise for sale. Driveways, parking lots or other non-sales areas shall be considered hardscape areas even if these areas are completely surrounded by sales lot on all sides. Luminaires qualifying for this allowance shall be within 5 mounting heights of the sales lot area.	Not Applicable	HB10 T34.2 "Automotive Sales, Sales - Medium Activity LZ1" 4.0 Horizontal FC Avg, 3:1 Avg:Min 2.0 Vertical FC Avg, 6:1 Avg:Min	HB10 T34.2 "Automotive Sales, Sales - Medium Activity LZ2" 5.0 Horizontal FC Avg, 3:1 Avg:Min 3.0 Vertical FC Avg, 6:1 Avg:Min	HB10 T34.2 "Automotive Sales, Sales - Medium Activity LZ3" 7.5 Horizontal FC Avg, 3:1 Avg:Min 4.0 Vertical FC Avg, 6:1 Avg:Min	HB10 T34.2 "Automotive Sales, Sales - Medium Activity LZ4" 10.0 Horizontal FC Avg, 3:1 Avg:Min 5.0 Vertical FC Avg, 3:1 Avg:Min

	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Vehicle Service Station Hardscape. Allowance for the total illuminated hardscape area less area of buildings, under canopies, off property, or obstructed by signs or structures. Luminaires qualifying for this allowance shall be illuminating the hardscape area and shall not be within a building, below a canopy, beyond property lines, or obstructed by a sign or other structure.	Not Applicable	HB10 T34.2 "Service Stations Outdoor Service - Medium Activity LZ1" 1.5 Horizontal FC Avg, 2:1 Avg:Min 1.5 Vertical FC Avg, 4:1 Avg:Min	HB10 T34.2 "Service Stations Outdoor Service - Medium Activity LZ2" 2.0 Horizontal FC Avg, 2:1 Avg:Min 2.0 Vertical FC Avg, 4:1 Avg:Min	HB10 T34.2 "Service Stations Outdoor Service - Medium Activity LZ3" 3.0 Horizontal FC Avg, 2:1 Avg:Min 3.0 Vertical FC Avg, 4:1 Avg:Min	HB10 T34.2 "Service Stations Outdoor Service - Medium Activity LZ4" 4.0 Horizontal FC Avg, 2:1 Avg:Min 4.0 Vertical FC Avg, 2:1 Avg:Min
Vehicle Service Station Canopies. Allowance for the total area within the drip line of the canopy. Luminaires qualifying for this allowance shall be located under the canopy.	Not Applicable	HB10 T34.2 "Service Stations Dispensing Islands - Medium Activity LZ1" 5.0 Horizontal FC Avg, 4:1 Avg:Min 5.0 Vertical FC Avg, 8:1 Avg:Min	HB10 T34.2 "Service Stations Dispensing Islands - Medium Activity LZ2" 7.5 Horizontal FC Avg, 4:1 Avg:Min 7.5 Vertical FC Avg, 8:1 Avg:Min	HB10 T34.2 "Service Stations Dispensing Islands - Medium Activity LZ3" 10.0 Horizontal FC Avg, 4:1 Avg:Min 10.0 Vertical FC Avg, 8:1 Avg:Min	HB10 T34.2 "Service Stations Dispensing Islands - Medium Activity LZ4" 15.0 Horizontal FC Avg, 4:1 Avg:Min 15.0 Vertical FC Avg, 4:1 Avg:Min
Sales Canopies. Allowance for the total area within the drip line of the canopy. Luminaires qualifying for this allowance shall be located under the canopy.	Not Applicable	HB10 T34.2 "Seasonal Open-Air Merchandise - LZ1" 1.5 Horizontal FC Avg, 2:1 Avg:Min 1.5 Vertical FC Avg, 4:1 Avg:Min	HB10 T34.2 "Seasonal Open-Air Merchandise - LZ2" 2.0 Horizontal FC Avg, 2:1 Avg:Min 2.0 Vertical FC Avg, 4:1 Avg:Min	HB10 T34.2 "Seasonal Open-Air Merchandise - LZ3" 3.0 Horizontal FC Avg, 2:1 Avg:Min 3.0 Vertical FC Avg, 4:1 Avg:Min	HB10 T34.2 "Seasonal Open-Air Merchandise - LZ4" 4.0 Horizontal FC Avg, 2:1 Avg:Min 4.0 Vertical FC Avg, 4:1 Avg:Min

	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Non-sales Canopies and Tunnels. Allowance for the total area within the drip line of the canopy or inside the tunnel. Luminaires qualifying for this allowance shall be located under the canopy or tunnel.	Not Applicable	HB10 T22.2 "Canopied Entries - Medium Activity LZ1" 0.8 Horizontal FC Avg, 2:1 Avg:Min 0.4 Vertical FC Avg, 4:1 Avg:Min	HB10 T22.2 "Canopied Entries - Medium Activity LZ2" 1.0 Horizontal FC Avg, 2:1 Avg:Min 0.6 Vertical FC Avg, 4:1 Avg:Min	HB10 T22.2 "Canopied Entries - Medium Activity LZ3" 1.5 Horizontal FC Avg, 2:1 Avg:Min 0.8 Vertical FC Avg, 4:1 Avg:Min	HB10 T22.2 "Canopied Entries - Medium Activity LZ1" 2.0 Horizontal FC Avg, 2:1 Avg:Min 1.0 Vertical FC Avg, 2:1 Avg:Min
Guard Stations. Allowance up to 1,000 square feet per vehicle lane. Guard stations provide access to secure areas controlled by security personnel who stop and may inspect vehicles and vehicle occupants, including identification, documentation, vehicle license plates, and vehicle contents. Qualifying luminaires shall be within two mounting heights of a vehicle lane or the guardhouse.	Not Applicable	HB10 T22.2 "Remote Monitored Site Gated Entries - Vehicles LZ1" 1.0 Horizontal FC Avg, 2:1 Avg:Min 0.8 Vertical FC Avg, 4:1 Avg:Min	HB10 T22.2 "Remote Monitored Site Gated Entries - Vehicles LZ2" 1.5 Horizontal FC Avg, 2:1 Avg:Min 1.0 Vertical FC Avg, 4:1 Avg:Min	HB10 T22.2 "Remote Monitored Site Gated Entries - Vehicles LZ3" 2.0 Horizontal FC Avg, 2:1 Avg:Min 1.5 Vertical FC Avg, 4:1 Avg:Min	HB10 T22.2 "Remote Monitored Site Gated Entries - Vehicles LZ4" 3.0 Horizontal FC Avg, 2:1 Avg:Min 2.0 Vertical FC Avg, 2:1 Avg:Min

	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Student Pick-up/Drop-off zone. Allowance for the area of the student pick-up/drop-off zone, with or without canopy, for preschool through 12th grade school campuses. A student pick-up/drop off zone is a curbside, controlled traffic area on a school campus where students are picked-up and dropped off from vehicles. The allowed area shall be the smaller of the actual width or 25 feet, times the smaller of the actual length or 250 feet. Qualifying luminaires shall be within two mounting heights of the student pick-up/drop-off zone.	Not Applicable	NO ALLOWANCE HB10 T36.2	HB10 T36.2 "Aviation Terminals Covered Bus and Shuttle Pick-Up/Drop-Off - Medium Activity LZ2" 1.0 Horizontal FC Avg, 2:1 Avg:Min 0.6 Vertical FC Avg, 4:1 Avg:Min	HB10 T36.2 "Aviation Terminals Covered Bus and Shuttle Pick-Up/Drop-Off - Medium Activity LZ3" 1.5 Horizontal FC Avg, 2:1 Avg:Min 0.8 Vertical FC Avg, 4:1 Avg:Min	NO ALLOWANCE
Outdoor Dining. Allowance for the total illuminated hardscape of outdoor dining. Outdoor dining areas are hardscape areas used to serve and consume food and beverages. Qualifying luminaires shall be within two mounting heights of the hardscape area of outdoor dining.	Not Applicable	HB10 T22.2 "Food Service, Restaurants - Fine Dining" 3.0 Horizontal FC Avg, 3:1 Avg:Min 1.0 Vertical FC Avg, 3:1 Avg:Min	HB10 T22.2 "Food Service, Restaurants - Fine Dining" 3.0 Horizontal FC Avg, 3:1 Avg:Min 1.0 Vertical FC Avg, 3:1 Avg:Min	HB10 T22.2 "Food Service, Restaurants - Fine Dining" 3.0 Horizontal FC Avg, 3:1 Avg:Min 1.0 Vertical FC Avg, 3:1 Avg:Min	HB10 T22.2 "Food Service, Restaurants - Fine Dining" 3.0 Horizontal FC Avg, 3:1 Avg:Min 1.0 Vertical FC Avg, 3:1 Avg:Min

	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Special Security Lighting for Retail Parking and Pedestrian Hardscape. This additional allowance is for illuminated retail parking and pedestrian hardscape identified as having special security needs. This allowance shall be in addition to the building entrance or exit allowance.	Not Applicable	G-1-16 “Retail Stores and Centers - Parking Lot" 3.0 Horizontal FC Avg; 4:1 Avg:Min	G-1-16 “Retail Stores and Centers - Parking Lot" 3.0 Horizontal FC Avg; 4:1 Avg:Min	G-1-16 “Retail Stores and Centers - Parking Lot" 3.0 Horizontal FC Avg; 4:1 Avg:Min	NO ALLOWANCE

Appendix M: Nonresidential Use Schedules

The lighting zone reclassification and general hardscape energy savings are based on the following nonresidential electric use schedules. The following schedules were applied during the 2019 Code Cycle and are reused for the 2022 Code Cycle. The dimming profiles for both summer and winter months are shown in the following figures.

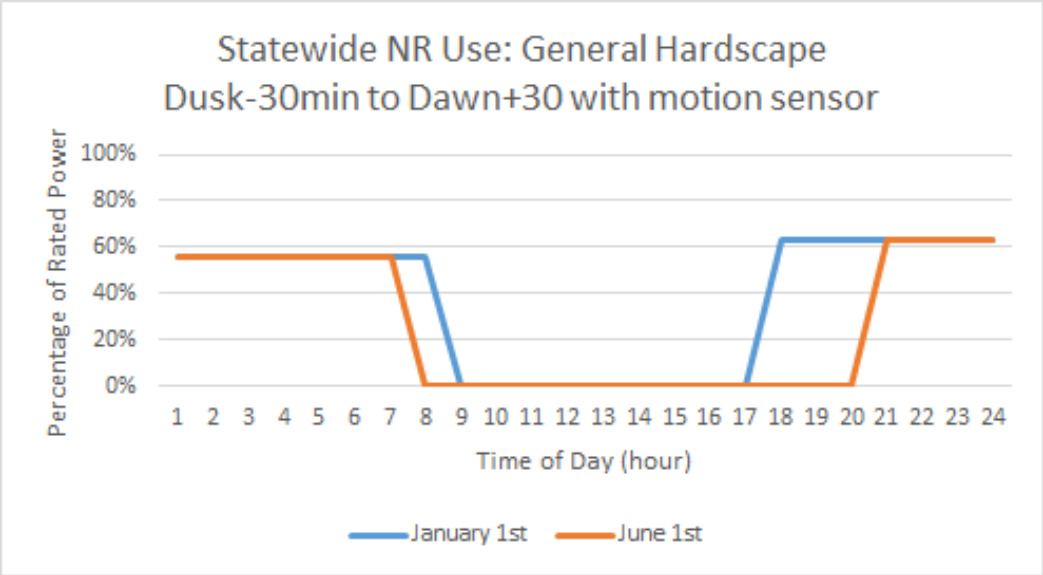

Figure 35: General Hardscape with Motion Sensor

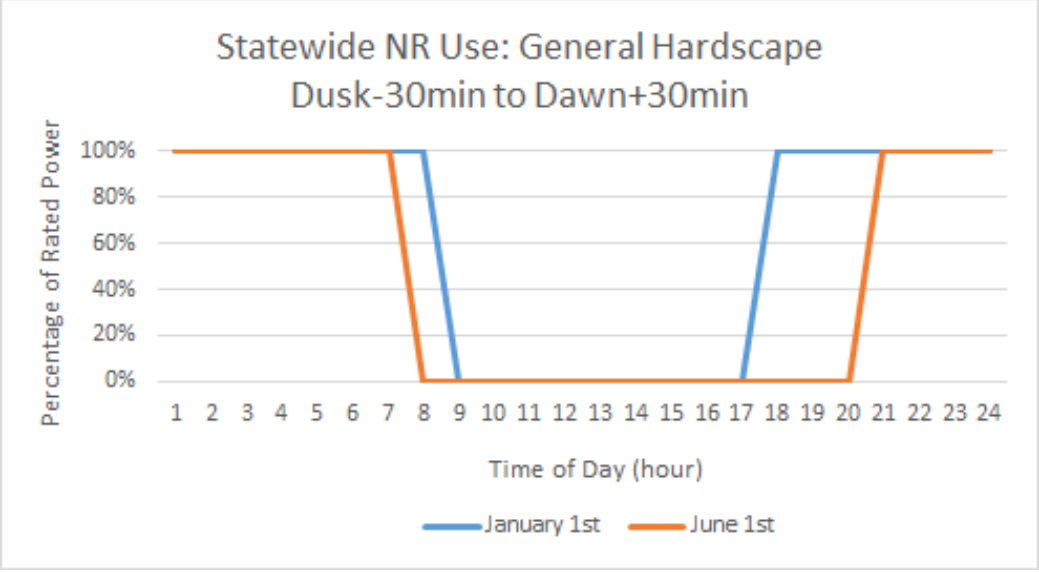

Figure 36: General Hardscape

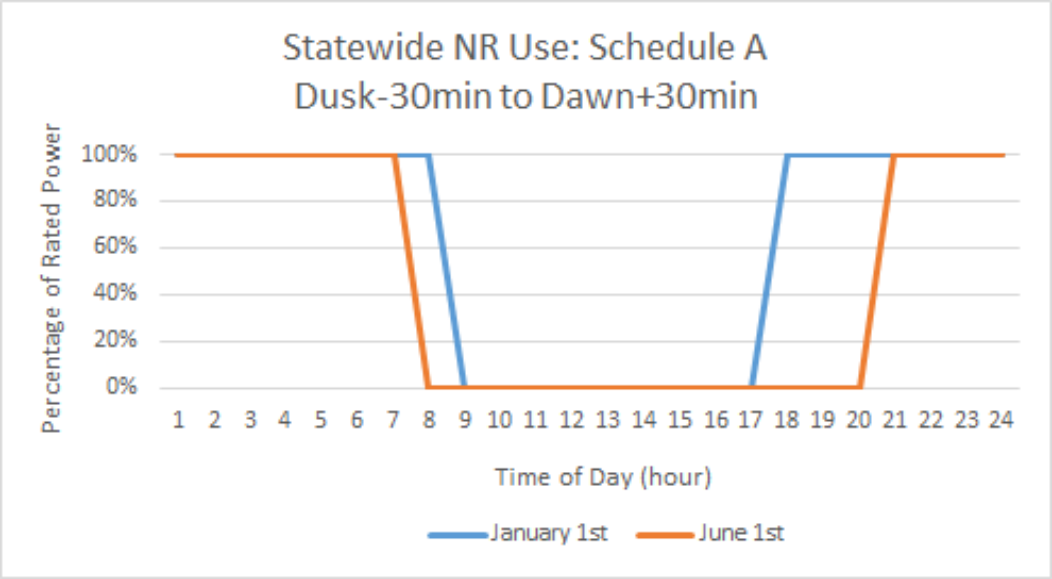

Figure 37: Schedule A

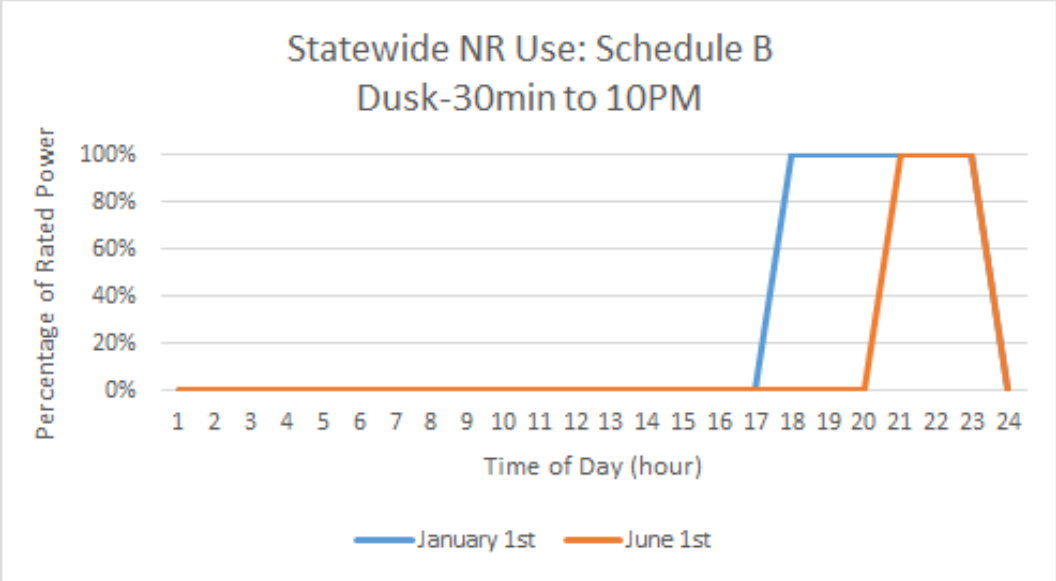

Figure 38: Schedule B

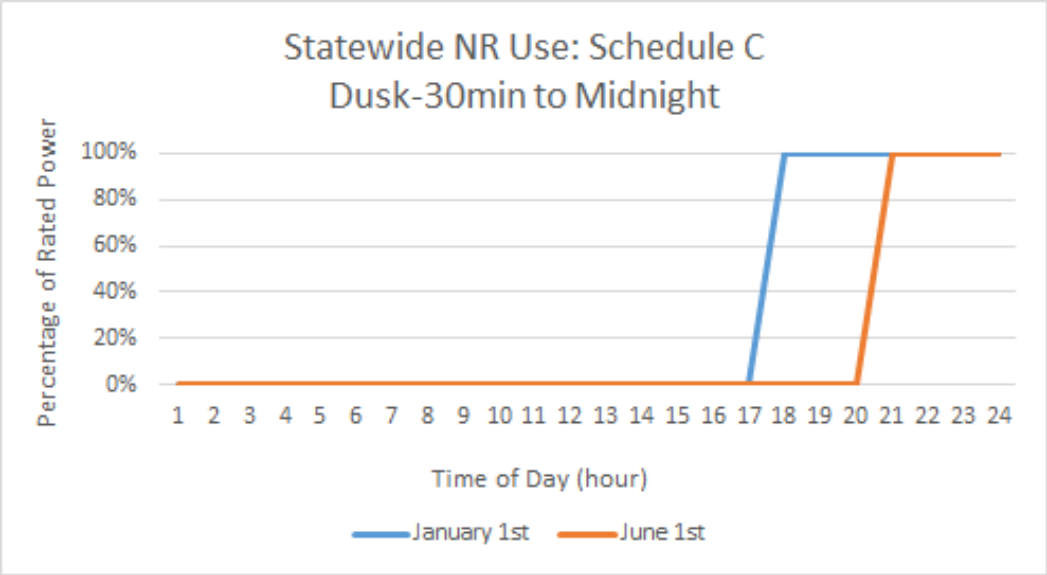

Figure 39: Schedule C

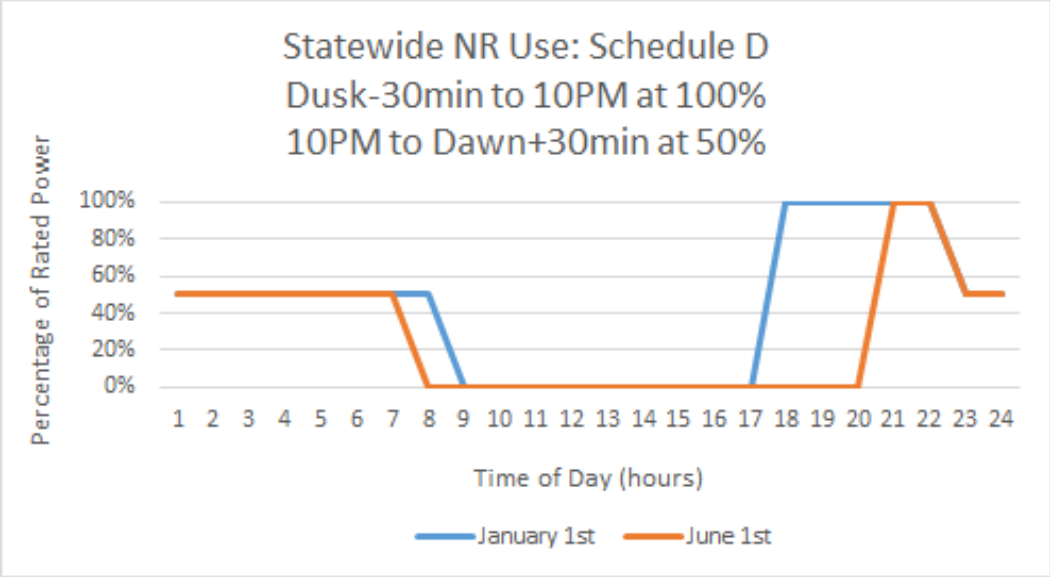

Figure 40: Schedule D

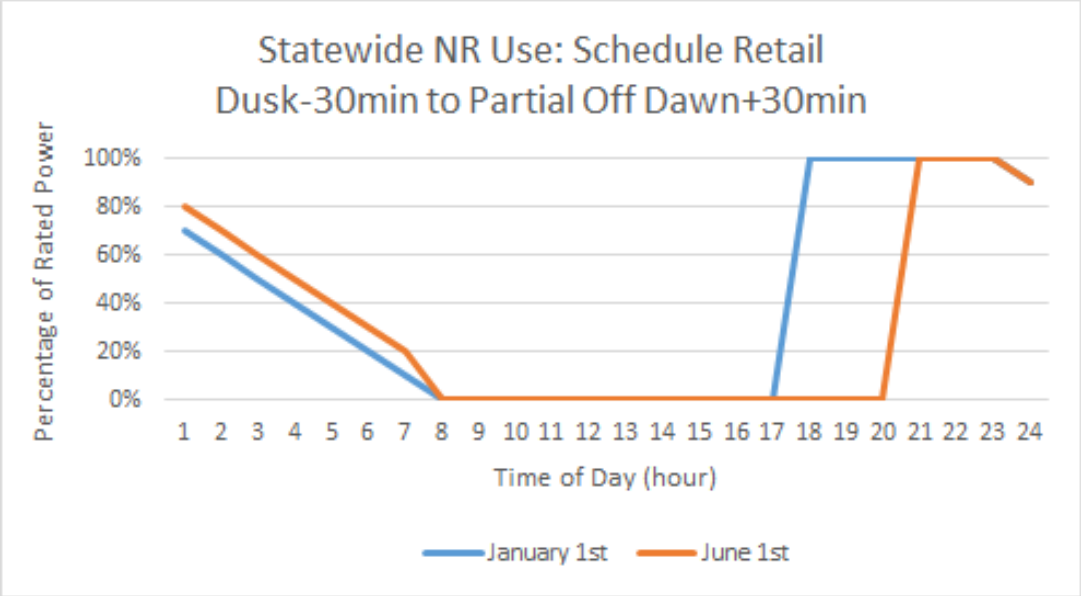

Figure 41: Schedule Retail

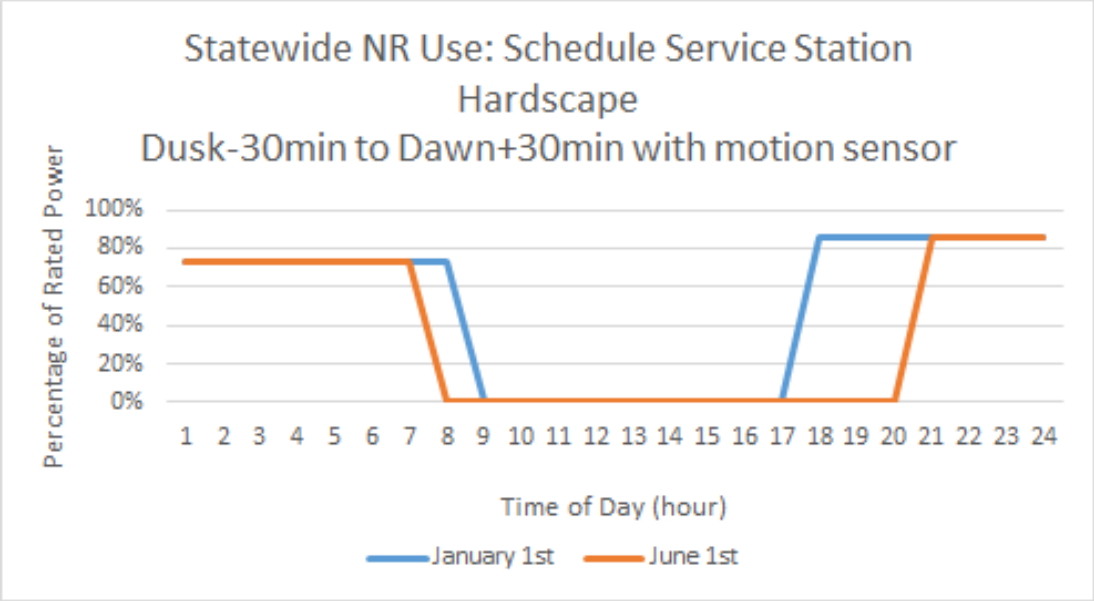

Figure 42: Schedule Service Station Hardscape

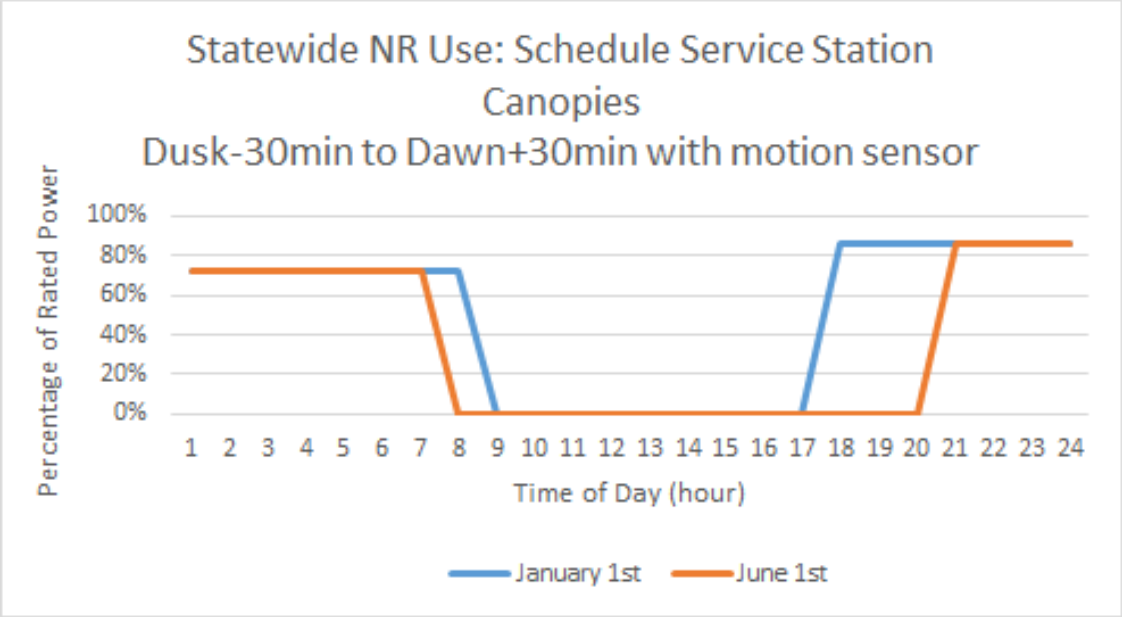

Figure 43: Schedule Service Station Canopies

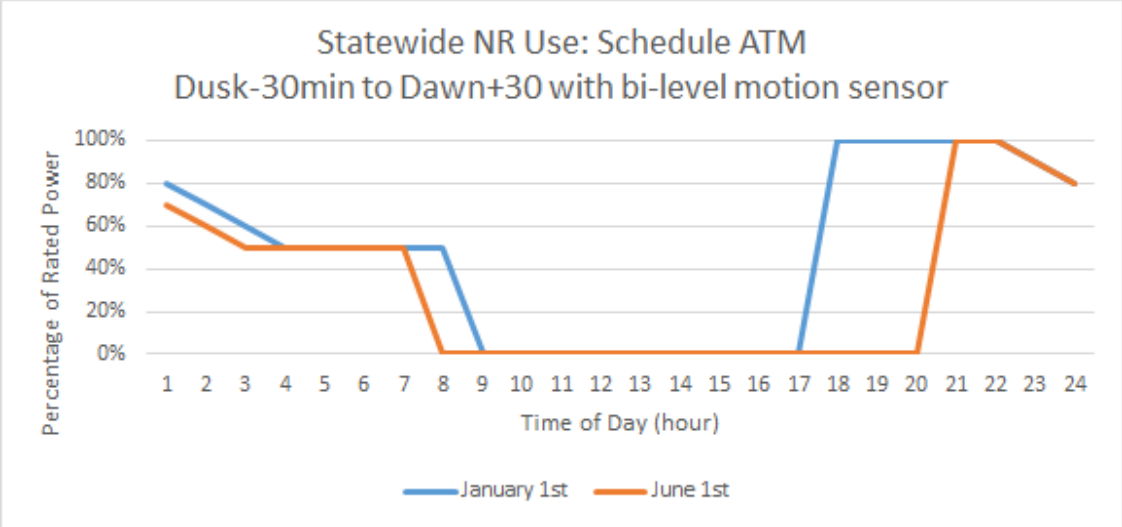

Figure 44: Schedule ATM.

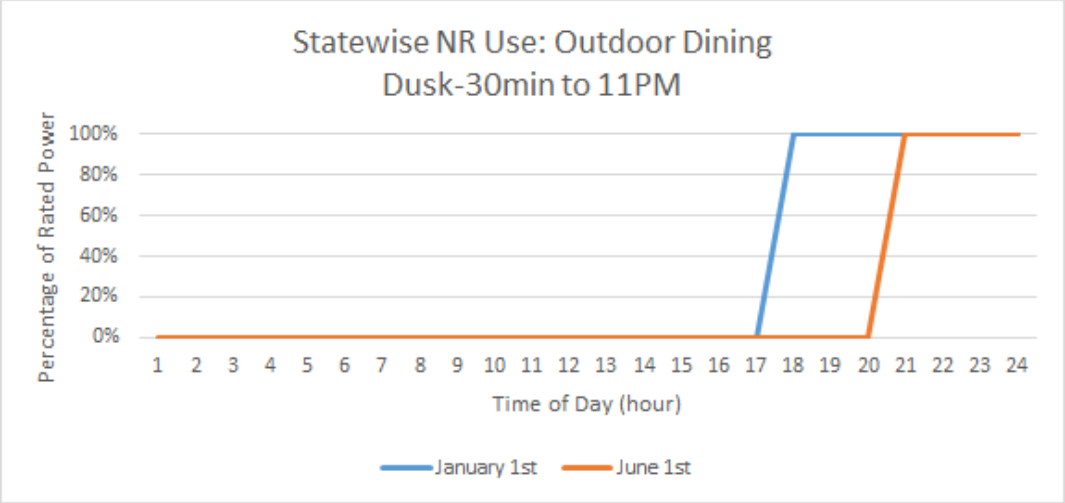

Figure 45: Schedule Outdoor Dining

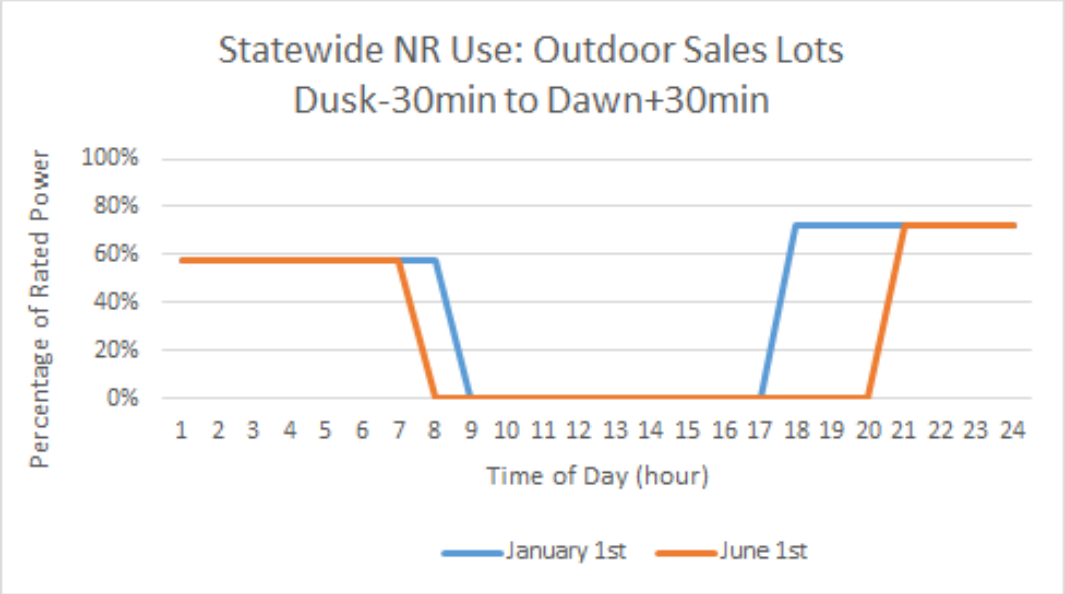

Figure 46: Schedule Outdoor Sales Lots

Appendix N: Nominal Cost Savings Tables

In Section 5.2 the energy cost savings of the proposed code changes over the 15-year period of analysis are presented in 2023 present value dollars. This appendix will present energy cost savings in nominal dollars. Energy costs are escalating as in the TDV analysis, but the time value of money is not included so the results are not discounted. The factor to convert Electric 15 Year Non-Residential costs to Nominal Cost Savings is 1.4099.

Table 114: Lighting Zone Reclassification: Nominal TDV Energy Cost Savings Over 15-Year Period of Analysis – Per Unit – New Construction and Alterations

Lighting Application	Units	15-Year TDV Electricity Cost Savings (Nominal $)	15-Year TDV Natural Gas Cost Savings (Nominal $)	Total 15-Year TDV Energy Cost Savings (Nominal $)
General Hardscape	Per Square Foot	0.011	N/A	0.011
Building Entrances or Exits	Each	5.167	N/A	5.167
Primary Entrances	Each	17.227	N/A	17.227
Drive Up Windows	Each	8.413	N/A	8.413
Vehicle Service Station Uncovered Fuel Dispenser	Each Pump Face	18.95	N/A	18.95
ATM Machine Lighting	Each	0	N/A	0
Outdoor Sales Frontage	Per Linear Foot	4.268	N/A	4.268
Hardscape Ornamental Lighting	Per Square Foot	0.006	N/A	0.006
Building Facades	Per Square Foot	0.061	N/A	0.061
Outdoor Sales Lots	Per Linear Foot	0.083	N/A	0.083
Vehicle Service Station Hardscape	Per Square Foot	0.042	N/A	0.042

Vehicle Service Station Canopies	Per Square Foot	0.142	N/A	0.142
Sales Canopies	Per Square Foot	0.282	N/A	0.282
Non-sales Canopies and Tunnels	Per Square Foot	0.069	N/A	0.069
Guard Stations	Per Square Foot	0.082	N/A	0.082
Student Pick-up/Drop-off zone	Per Square Foot	0.018	N/A	0.018
Outdoor Dining	Per Square Foot	0.010	N/A	0.010
Special Security Lighting for Retail Parking and Pedestrian Hardscape	Per Square Foot	0.001	N/A	0.001

Table 115: General Hardscape Lighting Power Allowance: Nominal TDV Energy Cost Savings Over 15-Year Period of Analysis – Per Square Foot

Lighting Application	Units	15-Year TDV Electricity Cost Savings (Nominal $)	15-Year TDV Natural Gas Cost Savings (Nominal $)	Total 15-Year TDV Energy Cost Savings (Nominal $)
General Hardscape – New Construction	Per Square Foot	$0.18	N/A	$0.18
General Hardscape – Alterations	Per Square Foot	$0.18	N/A	$0.18

Table 116: Multifamily Outdoor Lighting Power Allowance Nominal TDV Energy Cost Savings Over 15-Year Period of Analysis – Per Dwelling Unit – New Construction and Alterations

Building Prototype	Units	15-Year TDV Electricity Cost Savings (Nominal $)	15-Year TDV Natural Gas Cost Savings (Nominal $)	Total 15-Year TDV Energy Cost Savings (Nominal $)
Low Rise Garden	Dwelling Unit	$163.24	N/A	$163.24
Loaded Corridor	Dwelling Unit	$42.21	N/A	$42.21
Mid-Rise Mixed Use	Dwelling Unit	$50.70	N/A	$50.70
High Rise Mixed Use	Dwelling Unit	$29.03	N/A	$29.03

Appendix O: Security Camera Technology

During the 2019 Title 24 code cycle, there were discussions that security cameras are not capable of identifying colors and objects of concern in nighttime environments with low lighting levels. The Statewide CASE Team is proposing a security camera adder to ensure that end users with security concerns could install cameras within the hardscape area to achieve lighting levels greater than those recommended in the IES RP-8-18 Addendum 1 Chapter 17.

The Statewide CASE Team contacted stakeholders in the security camera industry to ensure that the proposed general hardscape allowance would allow for the continued functioning of security cameras. The Statewide CASE Team coordinated with security camera manufacturers, security camera installers, and a building management team to better understand current security camera technology and applications. The Statewide CASE Team found that most building security teams use cameras to identify objects or activities of concern within hardscape areas. The object, concerning activity, or vehicle is identified and can be tracked to provide license plate or facial identification if necessary. The security teams will often use colors, such as a red shirt or blue baseball cap, to identify and track the object or person of concern through the space.

The Statewide CASE Team found that current security cameras are capable of identifying color in low lighted environments. Many security cameras have pan, tilt, and zoom (PTZ) capabilities. These cameras are able to zoom into area of concern and identify people and objects of concern within the camera's detection area. The Statewide CASE Team studied six cameras commonly installed in exterior environments in 2019 to determine the minimum lighting level necessary for them to operate while providing color detection. One of the cameras studied was capable of identifying color when the light within the camera's visual scene (the entire area viewed by the security camera) was 0.17 lux at 50 IRE F1.8 (0.016 fc). The average lighting level required for color detection was 0.33 lux at 50 IRE F1.6 (0.031 fc).

If the luminance within the security camera's visual scene falls below the camera's color detection capabilities the camera will provide video in black and white. The average security camera studied was capable of providing black and white images in lighted environments as low as 0.025 lux at 50 IRE F1.6 (0.002 fc) within the visual field. When the lighting in the environment falls below that level – or in the absence of light – the security camera's infrared filter will be deactivated, and the camera will provide infrared video of the area. This infrared capability allows the security camera to identify people, animals, and capture other heat signatures in the absence of light.

The Statewide CASE Team expects that security camera technology will continue to quickly advance over the next couple years. The security camera experts contacted anticipate that security cameras installed in 2022 will be capable of differentiating

between various colors at half the luminance levels required by current technologies. Based on these discussions and the analysis of products currently available on the market, the Statewide CASE Team is confident that security cameras installed in 2022 will be capable of identifying security concerns throughout the general hardscape areas. The Statewide CASE Team is proposing the security camera adder for the 2022 code cycle to ensure that security cameras can be added to existing general hardscape applications with minimal lighting alterations in the future.

The Statewide CASE Team applied the proposed security camera allowance to the real hardscape site designs to determine the average illuminance levels that could be achieved with products currently available on the market. With the allowance a horizontal average of 32 lux (3 fc) can be achieved in the general hardscape area. This allowance would allow for higher lighting levels to be implemented in spaces with security concerns.

Appendix P: Ornamental Hardscape LED Conversion

During the 2019 Title 24 code cycle all the non-residential outdoor lighting sources were updated to an LED baseline. At that time the definition for ornamental hardscape luminaires in the 2019 Title 24, Part 6, Section 100.1 was updated to a 30-watt limit to match the average LED wattage of the hardscape ornamental luminaires studied during the 2019 code cycle. Unfortunately, this wattage limit was not included in 2019 Title 24, Part 6, Section 140.7. To resolve this, the Statewide CASE Team is proposing a reduction in the hardscape ornamental wattage to match the current LED baseline. The Statewide CASE Team has updated the 2019 code cycle analysis to only consider LED luminaires with initial luminaire lumens equivalent to each 100-watt legacy initial luminaire lumens. The Statewide CASE Team studied 35 different LED products offered by 24 different manufacturers to determine the proposed 50-watt limit for hardscape ornamental lighting. The products studied can be found in Table 117.

Table 117: LED Equivalent Ornamental Hardscape Products

Legacy Source						2019 LED Equivalent				
Luminaire Manufacturer Letter	Luminaire Product Number	Lamp Wattage	Lamp Type	Initial Luminaire Lumens	Lumens per Watt (LPW)	Luminaire Manufacturer Letter	Luminaire Product Number	System Watts	Initial Luminaire Lumens	Lumens per Watt (LPW)
LA	002	100	A19, Shatter Resistant Incandescent	960	10	LA	001	11	1,100	100
LB	003	100	A19, Frosted Incandescent	960	10	LB	001	11	1,100	100
LA	003	100	G40, Clear Incandescent	1,150	12	LC	001	6.5	810	125
LA	004	100	A19, Silver Bowl Incandescent	960	10	LD	001	7.5	680	91
LA	005	100	G40, Frosted Incandescent	1,150	12	LE	001	8.5	800	94
LE	002	100	A21 Incandescent	1,540	15	LB	002	16	1,550	97
LI	001	100	A21, Frosted Incandescent	1,042	10	LF	001	13.5	1,100	81
LE	003	100	G25, Silver Bowl Incandescent	1,000	10	LG	001	11	1,200	109
LJ	001	100	A21, Frosted Silver Bowl Incandescent	800	8	LH	001	14	1,100	79
AT	003	100	PSMH	3,314	24	W	004	30	3,354	110
AT	003	100	PSMH	3,628	26	E	001	25	3,789	149
W	008	100	PSMH	3,899	28	B	005	38	3,844	102
AT	003	100	PSMH	3,939	29	BD	001	71	3,943	56
AT	003	100	PSMH	4,354	32	V	007	35	4,348	124
A	005	100	PSMH	4,375	32	A	001	51	4,431	87
A	005	100	PSMH	4,437	32	BH	001	37	4,431	120
W	009	100	PSMH	4,572	33	E	003	38	4,552	120
W	008	100	PSMH	4,681	34	AU	003	42	4,570	109
AT	003	100	PSMH	4,683	34	C	010	44	4,612	105
W	009	100	PSMH	4,689	34	I	003	72	4,639	64
AT	003	100	PSMH	4,832	35	BF	001	67	4,843	111
W	009	100	PSMH	5,094	37	I	004	72	5,068	72
AT	003	100	PSMH	5,168	38	AQ	003	59	5,216	88
V	008	100	PSMH	5,313	39	C	008	52	5,396	104
AT	003	100	PSMH	5,394	39	V	006	75	5,398	72
AT	003	100	PSMH	5,623	41	B	005	58	5,638	97
W	008	100	PSMH	5,704	42	D	002	58	5,800	100
AT	003	100	PSMH	5,751	42	W	004	52	5,800	111
W	008	100	PSMH	5,795	42	T	002	59	5,888	100
W	008	100	PSMH	5,856	43	C	008	52	5,889	113
AT	003	100	PSMH	5,863	43	BF	003	64	5,983	94
AU	006	100	CMH	6,102	52	AF	003	70	6,102	87
AT	003	100	PSMH	6,114	45	D	002	58	6,200	107
A	005	100	PSMH	6,220	45	V	002	54	6,278	116
W	008	100	PSMH	6,255	46	BG	001	51	6,320	124
W	008	100	PSMH	6,280	46	BF	002	67	6,343	95
V	008	100	PSMH	6,779	49	B	006	81	6,779	84
A	005	100	PSMH	6,974	51	I	003	108	6,959	64
W	009	100	PSMH	7,205	53	AU	005	81	7,341	91
W	009	100	PSMH	7,241	53	AU	004	81	7,492	92
W	009	100	PSMH	7,315	53	AQ	004	104	7,529	72
Average				**4,464**	**33**	**Average**		**49**	**4,493**	**98**