

2008 Nonresidential Energy Plan Review Checklist Guide: For Newly Constructed Buildings

CALIFORNIA
ENERGY
COMMISSION

Energy Standards Hotline at: 1-800-772-3300

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Was the correct compliance software used? (Performance Only)

The energy compliance documentation must be developed from certified compliance software for the 2008 Building Energy Efficiency Standards (Standards). If an outdated version of the software has been used, the energy compliance documentation will have to be resubmitted using a current certified version. Certified versions of the software can be found at:

http://www.energy.ca.gov/title24/2008standards/2008_computer_prog_list.html.

Does the building “Comply” according to the PERF-1 Form? (Performance Only)

The Plans Examiner should check that the building in fact *complies*. When the performance approach is used Page 2 of the PERF-1 Form (which is generated by a compliant software program) will state if the building complies or not.

Are the Certificate(s) of Compliance and the PERF-1 Form(s) (Performance Only) filled out correctly and included on the plans?

All applicable Certificate(s) of Compliance and performance PERF-1 Form(s) shall be filed on the plans. To simplify enforcement the California Energy Commission (Energy Commission) recommends that the Certificate(s) of Compliance and PERF-1 Form(s) be printed on the plans (electronically incorporated on the plans). This includes the ENV-1C, MECH-1C, LTG-1C, OLTG-1C, SLTG-1C, RWH-1C and PERF-1 Form. Having these forms printed on the plans will also ensure that the energy documentation will not be lost in the field.

New for the 2008 Certificate(s) of Compliance is the Field Inspection Energy Checklist (Energy Checklist) portions of each 1C form. Under the Prescriptive Approach the Documentation Author is responsible for completing the Field Inspection Energy Checklist portions. For the Performance Approach the Energy Checklist will automatically be completed by the approved computer program. It is important that the Field Inspection Energy Checklist portions of each Certificate of Compliance has been completed and submitted with the Energy Documentation, because the Energy Checklist will be used by the Field Inspector during each applicable stage of inspection to verify compliance with the Standards.

Verify That the General Building Information Is Correct:

For The Performance Approach, the Plans Examiner shall verify the general building information on the PERF-1 Form in the same manner described below for the Prescriptive Approach.

For the Prescriptive Approach, the general building information shall be verified on the following forms: ENV-1C, MECH-1C, LTG-1C, OLTG-1C, SLTG-1C and RWH-1C.

General Information to be verified on each Certificate of Compliance (1C Form):

1. DATE: Look for the date on the form. If the plans were revised after the date, it is likely that the energy compliance documentation will need to be re-submitted to reflect the altered design. The Plans Examiner will determine whether or not the revisions to the plans would require re-submittal of the energy compliance documentation.
2. BUILDING FLOOR AREA (CONDITIONED AND UNCONDITIONED): The Plans Examiner shall verify that the building floor areas (in square feet) of both conditioned and unconditioned space on the Certificate of Compliance are specified on the plans.
3. CLIMATE ZONE: The building must be modeled in the correct Climate Zone because there are different energy efficiency requirements for each specific Climate Zone. There are 16 different Climate Zones in the state of California. To verify Climate Zone by zip code or city go to the Energy Commission's website at: www.energy.ca.gov/maps/building_climate_zones.html or call the Energy Standards Hotline at 1-800-772-3300.

The energy compliance documentation shall be re-submitted to determine compliance with the appropriate Climate Zone if the Climate Zone is incorrect or not listed on the Certificate of Compliance.

4. **BUILDING TYPE:** There are different requirements for different building types: Nonresidential, High-rise Residential, and Hotel/Motel. The Lighting and Envelope requirements vary for each building type. It is possible for a building to include more than one building or occupancy type, so the Plans Examiner shall verify that all applicable building types on the Certificate of Compliance are specified on the plans.

5. **PHASE OF CONSTRUCTION:** NEW CONSTRUCTION should be checked for all newly constructed buildings and when unconditioned space is converted to newly conditioned space.

6. **FRONT ORIENTATION OF THE BUILDING:** The Plans Examiner shall verify that the front orientation listed on the Certificate of Compliance accurately reflects how the building is situated on the lot, according to the plans. The Front Orientation is listed in degrees from North clockwise to East, and this should be checked against the North azimuth symbol on the plans.

7. ***Documentation Author's Declaration Statement:*** The Documentation Author is the person who prepared the energy compliance documentation and shall sign this Declaration Statement. The Documentation Author's signature declares that the energy compliance documentation is accurate and complete. The person's telephone number is provided to facilitate response to any questions that may arise. A Documentation Author may have additional certifications, such as an Energy Analyst or a Certified Energy Plans Examiner, and shall enter their certification number in the EA# or CEPE# box.

The Documentation Author shall complete and sign the Documentation Author's Declaration Statement. If the Documentation Author's Declaration Statement is incomplete or is not signed the Plans Examiner shall request that the Documentation Author complete and sign this statement on the Certificate of Compliance prior to approval of the plans for a building permit.

8. ***Principle Designer's Declaration Statement:*** This Declaration Statement is signed by the person who is responsible for the design of the building. The Principal Designer is also responsible for the accuracy of the energy compliance documentation, even if the actual work is delegated to someone

else (the Documentation Author as described above). The Principle Designer's signature declares that the energy compliance documentation is consistent with the plans. The Business and Professions Code governs who is qualified to accept responsibility of the building design and who can sign this statement. The person's telephone number is provided to facilitate response to any questions that may arise.

The Principle Designer shall complete and sign the Principle Designer's Declaration Statement. If this Principle Designer's Declaration Statement is incomplete or is not signed the Plans Examiner shall request that the Principle Designer complete and sign this statement on the Certificate of Compliance prior to approval of the plans for a building permit.

An engineer that signs the Principle Designer's Declaration Statement must provide their stamp (signed and dated) on the Certificate of Compliance. When more than one engineer is responsible for the building design, each engineer shall provide their signed and dated stamp on the Certificate of Compliance.

ENVELOPE

Is the Mandatory Measures note block on the plans?

A mandatory measures note block that identifies the Envelope mandatory measures shall be included on the plans. This helps the Builder, Plans Examiner, and Inspector identify the minimum mandatory measures that must be met.

The Documentation Author may use whatever format is most appropriate for specifying the mandatory measures in the plan set. In general, this will take the form of a note block located on the Structure/Architecture plans or next to the Envelope compliance forms, possibly with cross-references to other locations in the plans where measures are specified.

The Plans Examiner shall verify that the mandatory measures note block specifying the Envelope mandatory measures is located on the plans along with the Envelope compliance forms or appropriate sections of the Structure/Architecture plans.

Were all applicable forms submitted?

ENV-1C: All submittals

ENV-2C: Submit when the Envelope Component Approach is used

ENV-3C: Submit when the Overall Envelope TDV Approach is used

ENV-4C: Submit when skylights are required for large enclosed spaces in Climate

Zones 2 through 15 (*Prescriptive Method Only*)

To simplify enforcement, the Energy Commission recommends that all applicable Energy Forms (ENV-2C, ENV-3C, etc.) be printed on the plans (electronically incorporated onto the plans) along with the Certificate of Compliance. Having all of the energy forms on the plans simplifies the Plan Review process, and helps the Inspector identify the energy components that must be verified in the field. The Plans Examiner shall verify that all applicable forms have been submitted along with the Structure/Architecture plans.

Are all appropriate Acceptance Tests checked AND Fenestration products requiring verification identified on the Certificate of Compliance (ENV-1C)?

The Envelope Acceptance Test is a mandatory measure that requires the installing contractor to field verify the installation of site-built fenestration. Chapter 10 of the 2008 Nonresidential Compliance Manual provides detailed information on the Envelope Acceptance Test requirements and the procedures on how to conduct the Acceptance Test.

The Plans Examiner shall verify that the applicable Acceptance Test and all site-built fenestration products that require field verification are identified on the ENV-1C. The Plans Examiner shall request that the Documentation Author or Designer resubmit the ENV-1C identifying all site-built fenestration products requiring field verification if all site-built fenestration products are not specified on the ENV-1C.

It is important that the Plans Examiner verify the applicable Acceptance Test and all site-built fenestration products on the ENV-1C because the Inspector will reference the Acceptance Test and site-built fenestration products identified on the ENV-1C to verify which Acceptance Forms to collect before conducting a Final Inspection and issuing the Occupancy Permit for the building.

The Plans Examiner shall verify the following Acceptance Test and all site-built fenestration products on the ENV-1C:

| | | |
|----------------|--------------------------------|---|
| ENV-2A: | <i>Fenestration Acceptance</i> | Applies to new site-built fenestration products |
|----------------|--------------------------------|---|

Do all pages have the same run number and date? (Performance Only)

The Plans Examiner shall verify that **ALL** pages have the same run number and date as the PERF-1 Form. If the applicant models the entire building under the same computer run (Mechanical, Lighting, and Envelope Compliance) then all of the energy compliance forms (ENV, LTG, and MECH) should have the same run number and date as the PERF-1 Form.

When the applicant models the Envelope and Mechanical compliances separately, each computer run will have a different run number and date. The Plans Examiner shall verify that the ENV forms have the same run number and date as the PERF-1 Form for the Envelope Compliance.

Does the Energy Compliance Documentation match the plans?

Section 10-103 of the Administrative Regulations (Title 24, Part 1) mandates that the building characteristics modeled to demonstrate compliance with the Energy Standards shall be specified on the plans. The Plans Examiner shall verify that the window efficiencies, insulation values, solar reflectance and thermal emittance values, etc. from the Envelope compliance forms are specified on the appropriate sections of the Structure/Architecture plans.

Insulation for walls, ceilings, and floors (from Reference Joint Appendix JA4)

Verification:

The insulation values for walls, ceilings, and floors are specified under the Opaque Surface Details on Page 1 of the ENV-1C. On the ENV-1C, the Documentation Author will identify the assembly frame type, cavity insulation values, continuous insulation values, etc. for each assembly type. The Plans Examiner will verify that both the cavity and continuous insulation values identified on the form match the insulation values specified in the Cross Sections or Architecture Details of the Structure/Architecture plans. The Plans Examiner will also ensure that all applicable mandatory measures for insulation are specified on the mandatory measures note block.

Overview:

Assembly Frame Type

The Assembly Frame Type describes the material of the assembly (wood wall, metal roof, mass, furred, etc.). The size of the frame type shall also be identified, which details the dimensions of the framing (2x4, 2x6, etc.).

Cavity and Continuous R-Value

The Cavity R-Value specifies the thermal resistance value of the insulation in the cavity between framing members. The Continuous R-Value specifies the thermal resistance value of the insulation on top of the framing members or mass assembly (i.e. concrete), located on either the interior or exterior side of the assembly.

Furring

Furring details that an assembly consists of some type of mass (usually concrete) with wood or steel framing members placed on either the interior or exterior side of the mass. The Furring box shall be checked for all furring assemblies, and the Plans Examiner shall reference page 2 of the ENV-2C to verify the specifications for the furred assembly.

Furring R-Value

The Furring R-Value specifies the thermal resistance value of the insulation in the cavity between the framing members of the furred assembly.

Envelope Component Approach:

The Plans Examiner shall verify that the Proposed Assembly U-factor is equal to or less than the Standard U-factor. The other columns in between the U-factors, such as JA4 Table Reference, Cavity R-value, Continuous R-value and the Reference Row and Cell provide reference information for the Assembly U-factor values (from Reference Joint Appendix JA4) and should be randomly verified to ensure the values are correct.

Number of windows, window area and their orientation

Verification:

The number of windows (including glass doors and skylights), window area, and their orientation are specified under the Fenestration Surface Details on Page 1 of the ENV-1C. On the ENV-1C, the Documentation Author will identify the Fenestration Type, Surface Area, and Surface Orientation for each fenestration product. The Plans Examiner will verify that the number of windows (if modeled separately), window areas, and window orientations identified on the form match the window schedule on the Structure/Architecture plans.

Overview:

Fenestration Type

The Fenestration Type specifies the type of fenestration product, including the framing type (wood window, metal glass door, skylight, etc.)

Surface Area

The Surface Area specifies in square feet (ft²) the area of the fenestration product, including the framing. Each fenestration product for each orientation may be modeled separately, or the surface area of fenestration products with the same characteristics (same U-Factor and SHGC values) may be summed together for each orientation.

Surface Orientation

The Surface Orientation specifies the cardinal orientation the fenestration product is facing, as marked on a compass. The Surface Orientation may be listed in degrees from true North (i.e. 0° for North, 90° for East, 180° for South, etc.) or be identified by listing the first letter of the orientation (N = North, S = South, E = East, etc.).

Envelope Component Method:

Under the Envelope Component Approach, the total window area may not exceed 40% of the gross wall area (encompassing conditioned space) for the building. Likewise, the west facing window area may not exceed 40% of the west gross wall area (encompassing conditioned space). Alternatively, the maximum area may be the larger of multiplying the display perimeter by 6 ft, or 40% of the gross wall area. These maximum area requirements will affect those buildings with very large glass areas, such as high-rise offices, automobile showrooms or airport terminals.

The total window area of skylights shall not exceed 5% of the gross exterior roof area (encompassing conditioned space). This effectively prevents large skylights under the Envelope Component Approach. The total window area of skylights shall not exceed 10% of the gross exterior roof area (for buildings with an atrium over 55 ft high. The 55 ft height is also the height limitation at which the California Building Code requires a mechanical smoke-control system for such atriums (CBC Sec. 909). This means that the 10 percent skylight allowance is not allowed for atriums unless they also meet this smoke control requirement.

U-Factor and SHGC values for Fenestration

Verification:

The U-Factor and SHGC values of the fenestration products (windows, glass doors, skylights, etc.) are specified under the Fenestration Surface Details on Page 1 of the ENV-1C. On the ENV-1C, the Documentation Author will identify the Fenestration Type, U-Factor, SHGC, and Source of the window efficiency values for each fenestration product. The Plans Examiner will verify that the U-factor and SHGC values identified on the form match the window schedule on the Structure/Architecture plans. The Plans Examiner will also ensure that all applicable mandatory measures for fenestration products are specified on the mandatory measures note block.

Overview:

U-Factor

The U-Factor specifies the overall coefficient of thermal resistance value of the fenestration product, including the glazing (glass) and frame.

SHGC

The Solar Heat Gain Coefficient (SHGC) specifies the solar heat gain value of the fenestration product, including the glazing (glass) and frame.

Source

How the window efficiency values (U-factor and SHGC) were determined shall be identified on Page 1 of the ENV-1C. The applicant shall list NFRC as the “source” of the window efficiencies when the U-Factor and SHGC values come from an NFRC Label Certificate. For fenestration products that are not NFRC Rated,

the default U-factor and SHGC values from Standards Table 116-A and Table 116-B (on the next page) shall be used to determine the efficiency values. When the U-Factor and SHGC values come from the default tables in §116, the applicant shall list CEC as the “source” of the window efficiencies.

Standards Table 116-A

| FRAME | PRODUCT TYPE | SINGLE PANE U-FACTOR | DOUBLE PANE ¹ U-FACTOR | GLASS BLOCK ² 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. |
| | 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. |
| | 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 |
| | Doors | 0.99 | 0.53 | N.A. |
| | Greenhouse/garden windows | 1.94 | 1.06 | N.A. |
| | Skylight | 1.47 | 0.84 | N.A. |
| <p>1. For all dual-glazed fenestration products, adjust the listed U-factors as follows:</p> <ul style="list-style-type: none"> 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). <p>2. Translucent or transparent panels shall use glass block values.</p> | | | | |

Standards Table 116-B

| FRAME TYPE | PRODUCT | GLAZING | TOTAL WINDOW SHGC | | |
|----------------------|----------|---------|-------------------|-------------|--------------------------|
| | | | Single Pane | Double Pane | Glass Block ¹ |
| 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.

Envelope Component Method:

Under the Envelope Component Approach, the Proposed window efficiency values (U-factor and SHGC) identified under Window Details on Page 3 of the ENV-2C shall be equal to or less than the Standard U-factor and SHGC values from Standards Table 143-A, 143-B, or 143-C. The Plans Examiner Shall verify that the window efficiency values identified in the Fenestration *Proposed* columns are equal to or less than the window efficiency values identified in the Fenestration *Allowed* columns under Window Details on Page 3 of the ENV-2C.

Exterior Shading Devices (i.e. overhangs, fins, exterior shades)

Verification:

The exterior shading devices of the fenestration products (windows, glass doors, skylights, etc.) are specified under the Window Details on Page 3 of the ENV-2C for the Envelope Component Method

(Prescriptive) or under the Exterior Shading on Page 1 of the ENV-1C for the Performance Approach. On the ENV-1C or ENV-2C, the Documentation Author shall identify the exterior shading device (overhang, fin, etc.) and dimensions of the device (length, right extension, left extension, etc.) for each fenestration product with an exterior shading device. The Plans Examiner will verify that the exterior shading devices and dimensions for each device with a length extending beyond 4 feet identified on the ENV-1C or ENV-2C matches the window schedule on the Structure/Architecture plans.

NOTE: Skylights cannot be modeled with overhangs or fins. Skylight may only be modeled with exterior shading as an exterior shading device.

Overview:

Overhangs

For Overhangs with a length extending beyond 4 feet, the Plans Examiner shall verify that the values of the following dimensions (on the next page) from the ENV-1C or ENV-2C match the window schedule on the plans:

- Length – distance overhang extends out from the window.
- Height – distance from the top of the window to the overhang.
- Left Extension – distance the overhang extends past the left side of the window.
- Right Extension – distance the overhang extends past the right side of the window.

Fins

For Fins with a length extending beyond 4 feet, the Plans Examiner shall verify the values of the following dimensions from the ENV-1C or ENV-2C match the window schedule on the plans:

- Distance – distance from the side of the window to the fin.
- Length – distance the fin extends out from the window.
- Height – how tall the fin is.

Cool Roof Values (Solar Reflectance and Thermal Emittance)

Verification:

Depending on the type of roofing product, the solar reflectance and thermal emittance values of the proposed roofing product are specified on Page 2 of the ENV-1C. On the ENV-2C, the Documentation Author will identify the roof slope, product weight, product type, and solar reflectance and thermal emittance for each roofing product. The Plans Examiner shall verify that the solar reflectance and

thermal emittance values identified on the form match the values specified in the Cross Sections or Architecture Details of the Structure/Architecture plans. The Plans Examiner will also ensure that all applicable mandatory measures for the roofing product are specified on the mandatory measures note block.

Overview:

CRRC Product ID Number

The roofing product shall be certified by the Cool Roof Rating Council (CRRC). The CRRC Product ID Number listed on the ENV-2C shall match the CRRC-1 label included with the plans, or the CRRC-1 Product ID Number can be obtained from the CRRC Rated Product Directory at:

www.coolroofs.org/products/search.php.

Roof Slope

Identify from the plans the slope of the roof. A Low-Sloped roof has a pitch (rise to run) of 2:12 or less. Steep-Sloped roof has a pitch (rise to run) greater than 2:12.

Product Weight

Identify from the plans if the weight of the roofing product is greater than 5lb/ft² or equal to or less than 5lb/ft². This information may be obtained from the manufacturer's data sheet and should be included with the plans.

Product Type

Product Type indicates the type of product that is being installed for the roof top, i.e. single-ply roof, asphalt roof, metal roof, etc. The Structure/Architecture plans shall specify the type of roofing product.

Aged Solar Reflectance

The Aged Solar Reflectance value identified on the ENV-2C shall match the aged solar reflectance value listed on the CRRC-1 label or CRRC Rated Product Directory. When a roofing product does not have the aged solar reflectance value certified by the CRRC, then the Documentation Author shall input the initial solar reflectance value certified by the CRRC into the following equation to obtain a calculated aged solar reflectance:

$$0.2 + 0.7(\rho_{\text{initial}} - 0.2)$$

Where: ρ_{initial} is the initial solar reflectance value from the CRRC-1 label or CRRC Rated Product Directory.

Thermal Emittance

The thermal emittance identified on the ENV-2C shall match the thermal emittance listed on the CRRC-1 label or CRRC Rated Product Directory.

SRI (Solar Reflectance Index)

The SRI calculator may be used as an alternative to the thermal emittance and aged solar reflectance requirements. The SRI shall be calculated based on the aged solar reflectance and thermal emittance values of the roofing product from the CRRC-1 label or CRRC Rated.

Exceptions:

The following low-sloped roofing assemblies are exempt from the aged solar reflectance and thermal emittance requirements:

- Wood-framed roofs in Climate Zones 3 and 5 are exempt from the minimum requirements for solar reflectance and thermal emittance or SRI if the roof assembly has a U-factor of 0.039 or lower.
- Metal building roofs in Climate Zones 3 and 5 are exempt from the minimum requirements for solar reflectance and thermal emittance or SRI if the roof assembly has a U-factor of 0.048 or lower.
- 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 and thermal emittance or SRI.
- Roof constructions that have a thermal mass over the roof membrane with a weight of at least 25 lb/ft².

MECHANICAL

Is the Mandatory Measures note block on the plans?

A mandatory measures note block that identifies the Mechanical mandatory measures shall be included on the plans. This helps the Builder, Plans Examiner, and Inspector identify the minimum mandatory measures that must be met. The mandatory measures should also be specified in the mechanical documents or building plans.

The Documentation Author may include the MECH-2C Form on the plans to identify the Mechanical mandatory measures, or use whatever format is most appropriate for specifying the mandatory measures in the plan set. In general, this will take the form of a note block located on the mechanical plans or next to the mechanical compliance forms, possibly with cross-references to other locations in the plans where measures are specified.

The Plans Examiner shall verify that the mandatory measures note block or MECH-2C specifying the Mechanical mandatory measures is located on the plans along with the mechanical compliance forms or appropriate sections of the Mechanical plans.

Were all applicable forms submitted?

MECH-1C: All submittals

MECH-2C: All submittals – Can be included on plans as mandatory measures note block

MECH-3C: Submit when the occupied space is supplied with mechanical ventilation

MECH-4C: Submit when total fan system horsepower is greater than 25 hp (Prescriptive Method Only)

MECH-5C: Submit when demonstrating compliance with the Performance Approach (Equipment Details)

To simplify enforcement, the Energy Commission recommends that all applicable Energy Forms (MECH-2C, MECH-3C, etc.) be printed on the plans (electronically incorporated on the plans) along with the Certificate of Compliance. Having all of the energy forms on the plans simplifies the Plan Review process, and helps the Inspector identify the energy components that must be verified in the

field. The Plans Examiner shall verify that all applicable forms have been submitted along with the Mechanical plans.

Are all appropriate Acceptance Tests checked AND equipment/controls requiring testing identified on the Certificate of Compliance (MECH-1C)?

Acceptance Tests are mandatory measures that require the installing contractor to field verify and/or test specific HVAC equipment and controls to ensure that the newly installed equipment and controls function properly after installation. The only Acceptance Test conducted by a HERS Rater is the Air Distribution Test (MECH-4A). Chapter 10 of the 2008 Nonresidential Compliance Manual provides detailed information on the Mechanical Acceptance Test requirements, which equipment and controls require field verification and/or testing, and the procedures on how to conduct the Acceptance Tests.

The Plans Examiner shall verify that all applicable Acceptance Tests and all equipment and controls that require field verification and/or testing are identified on the MECH-1C. The Plans Examiner shall request that the Documentation Author or Designer resubmit the MECH-1C identifying all applicable Acceptance Tests if all applicable Acceptance Tests are not specified on the MECH-1C.

It is important that the Plans Examiner verify all applicable Acceptance Tests on the MECH-1C because the Inspector will reference the Acceptance Tests identified on the MECH-1C to verify which Acceptance Forms to collect before conducting a Final Inspection and issuing the Occupancy Permit for the building.

The Plans Examiner shall verify the following Acceptance Tests on the MECH-1C:

| | | |
|-----------------|---|--|
| MECH-2A: | <i>Ventilation Systems</i> | Applies to new variable air volume (VAV) and constant air volume (CAV) Systems |
| MECH-3A: | <i>Constant-Volume, Single-Zone, Unitary Air Conditioner and Heat Pumps</i> | Applies to new constant volume, single-zone, and unitary units with direct expansion (DX) cooling |
| MECH-4A: | <i>Air Distribution Systems</i> | Applies ONLY to single zone units serving 5,000 ft ² of space or less and where 25% or more of the duct surface area is in an |

| | | |
|-----------------|--|--|
| | | unconditioned space (HERS Verification) |
| MECH-5A: | <i>Air Economizer Controls</i> | Applies to new equipment with air economizer controls (Does not apply to factory installed economizers) |
| MECH-6A: | <i>Demand Control Ventilation (DCV)</i> | Applies to new DCV controls installed with HVAC systems |
| MECH-7A: | <i>Supply Fan Variable Flow Controls (VFC)</i> | Applies to new VAV fan volume controls installed with HVAC systems |
| MECH-8A: | <i>Valve Leakage Test</i> | Applies to new chilled and hot water systems that are designed for variable flow, or when there is more than one boiler or chiller in the plant and the primary pumps are connected to a common header |
| MECH-9A: | <i>Supply Water Temperature Reset</i> | Applies to new chilled or hot water systems that have a supply temperature reset control strategy programmed into the building automation system |

Acceptance Tests on the MECH-1C *continued*:

| | | |
|------------------|--|---|
| MECH-10A: | <i>Hydronic System Variable Flow Control</i> | Applies to new water systems that have been designed for variable flow, where the pumps are controlled by variable frequency drives (i.e. chilled and hot water systems; water-loop heat pump and air-conditioning systems) |
| MECH-11A: | <i>Automatic Demand Shed Control</i> | Applies to new Direct Digital Controls (DDC) to the zone level installed with HVAC system |
| MECH-12A: | <i>Fault Detection Shed Control for DX Units</i> | Applies to new Fault Detection and Diagnostics (FDD) for packaged Direct Expansion (DX) units. |
| MECH-13A: | <i>Automatic Fault Detection & Diagnostics</i> | Applies to new Fault Detection and Diagnostics (FDD) for air handler and zone |

| | | |
|------------------|---|--|
| | <i>for Air Handling & Zone Terminal Units</i> | terminal units |
| MECH-14A: | <i>Distributed Energy Storage DX AC Systems</i> | Applies to new constant and variable Direct Expansion (DX) systems with Distributed Energy Storage (DES/DXAC) |
| MECH-15A: | <i>Thermal Energy Storage (TES) Systems</i> | Applies to new thermal energy storage systems installed in conjunction with chilled water air conditioning systems |

Do all pages have the same run number and date? (Performance Only)

The Plans Examiner shall verify that **ALL** pages have the same run number and date as the PERF-1 Form. If the applicant models the entire building under the same computer run (Mechanical, Lighting, and Envelope Compliance) then all of the energy compliance forms (ENV, LTG, and MECH) should have the same run number and date as the PERF-1 Form.

When the applicant models the Mechanical and Envelope compliances separately, each computer run will have a different run number and date. The Plans Examiner shall verify that the MECH forms have the same run number and date as the PERF-1 Form for the Mechanical Compliance.

Does the Energy Compliance Documentation match the plans?

Section 10-103 of the Administrative Regulations (Title 24, Part 1) mandates that the building characteristics modeled to demonstrate compliance with the Energy Standards shall be specified on the plans. The Plans Examiner shall verify that the efficiencies, controls, insulation values, etc. from the Mechanical compliance forms are specified on the appropriate sections of the Mechanical plans.

Efficiencies and capacities of HVAC equipment

Verification:

Depending on the type of system (air side/water side) the HVAC equipment efficiencies and applicable prescriptive measures are specified on Page 1 or 2 of the MECH-2C. On the MECH-2C, the Documentation Author will identify the type of HVAC system, the number of systems, and the HVAC efficiencies and capacities or the page reference on the plans where the specifications for each item

that pertains to that particular HVAC system will be found. The Plans Examiner will verify that the efficiencies and capacities of the HVAC equipment identified on the form matches the mechanical schedule on the building plans. The Plans Examiner will also ensure that all applicable mandatory measures for the HVAC equipment (listed below) are specified on the MECH-2C and referenced on the mandatory measures note block.

NOTE: The MECH-2C may be incorporated on the plans as the Mechanical mandatory measures note block.

Overview:

Cooling/Heating Efficiency

Minimum HVAC efficiencies can be found in §112 of the Standards (Table 112-A through Table 112-M). HVAC equipment not regulated by §112 will have to meet the minimum efficiency requirements of the Appliance Efficiency Regulations. To comply, equipment specified on the plans and specifications must meet the minimum efficiencies listed in §112 of the Standards or the Appliance Efficiency Regulations.

Manufacturers of equipment regulated by the Appliance Efficiency Regulations are required to certify their equipment to the Energy Commission. To verify certification of HVAC equipment, use one of the following options:

- The Energy Commission's Appliances Database includes listings of certified HVAC equipment at: <http://www.energy.ca.gov/appliances/database/index.html>; or
- If the equipment is not found on the website, call the Energy Standards Hotline at: 1-800-772-3300 or (916) 654-5106.

Thermostat and Controls

Verification:

All HVAC systems must comply with the applicable mandatory controls that pertain to the system and shall be specified on Page 1 of the MECH-2C. The Plans Examiner will verify that the thermostat and controls for each HVAC system identified on the form match the mechanical schedule on the building plans. The Plans Examiner will also ensure that all applicable mandatory measures (listed below) for the HVAC thermostats and controls are specified on the MECH-2C and referenced on the mandatory measures note block.

NOTE: The MECH-2C may be incorporated on the plans as the Mechanical mandatory measures note block.

Overview:

Heat Pump Thermostat

Controls for heat pumps with supplementary electric resistance heaters must meet the following mandatory requirements:

- Prevent supplementary heater operation when the heating load can be met by the heat pump alone.
- The cut-on/off temperature for compression heating must be higher than the cut-on/off temperature for supplementary heating.

Furnace Controls

- Thermostats controlling unitary heating and/or cooling systems (including heat pumps) not connected to a central energy management control system must be a setback thermostat.
- Natural gas fan-type central furnaces may be installed only if they do not have a continuously burning pilot light.

Time Control

Times of Occupancy. The minimum rate of outdoor air required by §121(b)2, or the rate required for make-up of exhaust systems that are required for a process for control of odors or for the removal of contaminants within a space, shall be supplied at all times to each space when occupied.

Pre-Occupancy. The least of three air changes per hour or the minimum rate of outdoor air must be supplied to the whole building one hour prior to normal building occupancy.

Setback and Setup Control

Each HVAC system must have controls capable of the following:

1. Automatic shut off during periods of nonuse and shall have:
 - An automatic time switch complying with §119(c) that has an accessible 4 hour manual override; or
 - An occupancy sensor; or
 - A manually operated 4 hour timer.

2. Automatic restart and temporary operation as required to maintain:
 - A setback heating thermostat setpoint if the system provides mechanical heating; and
 - A setup cooling thermostat setpoint if the system provides mechanical cooling.

Outdoor Damper Control

The installed damper for outdoor air supply and exhaust equipment must automatically close upon fan shutdown.

Isolation Zones

A space conditioning system serving multiple zones with a combined conditioned floor area of more than 25,000 square feet must be designed, installed, and controlled to serve isolation areas. An isolation area is a zone or combination of zones not exceeding 25,000 square feet. Each isolation area must be provided with valves or dampers that allow the supply of heating or cooling to be reduced or shut-off independently of other isolation areas. Each isolation area shall be controlled by a device that meets the following:

Automatic shut off during periods of nonuse and shall have:

- An automatic time switch complying with §119(c) that has an accessible 4 hour manual override; or
- An occupancy sensor; or
- A manually operated 4 hour timer.

Ventilation and Ventilation Rates (cfm)

Verification:

Either natural or mechanical ventilation must be supplied to an occupied space. The designer must specify which type of ventilation will be supplied and reference the system on Page 1 of the MECH-2C. The Plans Examiner will verify that the ventilation (natural or mechanical) and minimum ventilation rates (cfm) for each HVAC system identified on the form matches the mechanical schedule on the building plans. When mechanical ventilation is to be supplied to the occupied space, a MECH-3C must be submitted showing the minimum ventilation requirements have been met. Verifying compliance with the ventilation requirements on the MECH-3C is discussed later in this guide (see **Additional HVAC Requirements**). The Plans Examiner will also ensure that all applicable mandatory measures

(listed below) for ventilation and ventilation rates (cfm) were specified on the MECH-2C and referenced on the mandatory measures note block.

NOTE: The MECH-2C may be incorporated on the plans as the Mechanical mandatory measures note block.

Overview:

Natural Ventilation

Natural outdoor ventilation may be provided for spaces where all normally occupied areas of the space are within a specific distance from an operable wall or roof opening through which outdoor air can flow. This distance is 20 feet for most spaces and 25 feet for hotel/motel guestrooms and high-rise residential spaces. The sum of the operable open areas must total at least 5 percent of the floor area of each space that is naturally ventilated. The openings must also be readily accessible to the occupants of the space at all times. Airflow through the openings must come directly from the outdoors; air may not flow through any intermediate spaces, such as other occupied spaces, unconditioned spaces, corridors, or atriums. High windows or operable skylights need to have a control mechanism accessible from the floor.

Minimum Ventilation

Mechanical outdoor ventilation must be provided for all spaces normally occupied that are not naturally ventilated. The Standards require that a space conditioning system provide outdoor air equal to or greater than the ventilation rates required for each of the spaces that it serves. For every space, the required ventilated air can be provided either directly through supply air, or indirectly through transfer of air from the plenum or an adjacent space, which is calculated on the MECH-3C (see **Additional HVAC Requirements**).

For each space requiring mechanical ventilation the ventilation rates must be no less than the larger of:

1. The conditioned floor area of the space multiplied by the applicable minimum ventilation rate from Standards Table 121-A (see *Table 121-A* below); or
2. 15 cfm per person multiplied by the expected number of occupants. For spaces with fixed seating (such as a theater or auditorium) the expected number of occupants is the number of fixed seats. For spaces without fixed seating, the expected number of occupants is assumed

to be no less than one-half of the maximum occupant load assumed for egress purposes in Table 4-2 of the 2008 Nonresidential Compliance Manual.

Standards Table 121-A Minimum Ventilation Rates

| TYPE OF USE | CFM PER SQUARE FOOT OF CONDITIONED FLOOR AREA |
|--|---|
| Auto repair workshops | 1.50 |
| Barber shops | 0.40 |
| Bars, cocktail lounges, and casinos | 0.20 |
| Beauty shops | 0.40 |
| Coin-operated dry cleaning | 0.30 |
| Commercial dry cleaning | 0.45 |
| High-rise residential | Ventilation Rates Specified by the CBC |
| Hotel guest rooms (less than 500 ft ²) | 30 cfm/guest room |
| Hotel guest rooms (500 ft ² or greater) | 0.15 |
| Retail stores | 0.20 |
| All others | 0.15 |

The actual supply air to any given space may be any combination of recirculated air, outdoor air, or air transferred directly from other spaces, provided:

- a. The total amount of outdoor air delivered by the space-conditioning system(s) to all spaces is at least as large as the sum of the space design quantities; and
- b. Each space always receives a supply airflow, including recirculated air and/or transfer air, no less than the calculated outdoor ventilation rate; and
- c. When using transfer air, none of the spaces from which air is transferred has any unusual sources of contaminants.

Air may be transferred using any method that ensures a positive airflow. Examples include dedicated transfer fans, exhaust fans and fan-powered VAV boxes. A system having a ducted return may be balanced so that air naturally transfers into the space. Exhaust fans serving the space may discharge directly outdoors, or into a return plenum. Transfer systems should be designed to minimize recirculation of transfer air back into the space; duct work should be arranged to separate the transfer air intake and return points.

VAV Minimum Position Control & Demand Control Ventilation

Demand controlled ventilation (DCV) systems reduce the amount of ventilation supply air in response to a measured level of carbon dioxide (CO₂) in the occupied zone. The Standards only permit CO₂ sensors for the purpose of meeting this requirement; VOC and so-called “IAQ” sensors are not approved as alternative devices to meet this requirement. The Standards only permit DCV systems to vary the ventilation component that corresponds to occupant bioeffluents (this is the basis for the 15 cfm/person portion of the ventilation requirement). The purpose of CO₂ sensors is to track occupancy in a space; however, there are many factors that must be considered when designing a DCV system. There is often a lag time in the detection of occupancy through the build-up of CO₂. This lag time may be increased by many factors that affect mixing, such as short circuiting of supply air or inadequate air circulation, as well as sensor placement and sensor accuracy. Build-up of odors, bioeffluents, and other health concerns may also lag changes in occupancy; therefore, the designers must be careful to specify CO₂ based DCV systems that are designed to provide adequate ventilation to the space by ensuring proper mixing, avoiding short circuiting, and proper placement and calibration of the sensors.

The Standards require the use of DCV systems for HVAC systems with all of the following characteristics:

- A. They are either single zone units with any controls or multiple zone systems with Direct Digital Controls (DDC) to the zone level; and
- B. They serve a space with a design occupant density of 40 ft²/person or smaller. For areas without fixed seating DCV systems are required when the design density for egress purposes in Table 4-2 of the 2008 Nonresidential Compliance Manual is 40 ft²/person or smaller; and
- C. Has an air economizer.

There are four exceptions to this requirement:

- 1. The following spaces are permitted to use DCV but are not required to: Classrooms, call centers, office spaces served by multiple zone systems that are continuously occupied during normal business hours with an occupant density greater than 25 people per 1000 ft² per §121(b)2B (Tables 4-1 and 4-2 in the 2008 Nonresidential Compliance Manual), healthcare facilities and medical buildings, and public areas of social services buildings.
- 2. Where the space exhaust is greater than the required ventilation rate from §121(b)2B minus 0.2 cfm/ft² of conditioned area.
- 3. DCV devices are not allowed in the following spaces: 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, or beauty salons.
- 4. Spaces with an area of less than 150 ft² or a design occupancy of less than 10 people per §121(b)2B (Tables 4-1 and 4-2 in the 2008 Nonresidential Compliance Manual).

Duct Insulation

Verification:

When the HVAC system uses a duct system to transfer conditioned air to a given space, the ducts must be insulated according to §124 and the duct insulation values shall be identified or referenced on Page 1 of the MECH-2C. The Plans Examiner will verify that the duct insulation values for each HVAC system identified on the form matches the mechanical schedule on the building plans. The Plans Examiner will also ensure that all applicable mandatory measures (listed below) for HVAC duct systems are specified on the MECH-2C and referenced on the mandatory measures note block.

NOTE: The MECH-2C may be incorporated on the plans as the Mechanical mandatory measures note block.

Overview:

Duct Insulation

All air distribution system ducts and plenums, including building cavities, mechanical closets, air handler boxes and support platforms used as ducts or plenums, are required to be installed and sealed in accordance with the 2007 California Mechanical Code (CMC) Sections 601, 602, 603, 604, 605 and Standard 6-5. Also, portions of the supply and return ducts located in any of the following places shall be insulated to a minimum level of R-8:

- Outdoors; or
- In a space between the roof and an insulated ceiling; or
- In a space directly under a roof with fixed vents or openings to the outside or unconditioned spaces; or
- In an unconditioned crawlspace; or
- In other unconditioned spaces.

Additionally, portions of the supply duct that is not located in any of the above listed spaces, including ducts buried in concrete slabs, shall be insulated to a minimum installed level of R-4.2 (or any higher level required by CMC section 605) or be enclosed in directly conditioned space.

Pipe Insulation

Verification:

Piping for all space-conditioning and service water heating systems shall be insulated according to §123 and the pipe insulation values shall be identified or referenced on Page 1 of the MECH-2C for

space conditioning systems, and on Page 3 of the MECH-2C for service water-heating systems. The Plans Examiner will verify that the pipe insulation values for each HVAC system (Page 1 of MECH-2C) and/or each water heating system (Page 3 of MECH-2C) identified on the form matches the mechanical/water-heating schedule on the building plans. The Plans Examiner will also ensure that all applicable mandatory measures (listed below) for pipe insulation are specified on the MECH-2C and referenced on the mandatory measures note block.

NOTE: The MECH-2C may be incorporated on the plans as the Mechanical mandatory measures note block.

Overview:

Pipe Insulation

The required thickness of piping insulation can be found in Standards Table 123-A (Table 123-A). Pipe insulation thickness will depend on the temperature of the fluid passing through the pipe, the pipe diameter, the function of the pipe within the system, and the pipe insulation’s thermal conductivity.

Standards Table 123-A

| FLUID TEMPERATURE RANGE (°F) | CONDUCTIVITY RANGE (in Btu-inch per hour per square foot per °F) | INSULATION MEAN RATING TEMPERATURE (°F) | NOMINAL PIPE DIAMETER (in inches) | | | | | |
|--|--|---|---|------------|--------|--------|-----|--------------|
| | | | Runouts up to 2 | 1 and less | 1.25-2 | 2.50-4 | 5-6 | 8 and larger |
| | | | INSULATION THICKNESS REQUIRED (in inches) | | | | | |
| Space heating systems (steam, steam condensate and hot water) | | | | | | | | |
| Above 350 | 0.32-0.34 | 250 | 1.5 | 2.5 | 2.5 | 3.0 | 3.5 | 3.5 |
| 251-350 | 0.29-0.31 | 200 | 1.5 | 2.0 | 2.5 | 2.5 | 3.5 | 3.5 |
| 201-250 | 0.27-0.30 | 150 | 1.0 | 1.5 | 1.5 | 2.0 | 2.0 | 3.5 |
| 141-200 | 0.25-0.29 | 125 | 0.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| 105-140 | 0.24-0.28 | 100 | 0.5 | 1.0 | 1.0 | 1.0 | 1.5 | 1.5 |
| Service water-heating systems (recirculating sections, all piping in electric trace tape systems, and the first 8 feet of piping from the storage tank for nonrecirculating systems) | | | | | | | | |
| Above 105 | 0.24-0.28 | 100 | 0.5 | 1.0 | 1.0 | 1.5 | 1.5 | 1.5 |
| Space cooling systems (chilled water, refrigerant and brine) | | | | | | | | |
| 40-60 | 0.23-0.27 | 75 | 0.5 | 0.5 | 0.5 | 1.0 | 1.0 | 1.0 |
| Below 40 | 0.23-0.27 | 75 | 1.0 | 1.0 | 1.5 | 1.5 | 1.5 | 1.5 |

The conductivity ranges in Table 123-A are typical for fiberglass or foam pipe insulation. In Table 123-A, runouts are defined as being less than two inches in diameter, less than 12 feet long, and connected to fixtures or individual terminal units. Piping within fan coil units and within other heating or cooling equipment may be considered runouts for the purposes of determining the required pipe insulation.

Piping that does not require insulation includes the following:

- Factory installed piping within space-conditioning equipment certified under §111 or §112. Nationally recognized certification programs that are accepted by the Energy Commission for certifying efficiencies of appliances and equipment are considered to meet the requirements for this exception.
- Piping that conveys fluid with a design operating temperature range between 60°F and 105°F, such as cooling tower piping or piping in water loop heat pump systems.
- Piping that serves process loads, gas piping, cold domestic water piping, condensate drains, roof drains, vents or waste piping.
- 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 materials to assure that no contact is made with the metal framing.

When insulating materials are used that have a conductivity value outside of the conductivity ranges listed in Table 123-A for the applicable fluid range, such as calcium silicate, Standards Equation 123-A may be used to calculate the required pipe insulation thickness.

Standards Equation 123-A 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 123-A, inches.
- K = Conductivity of alternate material at the mean rating temperature indicated in Table 123-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 123-A for the applicable fluid temperature range, Btu-inch per hour per square foot per °F.

The Standards also require that exposed pipe insulation be protected from damage by moisture, UV and physical abrasion, including 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.
- Insulation covering chilled water piping and refrigerant suction piping located outside the conditioned space shall include a vapor retardant located outside the insulation (unless the insulation is inherently vapor retardant), all penetrations and joints of which shall be sealed.

Service Hot Water Equipment

Verification:

All service hot water equipment shall be certified and meet the efficiency and installation requirements of §113. On Page 3 of the MECH-2C, the Documentation Author will identify the type of water heating system, the number of systems, and the water heater efficiency or the page reference on the plans where the specifications for each item that pertains to that particular water heating system will be found. The Plans Examiner will verify that the water heater efficiencies and installation criteria identified on the form matches the mechanical/water-heating schedule. The Plans Examiner will also ensure that all applicable mandatory measures (listed below) for water heating equipment are specified on the MECH-2C and referenced on the mandatory measures note block.

NOTE: The MECH-2C may be incorporated on the plans as the Mechanical mandatory measures note block.

Overview:

Water Heater Certification

Manufacturers of service water heating systems and equipment must certify that the system or equipment is equipped with automatic temperature controls that allow the temperature to be adjusted from the lowest to the highest allowed temperature settings for the intended use as listed in Table 2, Chapter 49 of the ASHRAE Handbook, HVAC Applications Volume.

NOTE: Water heaters that serve guest rooms in high-rise residential buildings and hotel/motel buildings must comply with the low-rise residential water heating standards in §151(f)8 and are exempt from the above requirement.

Water Heater Efficiency

All water heating systems and equipment must meet the applicable minimum efficiency requirements of the Appliance Efficiency Regulations as required by §111 and §113(b).

Service Water Heating Installation

Outlet Temperature Controls

On systems that have a total capacity greater than 167,000 Btu/hr, outlets requiring 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. All other demands requiring higher temperatures should be served by separate systems, or by boosters that raise the temperature of the primary supply.

Controls for Hot Water Distribution Systems

Service hot water systems with a circulating pump or with electrical heat trace shall include a control capable of automatically turning off the system when hot water is not required. Such controls include automatic time switches, interlocks with HVAC time switches, occupancy sensors, and other controls that accomplish the intended purpose.

Public Lavatories

Lavatories in public restrooms must have controls that limit the water supply temperature to 110°F. When the service water heater supplies only restrooms, the water heater thermostat may be set to no greater than 110°F to satisfy this requirement; otherwise controls such as automatic mixing valves must be installed.

Storage Tank Insulation

Unfired water heater storage tanks and backup tanks for solar water heating systems shall have:

1. External insulation with an R-value of at least R-12; or
2. Internal and external insulation with a combined R-value of at least R-16; or
3. The heat loss of the tank based on an 80°F water-air temperature difference shall be less than 6.5 Btu per hour per ft². This corresponds to an effective resistance of R-12.3.

Water Heating Recirculation Loops Serving Multiple Dwelling Units, High-Rise Residential, Hotel/Motel and Nonresidential Occupancies

Water heating recirculation loops shall meet the following requirements:

1. 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.
2. 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 through the recirculation loop.
3. 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.
4. 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 3 above.
5. Cold water supply and recirculation loop connection to hot water storage tank. Storage water heaters and boilers shall be plumbed in accordance with the boiler manufacturer's specifications. The cold water piping and the recirculation loop piping shall not be connected to the hot water storage tank drain port.
6. 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.

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 from site solar energy or recovered energy. This requirement may be waived for buildings where the State Architect determines that such systems are economically or physically infeasible.

Pipe Insulation

See **Pipe Insulation** above.

Pool and Spa Equipment

Verification:

All pool and spa equipment shall be certified and meet the efficiency and installation requirements of §114. On Page 3 of the MECH-2C, the Documentation Author will identify the type of pool and/or spa system, the number of systems, and the pool and/or spa equipment efficiencies or the page reference on the plans where the specifications for each item that pertains to that particular pool or spa heating system will be found. The Plans Examiner will verify that the pool and spa heating equipment efficiencies and installation criteria identified on the form matches the mechanical schedule. The Plans Examiner will also ensure that all applicable mandatory measures (listed below) for pool and spa equipment are specified on the MECH-2C and referenced on the mandatory measures note block.

NOTE: The MECH-2C may be incorporated on the plans as the Mechanical mandatory measures note block.

Overview:

Pool and Spa Efficiency and Control

All pool and spa heating systems and equipment must be certified by the manufacturer and listed by the Energy Commission as having:

1. An efficiency that complies with the Appliance Efficiency Regulations; and
2. An on-off switch mounted on the outside of the heater in a readily accessible location that allows the heater to be shut off without adjusting the thermostat setting; and
3. A permanent, easily readable, and weatherproof plate or card that gives instructions for the energy efficient operation of the pool or spa heater, and for the proper care of the pool or spa water when a cover is used; and
4. No electric resistance heating. The only exceptions are:
 - a) Listed packaged units with fully insulated enclosures and tight fitting covers that are insulated to at least R-6. Listed package units are defined in the National Electric Code and are typically sold as self-contained, UL Listed spas; or
 - b) Pools or spas deriving at least 60 percent of the annual heating energy from site solar energy or recovered energy.

Pool and Spa Installation

All pool or spa systems and equipment shall have all of the following:

1. If a pool or spa heating system does not currently use solar heating collectors for heating of the water, piping must be installed to accommodate for future solar installation. Contractors can choose 3 options to allow for the future addition of solar heating equipment:

- Leave at least 36 in. of pipe between the filter and heater to allow for the future addition of solar heating equipment; or
 - Plumb separate suction and return lines to the pool dedicated to future solar heating; or
 - Install built-up or built-in connections for future piping to solar water heating. An example of a built-in connection could be a capped off tee fitting between the filter and heater.
2. Pool and spa heating systems with gas or electric heaters for outdoor use must use a pool cover. The pool cover must be fitted and installed during the final inspection.

All pool systems shall also have:

1. Directional inlets must be provided for all pools that adequately mix the pool water; and
2. A time switch or similar control mechanism shall be provided for pools to control the operation of the circulation control system to allow the pump to be set or programmed to run in the off-peak demand period, and for the minimum time necessary to maintain the water in the condition required by applicable public health standards.

Pool Heater – No Pilot Light

Pool heaters may not have a continuously burning pilot light per §115.

Spa Heater – No Pilot Light

Spa heaters may not have a continuously burning pilot light per §115.

Additional HVAC Requirements

Prescriptive Requirements

When the Documentation Author demonstrates compliance with the Prescriptive Approach for Mechanical Compliance, the Plans Examiner shall verify compliance with all applicable Prescriptive requirements for each HVAC system.

The Prescriptive Requirements on page 1 of the MECH-2C may be found in the 2008 Nonresidential Compliance Manual:

- Heating/Cooling Loads (page 4-72)
- Fan Control (page 4-75)
- DP Sensor Location (page 4-76)
- Supply Pressure Reset (DDC only) (page 4-77)
- Simultaneous Heat/Cool (page 4-57)
- Economizer (page 4-59)
- Heat and Cool Air Supply Reset (page 4-66)
- Electric Resistance Heating (page 4-81)

- Heat Rejection System (page 4-67)
- Air Cooled Chiller Limitation (page 4-83)
- Duct Leakage Sealing (page 4-41)

The Prescriptive Requirements on page 2 of the MECH-2C may be found in the 2008 Nonresidential Compliance Manual:

- Cooling Tower Fan Controls (page 4-72)
- Cooling Tower Flow Controls (page 4-67)
- Variable Flow System Design (page 4-67)
- Chiller and Boiler Isolation (page 4-69)
- CHW and HHW Rest Controls (page 4-69)
- WLHP Isolation Valves (page 4-70)
- VSD on CHW, CW and WLHP Pumps > 5 HP (page 4-70)
- DP Sensor Location (page 4-70)

Mechanical Compliance Forms

MECH-3C Mechanical Ventilation and Reheat

Verification:

The MECH-3C is a worksheet provided to calculate the required amount of mechanical ventilation. The Plans Examiner shall verify that the information in bold below and on the next page is correct. If there are any discrepancies, the form shall be recalculated and resubmitted.

- A. Column A on the MECH-3C is where the designer will list the system; this will enable the Plans Examiner to locate the system and zone on the plans.**
- B. Column B is the conditioned floor area of the zone.**
- C. Column C is the ventilation rate (cfm/ft²) from Standards Table 121-A.
- D. Column D is the product of (B x C).
- E. Column E is the occupant load from the designer. Verify the correct occupant load from Table 4-2 in the 2008 Nonresidential Compliance Manual.
- F. Column F is the default of 15 cfm per person.
- G. Column G is the product of (E x F).
- H. Column H is the larger of D or G.**
- I. Column I must be greater than or equal to H or use transfer air from Column N to make up the difference.**
- J. Column J is 50% of the design zone supply cfm (found on the equipment schedule). This is calculated by multiplying the cfm by .5
- K. Column K is the product of column B and 0.4
- L. Column L is the larger of H, J, K or 300 cfm.
- M. Column M must be less than or equal to L and greater than H + N.
- N. Column N must be completed when H is greater than M. Transfer air must be greater than or equal to H – M.**

Overview:

All of the ventilation requirements are mandatory measures, some of which require Acceptance Testing. All enclosed spaces that are normally used by humans (spaces where people can be

reasonably expected to remain for an extended period of time) must be continuously ventilated during occupied hours with outdoor air using either natural or mechanical ventilation per §121. The Energy Commission highly recommends that spaces that may have unusual sources of contaminants be designed with enclosures to contain the contaminants and local exhaust systems to directly vent the contaminants outdoors. The designation and treatment of such spaces is subject to the designer's discretion.

Spaces needing special consideration may include:

- Commercial and coin-operated dry cleaners
- Bars and cocktail lounges
- Smoking lounges and other designated smoking areas
- Beauty and barbershops
- Auto repair workshops
- Print shops, graphic arts studios and other spaces where solvents are used in a process
- Copy rooms, laser printer rooms or other rooms where it is expected that equipment may generate heavy concentrations of ozone or other contaminants
- Blueprint machines

Spaces where occupancy will be brief and intermittent, and that do not have any unusual sources of air contaminants, do not need to be ventilated. For example:

- A closet does not need to be ventilated provided it is not normally occupied.
- A storeroom that is only infrequently or briefly occupied does not require ventilation.

However, a storeroom that can be expected to be occupied for extended periods for clean-up or inventory must be ventilated, preferably with systems controlled by a local switch so that the ventilation system operates only when the space is occupied.

MECH-4C FAN POWER CONSUMPTION

Verification:

All constant volume and variable air volume systems with a total combined brake horsepower greater than 25 hp shall provide a separate MECH- 4C. **Total combined means all fans within each system.** Each row of the MECH-4C form is to be filled out as the column header describes. The Plans Examiner will verify that the Adjusted Fan Power Index (Row 7) does not exceed 0.8 W/CFM for constant volume systems or 1.25 W/CFM for VAV systems.

Under the *Totals and Adjustments*:

1. Row 1 is the sum of the fan power from column F.
2. Row 2 is the supply design CFM.
3. Row 3 is Row 1 divided by Row 2.
4. Row 4 is the filter pressure drop. The pressure drop is only entered if it is greater than 1 in water column or 245 pascals.
5. Row 5 is the total fan pressure drop across the fan.
6. Row 6 is the fan adjustment as calculated by Standards Equation 144-A (on the next page).
7. Row 7 is calculated by Standards Equation 144-A.

Overview:

The required minimum efficiency for motors and drives can be found in the 2008 Reference Appendices, Nonresidential Appendix NA3 on the Energy Commission’s website at:

<http://www.energy.ca.gov/2008publications/CEC-400-2008-004/CEC-400-2008-004-CMF.PDF>

The brake horsepower shall be specified by the Mechanical Engineer or Designer in the mechanical equipment schedule. The Plans Examiner should also request that the Mechanical Engineer or Designer provide a mechanical equipment cut sheet from the manufacturer on all fan systems greater than 25 hp. Mechanical equipment cut sheets should also be provided on the plans for chiller towers, economizers, DCV systems, DDC, or for any other equipment that the Plans Examiner requests to complete their Plan Review.

Equation 144-A Adjusted Fan Power Index

Adjusted fan power index = Fan power index x Fan Adjustment

$$\text{Fan Adjustment} = 1 - \left(\frac{SP_a - 1}{SP_f} \right)$$

WHERE:

SP_a = Air pressure drop across the air-treatment or filtering system.
 SP_f = Total pressure drop across the fan.

All of the information needed to complete the form will be on the equipment cut sheets from the manufacturer. To simplify enforcement, the Plans Examiner shall require that the W/CFM for each fan system with 25 hp or greater be specified in the mechanical schedule on the plans, and verify that the W/CFM matches the MECH-4C.

INDOOR LIGHTING

Is the Mandatory Measures note block on the plans?

A mandatory measures note block identifying the Indoor Lighting mandatory measures shall be included on the plans. This helps the Builder, Plans Examiner, and Inspector identify the minimum mandatory measures that need to be met.

The Documentation Author designer may use whatever format is most appropriate for specifying the mandatory measures in the plan set. In general, this will take the form of a note block in the Electrical/Lighting plans or next to the Indoor Lighting compliance forms, possibly with cross-references to other locations in the plans where measures are specified.

The Plans Examiner shall verify that the mandatory measures note block specifying the Indoor Lighting mandatory measures is located on the plans along with the Indoor Lighting compliance forms or appropriate sections of the Electrical/Lighting plans.

Were all applicable forms submitted?

LTG-1C: All submittals

LTG-2C: Submit when control credits are taken

LTG-3C: All submittals – Indoor Lighting Power Allowances

LTG-4C: Submit when the Tailored Method is used

LTG-5C: Submit when line voltage track lighting will be installed

To simplify enforcement, the Energy Commission recommends that all applicable Energy Forms (LTG-2C, LTG-3C, etc.) be printed on the plans (electronically incorporated on the plans) along with the Certificate of Compliance. Having all of the energy forms on the plans simplifies the Plan Review process, and helps the Inspector identify the energy components that must be verified in the field. The Plans Examiner shall verify that all applicable forms have been submitted along with the Electrical/Lighting plans.

Are all appropriate Acceptance Tests checked AND controls requiring testing identified on the Certificate of Compliance (LTG-1C)?

Acceptance Tests are mandatory measures that require the installing contractor to field verify and/or test specific indoor lighting controls to ensure that the newly installed lighting controls function properly after installation. Chapter 10 of the 2008 Nonresidential Compliance Manual provides detailed information on the Indoor Lighting Acceptance Test requirements, which controls require field verification and/or testing, and the procedures on how to conduct the Acceptance Tests.

The Plans Examiner shall verify that all applicable Acceptance Tests and controls that require field verification and/or testing are identified on the LTG-1C. The Plans Examiner shall request that the Documentation Author or Designer resubmit the LTG-1C identifying all applicable Acceptance Tests if all applicable Acceptance Tests are not specified on the LTG-1C.

It is important that the Plans Examiner verify all applicable Acceptance Tests on the LTG-1C because the Inspector will reference the Acceptance Tests identified on the LTG-1C to verify which Acceptance Forms to collect before conducting a Final Inspection and issuing the Occupancy Permit for the building.

The Plans Examiner shall verify the following Acceptance Tests on the LTG-1C:

| | | |
|----------------|--------------------------|--|
| LTG-2A: | <i>Lighting Controls</i> | Applies to occupancy sensors, manual daylight controls, and automatic time switch controls |
|----------------|--------------------------|--|

Do all pages have the same run number and date? (Performance Only)

The Plans Examiner shall verify that **ALL** pages have the same run number and date as the PERF-1 Form.

If the applicant models the entire building under the same computer run (Mechanical, Lighting, and Envelope Compliance) then all of the energy compliance forms (ENV, LTG, and MECH) should have the same run number and date as the PERF-1 Form.

The Plans Examiner shall verify that the LTG forms have the same run number and date as the PERF-1 Form for the Lighting Compliance.

Under the Performance Approach, the Documentation Author cannot model the Indoor Lighting Compliance alone (Lighting Only), or use the Tailored Method to determine the allowed LPDs (watts per square foot). The Prescriptive Approach shall be used in these situations.

Does the Energy Compliance Documentation match the plans?

Section 10-103 of the Administrative Regulations (Title 24, Part 1) mandates that the building characteristics modeled to demonstrate compliance with the Energy Standards shall be specified on the plans. The Plans Examiner shall verify that the efficiencies and lighting system components from the Indoor Lighting forms are specified in the appropriate sections of the Electrical/Lighting plans.

LPDs (watts per square foot)

Verification:

The proposed installed watts for Conditioned and Unconditioned spaces shall be specified separately under the Luminaire Schedule on Page 2 of the LTG-1C. On the LTG-1C, the Documentation Author will identify a description of the luminaire, the watts per luminaire, and the number of luminaires for each different lighting fixture. The Plans Examiner shall verify that:

1. The Total Installed Watts specified on Page 2 of the LTG-1C is calculated correctly and equals the sum of all fixtures identified in the Luminaire Schedule. *NOTE:* The Total Installed Wattage for Conditioned and Unconditioned spaces shall be identified on separate LTG-1C Forms.
2. The Total Installed Watts does not exceed the Allowed Lighting Power (allowed watts) identified on Page 4 of the LTG-1C. The Allowed Lighting Power values listed on the LTG-1C shall match the Allowed Lighting Power values calculated on the LTG-3C, depending on the lighting method used (Complete Building, Area Category, or Tailored Method).
NOTE: The Allowed Lighting Power for Conditioned and Unconditioned spaces shall be calculated separately.

Once the Total Installed and Allowed Watts have been verified for compliance, the Plans Examiner shall verify that the lighting fixtures and proposed installed watts identified in the Luminaire Schedule (Page 2 of the LTG-1C) are specified in the Lighting Schedule or Electrical Plans.

Overview:

Luminaire wattage shall be determined as follows:

1. The wattage of luminaires with line voltage lamp holders, other than GU-24 lamps, that do not contain permanently installed ballasts or transformers shall be determined as follows:

- For other than recessed luminaires, the maximum relamping rated wattage of the luminaire, as listed on a permanent, pre-printed, factory-installed label, as specified by UL 1598.
 - For recessed luminaires, the larger of the maximum relamping rated wattage of the luminaire, as listed on a permanent, pre-printed, factory-installed label, as specified by UL 1598, or the following:
 - a. 50 watts per socket for luminaires with housings or trims with an aperture diameter less than 5 inches regardless of the mounting height; or
 - b. 50 watts per socket for luminaires with housings or trims with an aperture diameter greater than or equal to 5 inches and a mounting height of 11 feet or less; or
 - c. 60 watts per socket for luminaires with housings or trims with an aperture diameter greater than or equal to 5 inches and a mounting height greater than 11 feet but less than 15 feet; or
 - d. 75 watts per socket for luminaires with housings or trims with an aperture diameter greater than or equal to 5 inches and a mounting height of 15 feet or more.
 - For luminaires designed to accommodate a variety of trims or modular components that allow the conversion between screw-based and pin-based sockets without changing the luminaire housing or wiring, the highest wattage designated by the correlated marking on a permanent pre-printed, factory-installed label on the luminaire housing shall be used.
2. The wattage of luminaires with permanently installed or remotely installed ballasts shall be the operating input wattage of the rated lamp/ballast combination published in the manufacturer's catalogs based on independent testing lab reports as specified by UL 1598. The wattage of a compact fluorescent or high intensity discharge luminaire that can accommodate a range of wattages without changing the luminaire housing, ballast, or wiring shall be the larger of the installed wattage, or the average wattage of the lamp/ballast combinations for which the luminaire is rated.
 3. The wattage of line-voltage lighting track and plug-in busway which allows the addition or relocation of luminaires without altering the wiring of the system shall be determined by one of the following methods:
 - The wattage of line voltage busway and track rated for more than 20 amperes shall be the total volt-ampere rating of the branch circuit feeding the busway and track.
 - The wattage of line voltage busway and track rated for 20 amperes or less shall be determined by one of the following methods:
 - a. The volt-ampere rating of the branch circuit feeding the track or busway; or
 - b. The higher of the rated wattage of all of the luminaires included in the system, where wattage is determined according to Section 130(d)1, 2, 4, 5, or 6 as applicable, or 45 watts per linear foot; or
 - c. When using an integral current limiter, the higher of the volt-ampere rating of the integral current limiter controlling the track or busway, or 12.5 watts per linear foot of track or busway, provided that the integral current limiter complies with Section 119(l).
 4. The wattage of luminaires or lighting systems with permanently installed or remotely installed transformers shall be the rated wattage of the lamp/transformer combination, listed on a permanent, pre-printed, factory-installed label, as specified by UL 2108.

5. The wattage of light emitting diode (LED) Luminaires, or LED Light Engine with Integral Heat Sink shall be the maximum rated input wattage of the system when tested in accordance with Reference Joint Appendix JA8. The maximum rated input wattage shall be listed on a permanent, pre-printed, factory-installed label.
6. The wattage of all other miscellaneous lighting equipment shall be the maximum rated wattage of the lighting equipment, or operating input wattage of the system, listed on a permanent, pre-printed, factory-installed label, or published in the manufacturer's catalogs, based on independent testing lab reports as specified by UL 1574 or UL 1598.

GU-24 lamps, luminaires, and adaptors shall meet the following requirements:

1. Lamps with GU-24 bases shall have a minimum efficacy no lower than specified in Standards Table 150-C (see *Standards Table 150-C* on the next page).
2. The wattage of luminaires with GU-24 lamp holders shall be the operating input wattage as listed on a permanent, pre-printed, factory-installed label on the luminaire housing, as specified by UL. Luminaires with GU-24 lampholders shall not be rated for any lamp or lighting system that has an efficacy lower than specified in Standards Table 150-C.
3. Luminaires with GU-24 lampholders shall not have modular components allowing conversion to any lamp or lighting system that has an efficacy lower than specified in Standards Table 150-C.
4. There shall be no adaptors that convert a GU-24 socket or GU-24 lamp holder to any other line voltage socket or lamp holder, or to any lighting system that has an efficacy lower than specified in Standards Table 150-C.

Standards Table 150-C

| Lamp Power Rating for Non-LED Lighting (see Note 1), or System Power Rating for LED Lighting (see Notes 2, 3, and 4) | Minimum Lamp Efficacy for Non-LED Lighting, or Minimum System Efficacy for LED Lighting |
|--|--|
| 5 watts or less | 30 lumens per watt |
| over 5 watts to 15 watts | 40 lumens per watt |
| over 15 watts to 40 watts | 50 lumens per watt |
| over 40 watts | 60 lumens per watt |
| <p>Notes:</p> <ol style="list-style-type: none"> 1. Determine minimum lamp efficacy category for lighting systems which are not LED using the initial rated lumens divided by the rated watts of the lamp (not including the ballast). 2. To qualify as high efficacy, an LED luminaire shall meet the minimum system efficacy requirements in | |

Table 150-C when determined according to Reference Joint Appendix JA8, and be certified to comply with Section 119(m), and input power shall be determined according to Section 130(d)5.

3. For a Hybrid LED Luminaire to qualify as a high efficacy luminaire, all lighting systems in the luminaire shall qualify as high efficacy according to Section 150(k)1, and the LED Light Engine with Integral Heat Sink shall comply with Note 4, below.
4. To qualify as high efficacy, an LED Light Engine with Integral Heat Sink shall meet the minimum system efficacy requirements in Table 150-C when determined according to Reference Joint Appendix JA8, shall be certified to comply with Section 119(m), and input power shall be determined according to Section 130(d)5.

Exceptions:

There are several lighting applications that are exempt from the indoor luminaire power density (watts per square foot) requirements of §146:

1. In theme parks: Lighting for themes and special effects.
2. Studio lighting for film or photography provided that these lighting systems are separately switched from the general lighting system.
3. Lighting for dance floors, lighting for theatrical and other live performances, and theatrical lighting used for religious worship, provided that these lighting systems are in addition to a general lighting system and are separately controlled by a multiscene or theatrical cross-fade control station accessible only to authorized operators.
4. In civic facilities, transportation facilities, convention centers, and hotel function areas: Lighting for temporary exhibits, if the lighting is an addition to a general lighting system and is separately controlled from a panel accessible only to authorized operators.
5. Lighting installed by the manufacturer in refrigerated cases, walk-in freezers, vending machines, food preparation equipment, and scientific and industrial equipment.
6. In medical and clinical buildings: Examination and surgical lights, low-ambient night-lights, and lighting integral to medical equipment, provided that these lighting systems are in addition to and separately switched from a general lighting system.
7. Lighting for plant growth or maintenance, if it is controlled by a multi-level astronomical time-switch control that complies with the applicable provisions of §119.
8. Lighting equipment that is for sale.
9. Lighting demonstration equipment in lighting education facilities.
10. Lighting that is required for exit signs subject to the CBC. Exit signs shall meet the requirements of the Appliance Efficiency Regulations.
11. Exitway or egress illumination that is normally off and that is subject to the CBC.
12. In hotel/motel buildings: Lighting in guestrooms. Lighting in hotel/motel guestrooms shall comply with §130(b).
13. In high-rise residential buildings: Lighting in dwelling units. Lighting in high-rise residential dwelling units shall comply with §130(b).
14. Temporary lighting systems.
15. Lighting in Occupancy Group U buildings less than 1,000 square feet.
16. Lighting in unconditioned agricultural buildings less than 2,500 square feet.

17. Lighting in parking garages for seven or less vehicles: Lighting in parking garages for seven or less vehicles shall comply with the applicable provisions of §150(k).
18. Lighting for signs: Signs shall comply with §148.
19. Lighting in a videoconferencing studio: Up to 2.5 watts per square foot of lighting in a videoconferencing studio, provided the videoconferencing lighting is in addition to and separately switched from a general lighting system, all of the lighting is controlled by a multiscene programmable control system, and the video conferencing studio has permanently installed videoconferencing cameras, audio equipment, and playback equipment.
20. Lighting for automatic teller machines that are located inside parking garages.

Area Controls

Verification:

The mandatory measures requiring independent switching or control devices for each area enclosed by ceiling-height partitions are specified under the Mandatory Lighting Controls on Page 3 of the LTG-1C. Independent switching for an enclosed area will not be identified on the forms, but shall be specified on the Electrical Plans. On the LTG-1C, when a control device is used, the Documentation Author will identify the type of area control (i.e. an occupant sensor), the number of units, and the location in the building of the device used to control the lights. The Plans Examiner will verify that each area enclosed by ceiling-height partitions is controlled by manual switching on the Electrical Plans, or that the area control devices identified on the form are specified in the lighting schedule on the Electrical/Lighting plans.

Overview:

Each area enclosed by ceiling-height partitions (a partition that rises from the floor to the ceiling) shall be controlled by independent switching or a control device. This switching or control device shall be:

- Readily accessible; and
- Located so that a person using the device can see the lights or area controlled by that switch, or so that the area being lit is annunciated; and
- Manually operated, or automatically controlled by an occupant sensor that meets the applicable requirements of §119.

Other devices may be installed in conjunction with the switching or control device provided that they:

- Permit the switching or control device to manually turn the lights off in each area enclosed by ceiling-height partitions; and
- Reset the mode of any automatic system to normal operation without further action.

Occupant Sensors

Occupant sensors shall be capable of automatically turning off all the lights in an area no more than 30 minutes after the area has been vacated, and shall have 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 switch that turns the signal off.

In addition, ultrasonic and microwave devices shall have a built-in mechanism that allows calibration of the sensitivity of the device to room movement in order to reduce the false sensing of occupants, and shall comply with either Item 1 or 2 below, as applicable:

1. If the device emits ultrasonic radiation as a signal for sensing occupants within an area, the device shall:
 - Have had a Radiation Safety Abbreviated Report submitted to the Center for Devices and Radiological Health, Federal Food and Drug Administration, under 21 Code of Federal Regulations, Section 1002.12 (1996), and a copy of the report shall have been submitted to the California Energy Commission; and
 - Emit no audible sound; and
 - Not emit ultrasound in excess of the decibel (dB) values shown in Standards Table 119-A (see *Standards Table 119-A* on the next page), measured no more than 5 feet from the source on axis.
2. If the device emits microwave radiation as a signal for sensing occupants within the area, the device shall:
 - Comply with all applicable provisions in 47 Code of Federal Regulations, Parts 2 and 15 (1996), and have an approved Federal Communications Commission Identifier that appears on all units of the device and that has been submitted to the California Energy Commission; and
 - 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; and
 - Have permanently affixed to it installation instructions recommending that it be installed at least 12 inches from any area normally used by room occupants.

Standards Table 119-A

| MIDFREQUENCY 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 |

Exception:

Up to 0.3 watts per square foot of lighting in any area within a building that must be continuously illuminated for reasons of building security or emergency egress can be exempt from the area controls requirements if:

1. The area is designated a security or emergency egress area on the plans and specifications submitted to the enforcement agency; and
2. The security or egress lighting is controlled by switches accessible only to authorized personnel.

Multi-level Lighting Controls

Verification:

The mandatory measures requiring multi-level lighting controls for indoor lighting are specified under the Mandatory Lighting Controls on Page 3 of the LTG-1C. Multi-level switching will not be identified on the forms, but shall be specified on the Electrical Plans. On the LTG-1C, when a multi-level control device is used, the Documentation Author will identify the type of multi-level lighting control (i.e. a dimmer), the number of units, and the location in the building of the device used. For any enclosed space of 100 ft² or larger that has a connected lighting load exceeding 0.8 watts per square foot, the Plans Examiner will verify manual multi-level switching on the Electrical Plans, or that the multi-level lighting control devices identified on the form are specified in the lighting schedule of the Electrical/Lighting plans.

Overview:

The general lighting of any enclosed space 100 ft² or larger that has a connected lighting load that exceeds 0.8 watts per square foot shall have multi-level lighting controls. Multi-level controls shall have at least one control step that is between 30% and 70% of design lighting power and allow the power of all lights to be manually turned off. A reasonably uniform level of illuminance shall be achieved by any of the following:

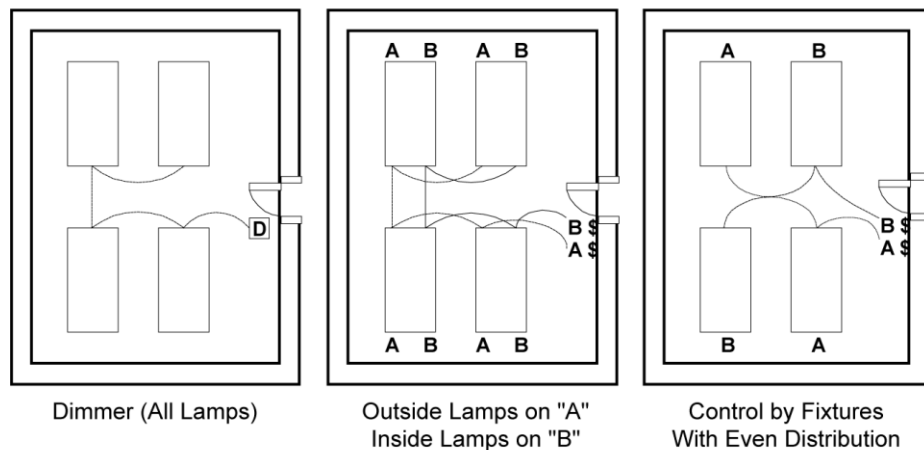
- Continuous or stepped dimming of all lamps or luminaires; or
- Switching alternate lamps in luminaires, alternate luminaires, or alternate rows of luminaires.

Other methods of achieving a reasonably uniform level of illuminance include (see *Multi-Level Switching* on the next page):

1. Using dimming controls (stepped or continuous dimming) to dim all lamps or luminaires will allow a range of 30% to 100% multi-level control of the connected general lighting load.

2. Switching the middle lamps of three lamp luminaires independently of outer lamps will allow the occupant 0%, 33%, 66% and 100% multi-level control of the connected general lighting load.
3. Separately switching "on" alternate rows of luminaires will allow 0%, around 50%, and 100% multi-level control of the connected general lighting load.
4. Separately switching "on" every other luminaire in each row (checkerboard) will allow 0%, around 50%, and 100% multi-level control of the connected general lighting load.
5. Separately switching lamps in each luminaire. Depending on the number of lamps in the luminaire, this method will be similar to numbers 2 or 4 above.

Multi-Level Switching



NOTE: Multi-level lighting controls are not required when the enclosed space is less than 100 ft², or the connected lighting load is 0.8 watts per square foot or less.

Dimmers

Dimmers used to control lighting shall:

- Be capable of reducing power consumption by a minimum of 65% when the dimmer is at its lowest light level; and
- Dimmers controlling incandescent or fluorescent lamps shall provide electrical outputs to lamps for reduced flicker operation through the dimming range so that the light output has an

- amplitude modulation of less than 30% for frequencies less than 200 Hz, and without causing premature lamp failure; and
- Be listed by a rating lab recognized by the International Code Council (ICC) as being in compliance with Underwriters Laboratories Standards; and
 - If the device is a wall box dimmer designed to be used in a three or more-way circuit with non-dimmable switches, the level set by the dimmer shall not be overridden by any of the switches in the circuit. The dimmer and all of the switches in the circuit shall have the capability of turning the lighting OFF if it is ON, and turning the lighting ON to the level set by the dimmer if the lighting is OFF. Any wall box dimmer that is connected to a system with an emergency override function shall be controlled by the emergency override.
 - If the device is a stepped dimmer, it shall include an off position to turn the lights completely off.

Multi-Level Occupant Sensors

Multi-level occupant sensors shall have an automatic OFF function that turns off all the lights, and either an automatic or a manually controlled ON function capable of meeting all the multi-level and uniformity requirements of §131(b) for the controlled lighting. The first stage shall be capable of activating between 30 to 70 percent of the lighting power in a room either through an automatic or manual action, and may be a switching or dimming system. After that event occurs the device shall be capable of all of the following actions when manually called to do so by the occupant:

- Activating the alternate set of lights.
- Activating 100 percent of the lighting power.
- Deactivating all lights.

Exceptions:

The following lighting applications are exempt from the multi-level lighting control requirements for indoor lighting:

1. Lights in corridors.
2. A space that has only luminaire with no more than two lamps.

Daylight Area Controls

Verification:

Daylight areas greater than 250 ft² shall have area controls for primary sidelit daylight areas and skylit daylight areas that meet the requirements of §131(c). Under Mandatory Lighting Controls on Page 3 of the LTG-1C, the Documentation Author will identify the type of area control (i.e. manual switching, occupancy sensor), the number of units, and location in the building of the device used. When the combined area of primary sidelit daylight area and skylit daylight area exceeds 250 ft², the Plans

Examiner will verify that the manual switching for the daylight areas on the Electrical Plans meets the area control requirements listed below, and/or that the area control devices identified on the form are specified in the lighting schedule of the Electrical/Lighting plans.

Overview:

When the combined area of both primary sidelit daylight area and skylit daylight area exceed 250 ft², luminaires providing general lighting that are in or partially in the skylit daylight area and/or the primary sidelit daylight area shall have at least one lighting control that:

- Controls at least 50 percent of the general lighting power in the primary sidelit and skylit daylight areas separately from other lighting in the enclosed space; and
- Controls luminaires in primary sidelit areas separately from skylit areas.

Primary Sidelit Daylight Area

Primary sidelit daylight area is defined as the combined primary sidelit area without double counting overlapping areas. The floor area for each primary sidelit area is directly adjacent to vertical glazing below the ceiling with an area equal to the product of the sidelit width and the primary sidelit depth.

The primary sidelit width is the width of the window plus, on each side, the smallest of:

- 2 feet; or
- The distance to any 5 feet or higher permanent vertical obstruction.

The primary sidelit depth is the horizontal distance perpendicular to the glazing which is the smaller of:

- One window head height; or
- The distance to any 5 feet or higher permanent vertical obstruction.

Skylit Daylight Area

Skylit daylight area is defined as the combined daylight area under each skylight without double counting overlapping areas. The daylight area under each skylight is bounded by the rough opening of the skylight, plus horizontally in each direction the smallest of:

- 70% of the floor-to-ceiling height; or
- The distance to any primary sidelit area, or the daylight area under rooftop monitors; or

- The distance to any permanent partition or permanent rack which is farther away than 70% of the distance between the top of the permanent partition or permanent rack and the ceiling.

Automatic Daylighting Controls

Verification:

Daylight areas greater than 2,500 ft² shall have automatic daylighting controls that meet the requirements of §131(c). Under Mandatory Lighting Controls on Page 3 of the LTG-1C, the Documentation Author will identify the type of automatic daylighting control (i.e. photocontrol, astronomical time switch, etc.), the number of units, and the location in the building of the device used. When the total primary sidelit daylight area exceeds 2,500 ft² or the total skylit daylight area exceeds 2,500 ft², the Plans Examiner will verify that the automatic daylighting controls for the daylight areas specified on the Electrical Plans meets the requirements listed below, and/or that the area control devices identified on the form are specified in the lighting schedule of the Electrical/Lighting plans.

Overview:

Primary Sidelit Daylight Area

The primary sidelit daylight area(s) shall be shown on the plans, and the general lighting in the primary sidelit daylighting areas exceeding 2,500 ft² in any enclosed space shall be controlled independently by an automatic daylighting control device with multi-level lighting control, including continuous dimming, and have at least one control step that is between 50% to 70% of rated power of the controlled lighting.

Exceptions:

The following lighting applications are exempt from the automatic daylighting controls requirements for primary sidelit daylight areas:

1. Primary sidelit daylight areas where the effective aperture is less than 0.1. The effective aperture for primary sidelit daylight areas is calculated according to Standards Equation 146-A (see *Standards Equation 146-A* below).
2. Primary sidelit daylight areas where existing adjacent structures are twice as tall as their distance away from the windows.
3. Parking garages.

Standards Equation 146-A

EQUATION 146-A – EFFECTIVE APERTURE OF THE PRIMARY SIDELIT AREA

$$\text{Primary Sidelit Effective Aperture} = \frac{\sum \text{Window Area} \times \text{VT}}{\text{Primary Sidelit Daylight Area}}$$

Where:

Window Area = rough opening of windows adjacent to the sidelit area, ft²

Window VT = visible light transmittance of window, no units

Primary Sidelit Daylight Area = see Section 131(c)1 daylight area, primary sidelit

Skylit Daylight Area

The skylit daylight area(s) shall also be shown on the plans, and the general lighting in the skylit daylight areas exceeding 2,500 ft² in any enclosed space shall be controlled independently by an automatic daylighting control device with multi-level lighting control, including continuous dimming, and have at least one control step that is between 50% to 70% of rated power of the controlled lighting.

Exceptions:

The following lighting applications are exempt from the automatic daylighting controls requirements for skylit daylight areas:

1. Skylit daylight areas where existing adjacent structures obstruct direct beam sunlight for at least 6 hours per day during the equinox as calculated using computer or graphical methods.
2. When the skylight effective aperture is greater than 4.0%, and all general lighting in the skylit area is controlled by a multi-level astronomical time switch that meets the requirements of §119(h) and that has an override switch that meets the requirements of §131(d)2 (see *Shut-Off Controls* on the next page).
3. Skylit daylight areas where the effective aperture is less than 0.006. The effective aperture for skylit daylight areas is defined in §146(a)2E (see section 5.2.1.5 of the 2008 Nonresidential Compliance Manual).

Automatic Daylighting Control Devices

Automatic daylighting control devices used to control lights in daylit zones shall:

- Be capable of reducing the power consumption of the general lighting in the controlled area by at least two thirds in response to the availability of daylight; and

- Dimmers controlling incandescent or fluorescent lamps shall provide electrical outputs to lamps for reduced flicker operation through the dimming range so that the light output has an amplitude modulation of less than 30% for frequencies less than 200 Hz, and without causing premature lamp failure; and
- If the devices reduce lighting in control steps, it shall incorporate time-delay circuits to prevent cycling of light level changes of less than 3 minutes and have a manual or automatic means of adjusting the deadband to provide separation of on and off points for each control step; and
- If the device is placed in calibration mode, it shall automatically restore its time delay settings to normal operation programmed time delays after no more than 60 minutes; and
- Have a setpoint control that easily distinguishes settings to within 10% of full scale adjustment; and
- Have a light sensor that has a linear response with 5% accuracy over the range of illuminance measured by the light sensor; and
- Have a light sensor that is physically separated from where calibration adjustments are made, or is capable of being calibrated in a manner that the person initiating calibration is remote from the sensor during calibration to avoid influencing calibration accuracy.

Multi-Level Astronomical Time Switch Controls

Multi-level astronomical time switch controls used to control lighting in daylit zones shall:

- Contain at least 2 separately programmable steps per zone that reduces illuminance in a relatively uniform manner as specified in §131(b); and
- Have a separate offset control for each step of 1 to 240 minutes; and
- Have sunrise and sunset prediction accuracy within +/- 15 minutes and timekeeping accuracy within 5 minutes per year; and
- Store astronomical time parameters (used to develop longitude, latitude, time zone) for at least 7 days if power is interrupted; and
- Display date/time, sunrise and sunset, and switching times for each step; and
- Have an automatic daylight savings time adjustment; and
- Have automatic time switch capabilities specified in §119(c).

Interior Photosensors

Interior photosensor shall not have a mechanical slide cover or other device that permits easy unauthorized disabling of the control, and shall not be incorporated into a wall-mounted occupant sensor.

Shut-off Controls

Verification:

Every floor shall have shut-off controls that meet the requirements of §131(d). Under Mandatory Lighting Controls on Page 3 of the LTG-1C, the Documentation Author will identify the type of shut-off control (i.e. occupant sensor, automatic time switch, etc.) the number of units, and the location in the building of the shut-off control used. The Plans Examiner will verify for every floor that all shut-off control devices identified on the form are specified in the Electrical Plans or in the lighting schedule of the Electrical/Lighting plans.

Overview:

In addition to the manual controls installed to comply with §131(a) and §131(b), for every floor, all indoor lighting systems shall be equipped with separate automatic controls to shut off the lighting. These automatic controls shall meet the requirements of §119 and may be an occupant sensor, automatic time switch, or other device capable of automatically shutting off the lighting.

Automatic Control Device

When an automatic control device is installed, it shall incorporate an override switching device that:

- Is readily accessible; and
- Is located so that a person using the device can see the lights or the area controlled by that switch, or so that the area being lit is annunciated; and
- Is manually operated; and
- Allows the lighting to remain on for no more than 2 hours when an override is initiated; and
Exception: In malls, auditoriums, single tenant retail spaces, industrial facilities, and arenas, where captive-key override is utilized, override time may exceed 2 hours.
- Controls an area enclosed by ceiling height partitions not exceeding 5,000 ft².
Exception: In malls, auditoriums, single tenant retail spaces, industrial facilities, convention centers and arenas, the area controlled may not exceed 20,000 ft².

Holiday Shut-Off

Automatic control devices 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. The following occupancies are exempt from the holiday “shut-off” requirements:

- Retail stores and associated malls

- Restaurants
- Grocery stores
- Churches
- Theaters

Office and Multi-Purpose Rooms

Offices 250 ft² or smaller, multipurpose rooms less than 1,000 ft², and classrooms and conference rooms of any size shall be equipped with occupant sensor(s) to shut off the lighting. In addition, controls shall be provided that allow the lights to be manually shut off in accordance with §131(a) regardless of the sensor status.

Exceptions:

The following lighting applications are exempt from the shut-off controls requirements for indoor lighting:

- Where the lighting system is serving an area that must be continuously lit 24 hours per day/365 days per year.
- Lighting in corridors, guestrooms, dwelling units of high-rise residential buildings and hotel/motels, and parking garages.
- Up to 0.3 watts per square foot of lighting in any area within a building that must be continuously illuminated for reasons of building security or emergency egress, provided that the area is designated a security or emergency egress area on the plans and specifications submitted to the enforcement agency.

Demand Responsive Lighting Controls

Verification:

Retail buildings with more than 50,000 ft² of sales floor area shall have demand responsive lighting controls that meet the requirements of §131(g). Under Mandatory Lighting Controls on Page 3 of the LTG-1C, the Documentation Author will identify the type of demand responsive lighting control (i.e. multi-level switching, dimmer, etc.) the number of units, and the location in the building of the shut-off control used. For retail buildings with a sales floor area greater than 50,000 ft², the Plans Examiner will verify that the demand responsive lighting controls identified on the form are specified in the Electrical Plans or in the lighting schedule of the Electrical/Lighting plans.

Overview:

Demand responsive automatic lighting controls that uniformly reduce lighting power consumption by a minimum of 15% shall be installed in retail buildings with sales floor areas greater than 50,000 ft². Demand responsive controls are connected to the local utility's demand response system. This system sends a signal that indicates the cost of power or a request to shed lighting according to utility developed protocols. The building operator programs the lighting controls to automatically reduce lighting power consumption in response to these signals. It is the responsibility of the designer to specify controls that are compatible with the local utility's demand response protocol.

Exception:

Buildings where more than 50% of the lighting power is controlled by daylighting controls are exempt from the demand responsive lighting control requirements.

OUTDOOR LIGHTING

Is the Mandatory Measures note block on the plans?

A mandatory measures note block that identifies the Outdoor Lighting mandatory measures shall be included on the plans. This helps the Builder, Plans Examiner, and Inspector identify the minimum mandatory measures that must be met.

The Documentation Author may use whatever format is most appropriate for specifying the mandatory measures in the plan set. In general, this will take the form of a note block located in the Electrical/Lighting plans or next to the Outdoor Lighting compliance forms, possibly with cross-references to other locations in the plans where measures are specified.

The Plans Examiner shall verify that the mandatory measures note block specifying the Outdoor Lighting mandatory measures is located on the plans along with the Outdoor Lighting compliance forms or appropriate sections of the Electrical/Lighting plans.

Were all applicable forms submitted?

OLTG-1C: All submittals

OLTG-2C: All submittals – Outdoor Lighting Power Allowance

To simplify enforcement the Energy Commission recommends that all applicable Energy Forms (OLTG-1C and OLTG-2C) be printed on the plans (electronically incorporated on the plans). Having all of the energy forms on the plans simplifies the Plan Review process, and helps the Inspector understand the energy components that must be verified in the field. The Plans Examiner shall verify that all applicable forms have been submitted along with the Electrical/Lighting plans.

Are all appropriate Acceptance Tests checked AND controls requiring testing identified on the Certificate of Compliance (OLTG-1C)?

Acceptance Tests are mandatory measures that require the installing contractor to field verify and/or test specific outdoor lighting controls to ensure that the newly installed lighting controls function properly after installation. Chapter 10 of the 2008 Nonresidential Compliance Manual provides detailed information on the Outdoor Lighting Acceptance Test requirements, which controls require field verification and/or testing, and the procedures on how to conduct the Acceptance Tests.

The Plans Examiner shall verify that all applicable Acceptance Tests and controls that require field verification and/or testing are identified on the OLTG-1C. The Plans Examiner shall request that the Documentation Author or Designer resubmit the OLTG-1C identifying all applicable Acceptance Tests if all applicable Acceptance Tests are not specified on the OLTG-1C.

It is important that the Plans Examiner verify all applicable Acceptance Tests on the OLTG-1C because the Inspector will reference the Acceptance Tests identified on the OLTG-1C to verify which Acceptance Forms to collect before conducting a Final Inspection and issuing the Occupancy Permit for the building.

The Plans Examiner shall verify the following Acceptance Tests on the OLTG-1C:

| | | |
|-----------------|--------------------------|---|
| OLTG-2A: | <i>Lighting Controls</i> | Applies to new outdoor motion sensors and outdoor shut-off controls (astronomical time switch and photocontrol) |
|-----------------|--------------------------|---|

Does the Energy Compliance Documentation match the plans?

Section 10-103 of the Administrative Regulations (Title 24, Part 1) mandates that the building characteristics modeled to demonstrate compliance with the Energy Standards shall be specified on the plans. The Plans Examiner shall verify that the efficiencies and lighting system components from the Outdoor Lighting forms are specified in the appropriate sections of the Electrical/Lighting plans.

Outdoor Lighting Zone

Verification:

The outdoor lighting zone for outdoor lighting is specified on Page 3 of the OLTG-1C. On the OLTG-1C, the Documentation Author will identify the Outdoor Lighting Zone, and if the lighting zone was determined by default according to Standards Table 10-114-A (see *Standards Table 10-114-A* on the next page) or if the lighting zone was amended by the local jurisdiction having authority (JHA). The Plans Examiner shall verify that the Outdoor Lighting Zone(s) identified on the form are correct (majority of the time, according to Standards Table 10-114-A) and match the Outdoor Lighting Zone(s) specified on the Electrical/Lighting Plans.

Overview:

The lighting power allowance (watts per square foot) for outdoor hardscape lighting, specific application lighting, and ordinance lighting vary depending on the Outdoor Lighting Zone of the building. Outdoor Lighting Zones are defined in Standards Table 10-114-A (on the next page):

| Zone | Ambient Illumination | State wide Default Location | Moving Up to Higher Zones | Moving Down to Lower Zones |
|-------------|-----------------------------|---|---|--|
| LZ1 | Dark | 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. | A government designated park, recreation area, wildlife preserve, or portions thereof, can be designated as LZ2 or LZ3 if they are contained within such a zone. | Not applicable. |
| LZ2 | Low | Rural areas, as defined by the 2000 U.S. Census. | 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 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 | Medium | Urban areas, as defined by the 2000 U.S. Census. | 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. |

The Documentation Author will most likely determine the Outdoor Lighting Zone for their project by using the Default Location definition in Standards Table 10-114-A. Majority of buildings are located in Rural areas (Lighting Zone 2) and Urban areas (Lighting Zone 3), as defined by the 2000 U.S. Census. The Plans Examiner can use the U.S. Census website to verify the Rural and Urban areas of their jurisdiction at:

http://factfinder.census.gov/servlet/AdvancedGeoSearchMapFramesetServlet?_l

How To Use The U.S. Census Website

The U.S. Census website provides a handy way to determine if a property is in a rural (statewide default Lighting Zone 2) or urban (statewide default Lighting Zone 3) census tract.

There is more information on the 2000 U.S. Census map than is needed to determine the default Lighting Zone. Removing some of that information by changing the Legend may make it easier to determine if the property is in either a rural or urban census tract. The following changes to the Legend may be helpful:

1. Click on the "Legend" link on the left side of the webpage and:

- Under the Boundaries tab, remove the checks from all of the check boxes, except for 2000 Urban Areas.
- Under the Features tab, check the check boxes for National Park and Other Park. If you use these features, recognize that the map may not correctly show all government designated parks, and may not show recreation areas and wildlife preserves.
- Click on Update to see the map with the new Legend settings and save the new Legend settings.

Automatic Shut-off controls

Verification:

All permanently installed outdoor lighting shall have shut-off controls meeting the requirements of §132(c). Under Mandatory Controls on Page 2 of the OLTG-1C, the Documentation Author will identify a photocontrol or astronomical time switch as the shut-off control(s) for the outdoor lighting. The Plans Examiner will verify that the shut-off controls identified on the form match the shut-off controls specified on the Electrical Plans or in the lighting schedule of the Electrical/Lighting plans.

Overview:

All permanently installed outdoor lighting shall be controlled by a photocontrol or astronomical time switch that automatically turns off the outdoor lighting when daylight is available. Automatic time switch control devices used to control outdoor lighting shall:

- (a) Be capable of programming different schedules for weekdays and weekends; and
- (b) Have program backup capabilities that prevent the loss of the device's schedules for at least 7 days, and the device's time and date setting for at least 72 hours if power is interrupted.

Outdoor astronomical time switch controls used to control outdoor lighting shall:

- Contain at least 2 separately programmable steps per function area; and
- Have the ability to independently offset the on and off times for each channel by 0 to 99 minutes before or after sunrise or sunset; and
- Have sunrise and sunset prediction accuracy within +/- 15 minutes and time keeping accuracy within 5 minutes per year; and
- Store astronomical time parameters (used to develop longitude, latitude, time zone) for at least 7 days if power is interrupted; and
- Display time/date, sunrise, and sunset; and
- Have an automatic daylight savings time adjustment; and
- Have automatic time switch capabilities specified in §119(c).

Exception:

Lighting in tunnels and large covered areas that require illumination during daylight hours is exempt from the shut-off control requirements for outdoor lighting.

Automatic Multi-Level lighting controls

Verification:

The outdoor lighting applications listed in the Overview on the next page shall have automatic multi-level lighting controls that meet the requirements of §132(c). Under Mandatory Controls on Page 2 of the OLTG-1C, the Documentation Author will identify an automatic time switch control that reduces lighting power. The Plans Examiner will verify that the automatic time switch controls for reducing lighting power identified on the form are specified on the Electrical Plans or in the Lighting Schedule of the Electrical/Lighting plans.

Overview:

Lighting for building facades, parking lots, sales and non-sales canopies, outdoor sales areas and student pick-up/drop-off zones, where two or more luminaires are used, automatic time switch controls are required to provide the owner with the ability to turn off the lighting when it is not needed, and to reduce the lighting power by at least 50% but not exceeding 80%. This switching scenario is sometimes referred to as multi-level switching. Continuous dimming control strategies also satisfy this requirement as long as their dimming range encompasses the 50% to 80% power reduction range.

There are a number of options available to meet the automatic multi-level switching requirements:

- Dimmable lighting systems can be used to meet the outdoor multi-level switching requirements. For HID fixtures, the high-low strategy (i.e. having options of 100% or 60% of full rated lighting power) or continuous dimming capable of reducing the connected lighting power by 50% to 80% may be used. For HID and LED fixtures, stepped dimming is acceptable provided that steps are available that are within the 50% to 80% range. LED continuous dimming strategies are acceptable as long as their dimming capacity encompasses the 50% to 80% range.
- When there are two or more fixtures on a single pole, the fixtures can be switched separately.
- Every other fixture or pole can be switched separately (also known as checkerboard switching).
- Every other row of fixtures or poles can be switched separately.
- The front half of a parking lot can be switched separately from the back half or sides of the parking lot.
- Lighting systems equipped with motion sensors and photoelectric switches. This option works well with fluorescent and LED sources. HID sources may employ the high-low strategy with motion sensors.

Exceptions:

The following lighting applications are exempt from the automatic multi-level lighting control requirements for outdoor lighting:

1. Lighting required by a health or life safety statute, ordinance, or regulation, including but not limited to, emergency lighting.
2. Lighting for steps or stairs that require illumination during daylight hours.
3. Lighting that is controlled by both a motion sensor and photocontrol.
4. Lighting for facilities that have equal lighting requirements at all hours and are designed to operate continuously. This may include a business that has substantial and continuous onsite traffic 24 hours a day. A grocery store that is open 24 hours a day typically does not need 100% of the parking lot lighting on all night long. The parking lot for a business that closes at night would not have equal lighting requirements at all hours.
5. Temporary outdoor lighting as defined by §101.
6. Signs.

LPDs (watts per square foot)

Verification:

The proposed installed watts for outdoor lighting shall be specified under the Luminaire Schedule on Page 2 of the OLTG-1C. On the OLTG-1C, the Documentation Author will identify a description of the

luminaire, the watts per luminaire, and the number of luminaires for each different lighting fixture. The Plans Examiner shall verify that:

- The Total Installed Watts specified on Page 2 of the OLTG-1C is calculated correctly and equals the sum of all fixtures identified in the Luminaire Schedule (the Total Installed Watts from the Luminaire Schedule shall also be entered on Page 4 of the OLTG-1C, and the values from both pages should match).
- The Total Installed Watts does not exceed the Allowed Lighting Power (allowed watts) identified on Page 4 of the OLTG-1C. The Allowed Lighting Power values listed on the OLTG-1C shall match the Allowed Lighting Power values calculated on the OLTG-3C, depending on the lighting application (General Hardscape, Specific Application, Ornamental, etc.).

Once the Total Installed and Allowed Watts have been verified for compliance, the Plans Examiner shall verify that the lighting fixtures and the proposed installed watts identified in the Luminaire Schedule (Page 2 of the OLTG-1C) are specified on the Electrical Plans or in the Lighting Schedule of the Electrical/Lighting plans.

Overview:

Luminaire wattage shall be determined as follows:

1. The wattage of luminaires with line voltage lamp holders, other than GU-24 lamps, that do not contain permanently installed ballasts or transformers shall be determined as follows:
 - For other than recessed luminaires, the maximum relamping rated wattage of the luminaire, as listed on a permanent, pre-printed, factory-installed label, as specified by UL 1598.
 - For recessed luminaires, the larger of the maximum relamping rated wattage of the luminaire, as listed on a permanent, pre-printed, factory-installed label, as specified by UL 1598, or the following:
 - a. 50 watts per socket for luminaires with housings or trims with an aperture diameter less than 5 inches regardless of the mounting height; or
 - b. 50 watts per socket for luminaires with housings or trims with an aperture diameter greater than or equal to 5 inches and a mounting height of 11 feet or less; or
 - c. 60 watts per socket for luminaires with housings or trims with an aperture diameter greater than or equal to 5 inches and a mounting height greater than 11 feet but less than 15 feet; or
 - d. 75 watts per socket for luminaires with housings or trims with an aperture diameter of greater than or equal to 5 inches and a mounting height of 15 feet or more.
 - For luminaires designed to accommodate a variety of trims or modular components that allow the conversion between screw-based and pin-based sockets without changing the luminaire housing or wiring, the highest wattage designated by the

correlated marking on a permanent pre-printed, factory-installed label on the luminaire housing shall be used.

2. The wattage of luminaires with permanently installed or remotely installed ballasts shall be the operating input wattage of the rated lamp/ballast combination published in the manufacturer's catalogs based on independent testing lab reports as specified by UL 1598. The wattage of a compact fluorescent or high intensity discharge luminaire that can accommodate a range of wattages without changing the luminaire housing, ballast, or wiring shall be the larger of the installed wattage, or the average wattage of the lamp/ballast combinations for which the luminaire is rated.
3. The wattage of line-voltage lighting track and plug-in busway which allows the addition or relocation of luminaires without altering the wiring of the system shall be determined by one of the following methods:
 - The wattage of line voltage busway and track rated for more than 20 amperes shall be the total volt-ampere rating of the branch circuit feeding the busway and track.
 - The wattage of line voltage busway and track rated for 20 amperes or less shall be determined by one of the following methods:
 - a. The volt-ampere rating of the branch circuit feeding the track or busway; or
 - b. The higher of the rated wattage of all of the luminaires included in the system, where wattage is determined according to Section 130(d)1, 2, 4, 5, or 6 as applicable, or 45 watts per linear foot; or
 - c. When using an integral current limiter, the higher of the volt-ampere rating of the integral current limiter controlling the track or busway, or 12.5 watts per linear foot of track or busway, provided that the integral current limiter complies with Section 119(l).
4. The wattage of luminaires or lighting systems with permanently installed or remotely installed transformers shall be the rated wattage of the lamp/transformer combination, listed on a permanent, pre-printed, factory-installed label, as specified by UL 2108.
5. The wattage of light emitting diode (LED) Luminaires, or LED Light Engine with Integral Heat Sink shall be the maximum rated input wattage of the system when tested in accordance with Reference Joint Appendix JA8. The maximum rated input wattage shall be listed on a permanent, pre-printed, factory-installed label.
6. The wattage of all other miscellaneous lighting equipment shall be the maximum rated wattage of the lighting equipment, or operating input wattage of the system, listed on a permanent, pre-printed, factory-installed label, or published in the manufacturer's catalogs, based on independent testing lab reports as specified by UL 1574 or UL 1598.

Exceptions:

There are several lighting applications that are exempt from the outdoor luminaire power density (watts per square foot) requirements of §147:

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 playground.

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 specifically for Automated Teller Machines as required by California Financial Code Section 13040, or required by law through a local ordinance.
7. Lighting for public monuments.
8. Signs. Signs shall meet the requirements of §148.
9. Lighting used in or around swimming pools, water features, or other locations subject to Article 680 of the California Electrical Code.
10. Lighting of tunnels, bridges, stairs, and wheelchair elevator lifts for American with Disabilities Act (ADA) compliance, and ramps that are other than parking garage ramps.
11. Landscape lighting.
12. In theme parks: outdoor lighting for themes and special effects.
13. Lighting for outdoor theatrical and other outdoor live performances, provided that these lighting systems are in addition to area lighting systems and are controlled by a multiscene or theatrical cross-fade control station accessible only to authorized operators.
14. Outdoor lighting systems for qualified historic buildings, as defined in the California Historic Building Code (Title 24, Part 8).

Lamp Efficacy

Verification:

The Documentation Author will identify the rated wattage of each luminaire on Page 2 of the OLTG-1C. Every luminaire with lamps rated over 100 watts shall either have a lamp efficacy of at least 60 lumens per watt, or be controlled by a motion sensor. The Plans Examiner shall verify that all luminaires rated over 100 watts identified on the form are specified as having a minimum lamp efficacy of 60 lumens per watt or controlled by a motion sensor on the Electrical Plans or in the Lighting Schedule of the Electrical/Lighting plans.

Overview:

All outdoor luminaires with lamps rated over 100 watts must either have a lamp efficacy of at least 60 lumens per watt or be controlled by a motion sensor. Lamp efficacy, for the purposes of complying with this requirement, is the rated initial lamp lumens divided by the rated lamp power (watts), without including auxiliaries such as the ballast. This requirement will mostly impact fixtures that are designed for mercury vapor lamps and larger wattage incandescent lamps. Most linear fluorescent, metal halide, and high-pressure sodium lamps have a lamp efficacy greater than 60 lumens per watt and will easily comply.

Exceptions:

The following lighting applications are exempt from the lamp efficacy requirements for outdoor lighting:

1. Lighting required by health or life safety statute, ordinance, or regulation, included but not limited to, emergency lighting.
2. Lighting used in or around swimming pools, water features, or other locations subject to Article 680 of the California Electrical Code.
3. Searchlights.
4. Theme lighting for use in theme parks.
5. Lighting for film or live performance.
6. Temporary outdoor lighting.
7. Light emitting diode, light emitting capacitors, neon and cold cathode lighting.
8. Sign lighting.

Cutoff Luminaires

Verification:

The Documentation Author will identify the rated wattage of each luminaire on Page 2 of the OLTG-1C. All outdoor luminaires with lamps rated over 175 watts in hardscape areas, including parking lots, building entrances, sales and non-sales canopies, and outdoor sales areas shall meet the cutoff requirements of §132(b). The Plans Examiner shall verify that all luminaires rated over 175 watts identified on the form that will provide illumination for the lighting applications listed above are specified as cutoff luminaires on the Electrical Plans or in the Lighting Schedule of the Electrical/Lighting plans.

Overview:

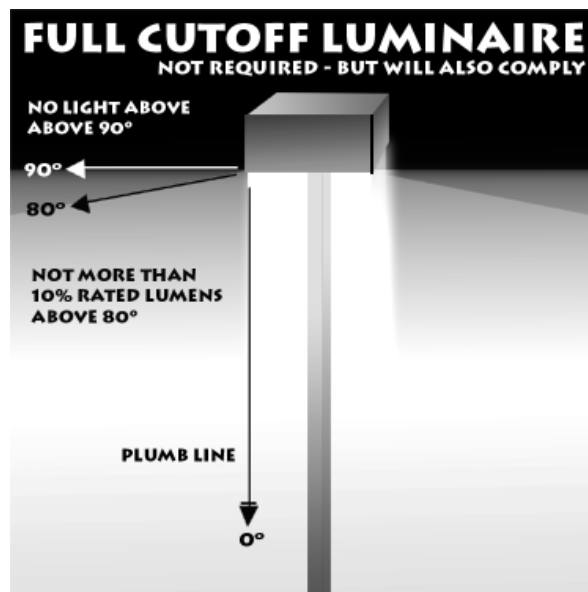
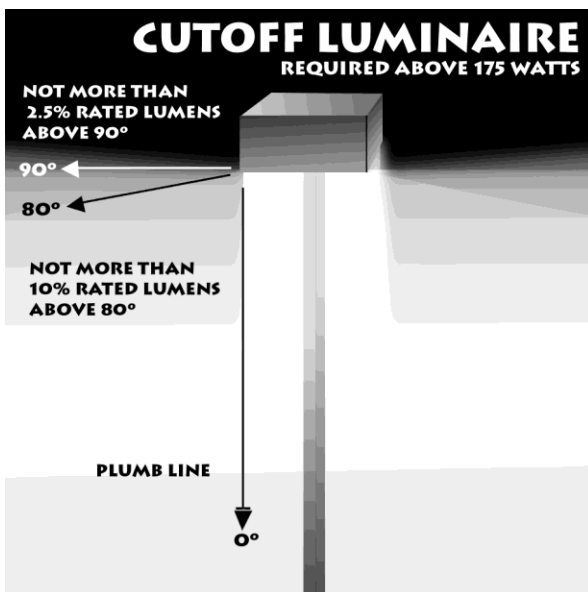
All outdoor luminaires that use lamps rated greater than 175 watts in hardscape areas, including parking lots, building entrances, sales and non-sales canopies, and all outdoor sales areas shall be designated cutoff for light distribution. To comply with this requirement, the luminaire shall be rated cutoff in a photometric test report that includes any tilt or other non-level mounting conditions of the installed luminaire. Cutoff is a luminaire light distribution classification where the candela per 1,000 lamp lumens does not numerically exceed 25 (2.5%) at or above a vertical angle of 90 degrees above nadir, and 100 (10%) at or above a vertical angle of 80 degrees above nadir. Nadir is in the direction of straight down, as would be indicated by a plumb line (see *Nadir and Plumb Line Defined* on page 57). 90 degrees above nadir is horizontal. 80 degrees above nadir is 10 degrees below horizontal.

Exceptions:

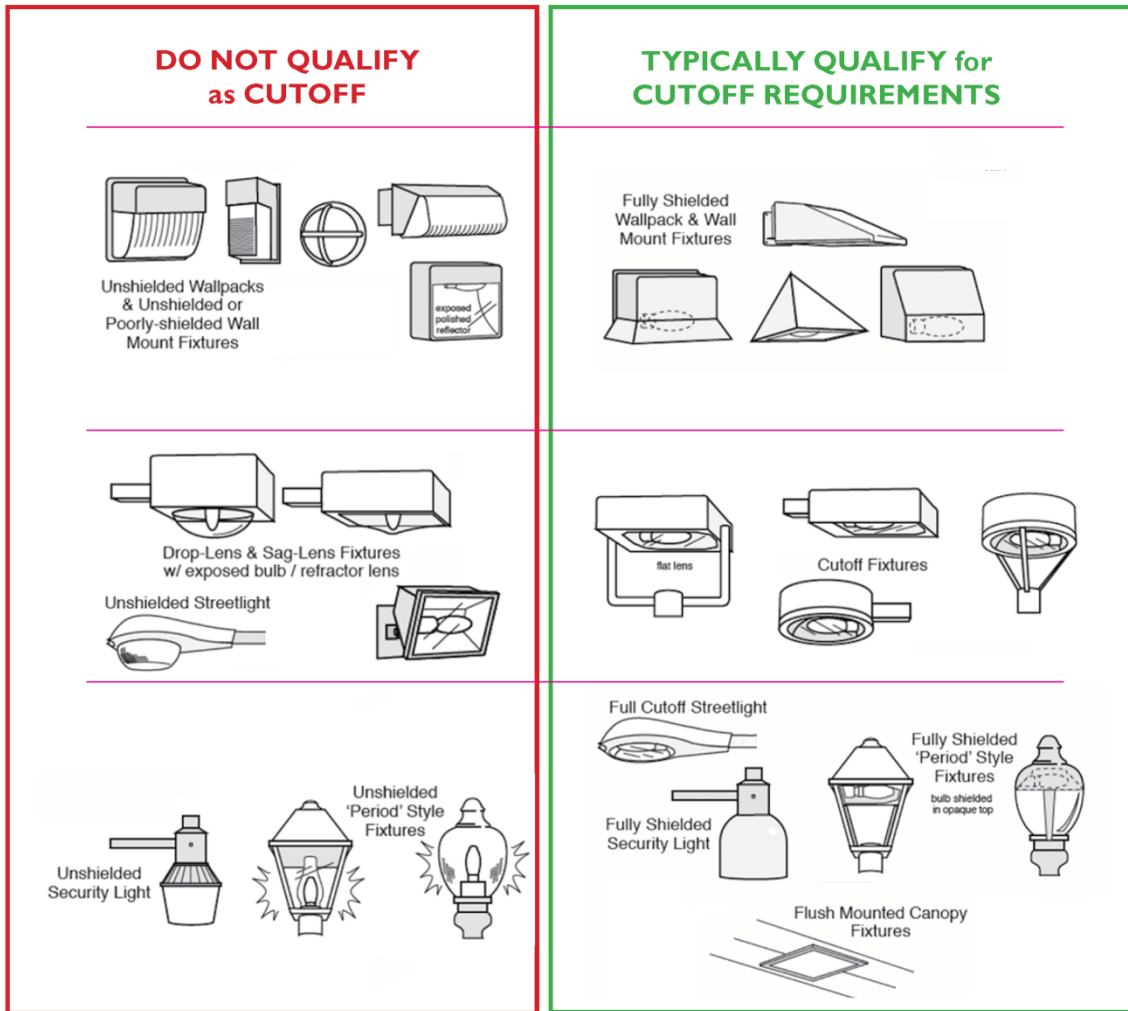
The following lighting applications are exempt from the cutoff requirements for outdoor lighting:

1. Signs.
2. Lighting for building facades, public monuments, statues, and vertical surfaces of bridges.
3. Lighting required by a health or life safety statute, ordinance, or regulation, including but not limited to, emergency lighting.
4. Temporary outdoor lighting.
5. Lighting used in or around swimming pools, water features, or other locations subject to Article 680 of the California Electrical Code.
6. 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 cutoff requirements in Section 132(b); and
 - B. Spacing between existing poles is greater than 6 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.

Nadir and Plumb Line Defined



Qualifying Cutoff Luminaires Graphic



SIGN LIGHTING

Is the Mandatory Measures note block on the plans?

A mandatory measures note block that identifies the Sign Lighting mandatory measures shall be included on the plans. This helps the builder, Plans Examiner, and Inspector identify the minimum mandatory measures that must be met.

The responsible person may include the SLTG-1C Form on the plans to identify the Sign Lighting mandatory measures, or use whatever format is most appropriate for specifying the mandatory measures in the plan set. In general, this will take the form of a note block located on the Electrical/Lighting plans or next to the Sign Lighting compliance forms, possibly with cross-references to other locations in the plans where measures are specified.

The Plans Examiner shall verify that the Mandatory Measures note block specifying the Sign Lighting mandatory measures is located on the plans along with the Sign Lighting compliance forms or appropriate sections of the Electrical/Lighting plans.

Were all applicable forms submitted?

SLTG-1C: All submittals

To simplify enforcement the Energy Commission recommends that the SLTG-1C be printed on the plans (electronically incorporated on the plans). Having all of the energy forms on the plans simplifies the Plan Review process, and helps the Inspector understand the energy components that must be verified in the field. The Plans Examiner shall verify that all applicable forms have been submitted along with the Electrical/Lighting plans.

Does the Energy Compliance Documentation match the plans?

Section 10-103 of the Administrative Regulations (Title 24, Part 1) mandates that the building characteristics modeled to demonstrate compliance with the Energy Standards shall be specified on the plans. The Plans Examiner shall verify that the efficiencies and sign lighting components from the Sign Lighting forms are specified in the appropriate sections of the Electrical/Lighting plans.

Automatic Time Switch Controls

Verification:

All permanently connected signs shall have automatic time switch controls that meet the requirements of §133. Under Mandatory Sign Lighting Controls on Page 2 of the SLTG-1C, the responsible person will identify that automatic time switch controls are required by checking the “Yes”

box next to the applicable requirement. If required, the Plans Examiner shall verify that all applicable automatic time switch control requirements (listed on the next page) identified on the form match the sign controls specified on the Electrical Plans or in the Lighting Schedule of the Electrical/Lighting plans.

Overview:

All signs, both indoor and outdoor, with permanently connected lighting shall be controlled with an automatic time switch control device or system that:

- Is capable of programming different schedules for weekdays and weekends; and
- Has program backup capabilities that prevent the loss of the device's schedules for at least 7 days, and the device's time and date setting for at least 72 hours if power is interrupted.

Photocontrol or Astronomical Time Switch Controls

Verification:

All permanently connected signs shall have either a photocontrol or outdoor astronomical time switch controls that meet the requirements of §133. Under Mandatory Sign Lighting Controls on Page 2 of the SLTG-1C, the responsible person will identify that photocontrol or outdoor astronomical time switch controls are required by checking the "Yes" box next to the applicable requirement. If required, the Plans Examiner shall verify that all photocontrol or outdoor astronomical time switch control requirements (listed below) identified on the form match the outdoor sign controls specified on the Electrical Plans or in the Lighting Schedule of the Electrical/Lighting plans.

Overview:

All outdoor signs shall be controlled with either a photocontrol or outdoor astronomical time switch controls.

Outdoor Astronomical Time Switch Controls

Outdoor astronomical time switch controls used to control outdoor sign lighting shall:

- Contain at least 2 separately programmable steps per function area; and
- Have the ability to independently offset the on and off times for each channel by 0 to 99 minutes before or after sunrise or sunset; and
- Have sunrise and sunset prediction accuracy within +/- 15 minutes and time keeping accuracy within 5 minutes per year; and

- Store astronomical time parameters (used to develop longitude, latitude, time zone) for at least 7 days if power is interrupted; and
- Display time/date, sunrise, and sunset; and
- Have an automatic daylight savings time adjustment; and
- Have automatic time switch capabilities specified in §119(c).

Exception:

Outdoor signs in tunnels and large covered areas that require illumination during daylight hours are exempt from the photocontrol and outdoor astronomical time switch control requirements.

Dimming Controls

Verification:

All permanently connected signs shall have a dimmer that meets the requirements of §133. Under Mandatory Sign Lighting Controls on Page 2 of the SLTG-1C, the responsible person will identify that a dimmer is required by checking the “Yes” box next to the applicable requirement. If required, the Plans Examiner shall verify that all dimming requirements (listed below) identified on the form match the outdoor sign controls specified on the Electrical Plans or in the Lighting Schedule of the Electrical/Lighting plans.

Overview:

All outdoor signs shall be controlled with a dimmer that provides the ability to automatically reduce sign power by a minimum of 65% during nighttime hours.

Exceptions:

There are three exceptions to the dimming control requirements for signs:

1. Signs that are illuminated for less than 1 hour per day during daylight hours
2. Outdoor signs in tunnels and large covered areas that require illumination during daylight hours.
3. Metal halide, high pressure sodium, cold cathode, and neon lamps used to illuminate signs or parts of signs.

Demand Responsive Electronic Message Center Control

Verification:

Electronic Message Centers (EMC) having a connected lighting power load greater than 15 kW shall have demand response controls that meet the requirements of §133. Under Mandatory Sign Lighting Controls on Page 2 of the SLTG-1C, the responsible person will identify the demand response control requirements for an Electronic Message Center by checking the “Yes” box next to the applicable requirement. If required, the Plans Examiner shall verify that all demand response controls requirements for an Electronic Message Center (listed below) identified on the form match the outdoor sign controls specified on the Electrical Plans or in the Lighting Schedule of the Electrical/Lighting plans.

Overview:

An Electronic Message Center (EMC) having a new connected lighting power load greater than 15 kW shall have a control installed that is capable of reducing the lighting power by a minimum of 30% when receiving a demand response signal that is sent out by the local utility.

Exception:

EMCs required by a health or life safety statute, ordinance, or regulation, including but not limited to exit signs and traffic signs are exempt from the Electronic Message Center requirements.

LPDs (watts per square foot) OR meets Alternative Lighting Sources Requirements

Verification:

The design watts or alternative lighting sources for signs are specified on Page 3 and Page 4 respectively of the SLTG-1C. On the SLTG-1C, the responsible person will identify the type of sign and design wattage or alternative lighting source for each sign. The Plans Examiner shall verify that either the design wattages or alternative lighting sources identified on the form match the wattages or lighting sources specified on the Electrical Plans or in the Lighting Schedule of the Electrical/Lighting plans.

Overview:

Allowed Watts

For internally illuminated signs, the maximum allowed lighting power (watts per square foot) 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.

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 to determine the illuminated sign area.

Design Watts

The design watts shall be the total connected lighting load of the sign, including power used by lamps, ballasts, transformers, power supplies, etc. On Page 3 of the SLTG-1C, the design watts (Row G) shall be equal to or less than the allowed watts (Row F) for compliance.

Light Source

The sign does not have to meet the allowed lighting power (watts per square foot) requirements if the sign is equipped with one or more of the following light sources as specified on Page 4 of the SLTG-1C:

1. High pressure sodium lamps; or
2. Pulse start or ceramic metal halide lamps served by a ballast that has a minimum efficiency of 88% or greater:
3. Pulse start metal halide lamps 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%. *NOTE:* For pulse start ceramic metal lamps, the Standards define the ballast efficiency as the measured output wattage to the lamp divided by the measured operating input wattage when tested according to ANSI C82.6-2005.
4. Neon or cold cathode lamps with transformer or power supply efficiency greater than or equal to following:
 - A minimum efficiency of 75% when the transformer or power supply rated output current is less than 50mA; or
 - A minimum efficiency of 68% when the transformer or power supply rated output current is 50mA or greater.

NOTE: For neon and cold cathode lamps, the Standards define the power supply efficiency as the ratio of the output wattage to the input wattage is at 100% tubing load.

5. Fluorescent lamps with a minimum color rendering index (CRI) of 80.
6. Light emitting diodes (LEDs) with a power supply having an efficiency of 80% or greater.
There is one exception to this requirement [Exception to §148(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).

7. Compact fluorescent lamps that do not contain a medium screw base sockets (E24/E26).
8. Electronic ballasts with a fundamental output frequency not less than 20 kHz;

Exceptions:

There are three exceptions to the above maximum allowed lighting power and alternative lighting source requirements for signs:

1. Unfiltered incandescent lamps that are not part of an Electronic Message Center (EMC), an internally illuminated sign, or an externally illuminated sign.
2. Exit signs. Exit signs shall meet the requirements of the Appliance Efficiency Regulations (Title 20).
3. Traffic Signs. Traffic signs shall meet the requirements of the Appliance Efficiency Regulations (Title 20).

REFRIGERATED WAREHOUSES

Is the Mandatory Measures note block on the plans?

The 2008 Energy Efficiency Standards will require that refrigerated warehouse greater than 3,000 ft² comply with §126. Any refrigerated warehouse with a total square footage of 3,000 ft² or less must comply with the Appliance Efficiency Regulations (Title 20) for walk-in refrigerators/freezers.

A mandatory measures note block identifying the Refrigerated Warehouses mandatory measures shall be included on the plans. This helps the Builder, Plans Examiner, and Inspector identify the minimum mandatory measures that need to be met

The Documentation Author may include the RWH-1C Form on the plans to identify the Refrigerated Warehouse mandatory measures, or use whatever format is most appropriate for specifying the mandatory measures in the plan set. In general, this will take the form of a note block located in the mechanical plans, possibly with cross-references to other locations in the plans where measures are specified.

The Plans Examiner shall verify that the mandatory measures note block or RWH-1C specifying the Mechanical and Envelope mandatory measures is located on the plans.

NOTE: ALL of the Mechanical and Envelope requirements for Refrigerated Warehouses greater than 3,000 ft² are mandatory measures. There are no Prescriptive or Performance Methods available to demonstrate compliance. All of the following mandatory measures shall be met.

Were all applicable forms submitted?

RWH-1C: All submittals

To simplify enforcement the Energy Commission recommends that the RWH-1C be printed on the plans (electronically incorporated on the plans). Having all of the energy forms on the plans simplifies the Plan Review process, and helps the Inspector understand the energy components that must be verified in the field. The Plans Examiner shall verify that all applicable forms have been submitted along with the Mechanical and Structure/Architecture plans

Insulation for Walls, Ceilings and Floors

Verification:

On Page 2 of the RWH-1C, the Documentation Author will identify the insulation values for all envelope assemblies (walls, ceilings, and floors). The Plans Examiner shall verify that the insulation values identified on the form match the insulation values specified on the Cross Sections or Architecture Details of the Structure/Architecture plans. The Plans Examiner shall also verify that the insulation values on the RWH-1C are equal to or greater than the minimum insulation requirements in Standards Table 126-A (see *Standards Table 126-A* on the next page).

Overview:

Insulation Requirements

The minimum R-values of insulation applied to the enclosing surfaces of cold storage and frozen storage spaces are shown in Standards Table 126-A below:

Standards Table 126-A Refrigerated Warehouse Insulation

| Space | Surface | Minimum R-Value (°F·hr·ft ² /Btu) |
|----------------|--------------|---|
| Frozen Storage | Roof/Ceiling | R-36 |
| | Wall | R-36 |
| | Floor | R-36 |
| Cold Storage | Roof/Ceiling | R-28 |
| | Wall | R-28 |

The R-values shown in Standards Table 126-A apply to all surfaces enclosing a refrigerated space, including refrigerated spaces adjoining conditioned spaces, other refrigerated spaces, unconditioned buffer spaces and the outdoors. The R-values are the nominal insulation R-values and do not include the R-value of other building materials or internal or external “film” resistances. The R-values shown in Standards Table 126-A are independent of the thermal mass of the enclosing surface.

Underslab Heating

Verification:

The mandatory measures do not allow the use of electric resistance heating for the purpose of underslab heating (with one exception explained below in Overview). The mechanical equipment for underslab heating will not be specified on the RHW-1C, so the Plans Examiner shall verify that the mechanical equipment specified on the Mechanical Plans does not use electric resistance heating, or that electric resistance heating is used that meets the exception below. When electric resistance heating is used for underslab heating, the Plans Examiner shall request that a mandatory measures note block identifying the electric resistance heating meets the exception requirements be included on the Mechanical Plans.

Overview:

Under floor heating systems should be used under frozen storage warehouses to prevent soil freezing and expansion. Under floor heating can be electric resistance, forced air, or heated fluid; however,

under floor heating systems utilizing electric resistance heating elements are not permitted unless they are thermostatically controlled and disabled during the summer on peak period. The summer on peak period is defined by the supplying electric utility, but generally occurs from 12 PM to 6 PM weekdays during the months of May through October. The control system used to control any electric resistance under floor heating elements must turn the elements off during this period. The control system used to control electric resistance under floor heating elements must be shown on the building drawings and the control sequence demonstrating compliance with this requirement must be documented on the drawings and in the control system specifications.

Evaporators

Verification:

Fan-powered evaporators shall meet the fan type and fan speed requirements (see [Overview](#) below) of §126(c). On Page 3 of the RWH-1C, the Documentation Author will identify each evaporator system and the page reference or Mechanical Schedule on the plans where the specifications (including fan type and speed) for each evaporator system may be found. For fan-powered evaporators, the Plans Examiner shall verify that the fan type and fan speed for each system specified on the Mechanical Plans or in the Mechanical Schedule meets the requirements of §126(c) identified on Page 3 of the RWH-1C.

Overview:

Fan powered evaporators used in coolers and freezers have limits on the fan motor type for small fan motors and requirements for fan speed control. Single phase fan motors less than 1 hp and less than 460 volts must be electronically commutated. When required by the Enforcement Agency, documentation may be submitted along with the plans that identify the use of electronically commutated motors in the fan powered evaporators containing single phase fan motors smaller than 1 hp.

In addition to the requirement for electronically commutated motors in small evaporator fans, evaporator fans shall be variable speed and the speed shall be controlled in response to space conditions. Two-speed control is not an acceptable method. Units are generally controlled based on local space temperature, but other conditions, such as relative humidity, uniformity of air flow, and product temperature may also apply. Maintaining product quality should always be the first consideration. In most cases, variable frequency drives are used to control the speed of evaporator fan motors, although controllers designed to vary the speed of electronically commutated motors may be used to control these types of motors.

A common strategy for controlling fan speed in response to space conditions is to use a controller that measures the difference between the space temperature and the space temperature setpoint, and sends a control signal proportional to the temperature difference. A variable frequency drive is used to reduce fan speed as the space temperature setpoint is met. There is no requirement for minimum speed (how much the speed of the fan is reduced when the room is at setpoint temperature), although variable speed control of air unit fans has been successfully used with minimum speeds of 80% or lower on direct expansion coils and 70% or lower on flooded or recirculated coils. The minimum fan speed setting is up to the discretion of the system designer and operator, but the capability to reduce the fan speed in response to space conditions must be provided. The fan speed may be adjusted to maintain adequate air circulation in order to ensure product integrity and safety.

Note: Evaporators served by a single compressor without unloaded unloading capability are exempt from the fan speed and fan response control requirements.

Compressors

Verification:

Compressors shall meet the minimum condensing temperature and compressor speed requirements (see Overview below) of §126(e). On Page 3 of the RWH-1C, the Documentation Author will identify each compressor system and the page reference or Mechanical Schedule on the plans where the specifications (including minimum condensing temperature and compressor speed) for each compressor may be found. The Plans Examiner shall verify that the minimum condensing temperature and compressor speed for each system specified on the Mechanical Plans or in the Mechanical Schedule meets the requirements of §126(e) identified on Page 3 of the RWH-1C.

Overview:

Minimum Condensing Temperature

All compressors shall be designed to operate at a minimum condensing temperature of 70°F (21°C) or less.

Part Load Efficiency

Single screw compressors greater than 50 hp serving a single suction group shall utilize a variable speed drive as the primary means of capacity control, or provide documentation that demonstrates the part load efficiency of the compressor is such that the compressor consumes 60% of rated power at 50% of full load input. Single compressor systems include systems served by backup or swing

compressors. When there is a single dedicated screw compressor greater than 50 hp serving a suction group, and a variable speed drive is installed on the compressor, the presence of the variable speed drive is the only documentation needed. If a variable speed drive is not used for this application then a manufacturer's certification of tested part load and full load results for this model of compressor must be provided. The manufacturer's certification requires the following publicly available data:

- Physical test results of the proposed compressor model at full rated refrigeration load and at 50% of full load.
- This physical test must be conducted with no liquid subcooling and 10°F (5.5°C) superheat for both the full load and 50% load conditions.
- The condensing temperature must be identical for both full load and 50% load tests.
- Raw data from physical tests and calculations that show that the input power to the compressor at 50% of load does not exceed 60% of full load power.
- This data must be submitted to the California Energy Commission and must be kept on file by the manufacturer.

Note: Refrigeration plants with more than one dedicated compressor per suction group are exempt from the part load efficiency requirements.

Condensers

Verification:

Evaporative condensers and air-cooled condensers shall meet the design conditions requirements (see Overview below) of §126(d). On Page 3 of the RWH-1C, the Documentation Author will identify each evaporative and/or air-cooled condenser system, and the page reference or Mechanical Schedule on the plans where the specifications (including the design conditions) for each condenser system. The Plans Examiner shall verify that the design conditions for evaporative and air-cooled condensers for each system specified on the Mechanical Plans or Mechanical Schedule meets the requirements of §126(d) identified on Page 3 of the RWH-1C.

Overview:

All refrigeration systems using ammonia as the refrigerant must be evaporative cooled. This requirement may be met by an evaporative condenser or by the use of a water-cooled condenser connected to a closed loop fluid cooler or cooling tower. Air cooled condensers and groundwater condensers are not permitted in ammonia systems. Air cooled condensers are permitted in systems using refrigerants other than ammonia.

Evaporative Condenser Fan Speed Control

All condenser fans for evaporative condensers shall be continuously variable speed and the condensing temperature control system shall control the speed of all condenser fans serving a common condenser loop in unison. The minimum condensing temperature set point shall be less than or equal to 70°F.

Air-Cooled Condenser Fan Speed Control

All condenser fans for air-cooled condensers shall be continuously variable speed and the condensing temperature or pressure control system shall control the speed of all the condenser fans serving a common loop in unison. The minimum condensing temperature set point shall be less than or equal to 70°F, or reset in response to ambient drybulb temperature or refrigeration system load.

Condenser Fan Motor

All single phase condenser fans motors less than 1 horsepower and less than 460V shall be either permanent split capacitor or electronically commutate motors.

Evaporative Condensers

Condensing temperatures for evaporative condensers under design conditions, including condensers served by cooling towers, shall be less than or equal to:

- Design wetbulb (WB) temperature plus 20°F in locations where the design WB temperature is less than or equal to 76°F; or
- Design WB temperature plus 19°F in locations where the design WB temperature is between 76°F and 78°F; or
- Design WB temperature plus 18°F in locations where the design WB temperature is greater than or equal to 78°F

Air-cooled Condensers

Condensing temperatures for air-cooled condensers under design conditions shall be less than or equal to the design drybulb (DB) temperature plus 10°F for systems serving frozen storage and shall be less than or equal to the design DB temperature plus 15°F for systems serving cold storage.