

CODES AND STANDARDS ENHANCEMENT INITIATIVE (CASE)

Results Report – Proposals Based on ASHRAE 90.1-2013

Measure Number: 2016- NR-ASHRAE2-F

ASHRAE

2016 CALIFORNIA BUILDING ENERGY EFFICIENCY STANDARDS

California Utilities Statewide Codes and Standards Team

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1. PREFACE

The Codes and Standards Enhancement (CASE) initiative presents recommendations to support California Energy Commission's (CEC) efforts to update California's Building Energy Efficiency Standards (Title 24) to include new requirements or to upgrade existing requirements for various technologies. The four California Investor Owned Utilities (IOUs) – Pacific Gas and Electric Company (PG&E), San Diego Gas and Electric (SDG&E), Southern California Edison (SCE) and Southern California Gas Company (SoCalGas) – and Los Angeles Department of Water and Power (LADWP) sponsored this effort. The program goal is to prepare and submit proposals that will result in cost-effective enhancements to energy efficiency in buildings. This report and the code change proposal presented herein is a part of the effort to develop technical and cost-effectiveness information for proposed regulations on building energy efficient design practices and technologies. The final language that was adopted by CEC is different from the proposed language that was presented in the CASE Report, and this report will detail the differences between the utility team proposal and adopted language that is now included in the 2016 Building Energy Efficiency Standards.

2. EXECUTIVE SUMMARY

2.1 Measure Description

The code changes that were adopted as a result of this CASE measure updated the Title 24 Building Energy Efficiency Standards so standards in California were at least as stringent as standards in ASHRAE 90.1-2013. Each sub-measure is described below.

2.1.1 Elevator Ventilation and Cab Lighting Measure

The Elevator Ventilation and Cab Lighting Measure aligned Title 24 with Section 10.4.3 of ASHRAE 90.1-2013. According to ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers), the lighting in the cab (not including signals and displays) shall not have an efficacy less than 35 lumens per watt (LPW). Cab ventilation fans for elevators without air conditioning shall not consume over 0.33 watts (W) per cubic feet per minute (cfm) at maximum speed. After being unoccupied at rest with the elevator doors shut for over 15 minutes, cab interior lighting and ventilation shall be shut off until required for operation. In order to promote the use of more efficiency lighting, the Statewide CASE Team proposed a limit of 0.6 watts per square foot for lighting in elevator cabins to replace the 35 lumen per watt requirement from ASHRAE 90.1-2013. The lighting power density approach allows the lighting designer to consider trade-offs between source efficacy, optical efficacy, surface reflectance, and design illuminance to hit the watts per square foot target.

This proposal resulted in modifications to Sections 120.6 and 140.6 of Title 24. The proposal also added a new section for elevator testing in the Reference Appendices. CEC adopted the 2016 Standards and Reference Appendices on June 10, 2015.

The compliance manuals and compliance forms will be updated to reflect the changes to the standards. This change does require changes to the Alternative Calculation Manual (ACM) Reference Manuals or the compliance software.

2.1.2 Escalator and Moving Walkway Speed Control Measure

The Escalator and Moving Walkway Speed Control Measure requires escalators and moving walkways located in airports, hotels, and transit areas to automatically slow to the minimum permitted speed in accordance with ASME A17.1/CSA B44 when not conveying passengers. ASME A17.1/CSA B44 lists the following requirements for escalators and moving walkways with variable speeds:

- Acceleration and deceleration shall not exceed 1.0 feet per square second (ft/sec²)
- Rated Speed 100 feet per minute (ft/min) is not exceeded
- Minimum speed not less than 10 ft/min
- Passenger detection provided at both landings
- Deceleration does not occur until 3 times the length of time for passengers to transfer between landings
- Means to detect failure of passenger detection
- If failure is detected, run at full rated speed only

This proposal resulted in modifications to Sections 100.1 and 120.6 of Title 24. The proposal also added a section for escalator and moving walkway testing in the Reference Appendices. CEC adopted the 2016 Standards and Reference Appendices on June 10, 2015.

The compliance manuals and compliance forms will be updated to reflect the changes to the standards. This change does require changes to the Alternative Calculation Manual (ACM) Reference Manuals or the compliance software.

2.1.3 Direct Digital Controls Measure

The Direct Digital Control (DDC) Measure updated Title 24 to require DDC systems to the zone level in certain applications in new buildings, alterations and additions. This measure applies to all HVAC (Heating Ventilation and Air Conditioning) systems of a minimum size to ensure that it is cost-effective to incorporate DDC. The measure also specifies the minimum capability of such mandated DDC systems.

A requirement for Optimum Start/Stop controls was included in the proposed language around the DDC measure to enhance the energy savings of DDC systems when installed to the zone level. This requirement leverages DDC to minimize the operating hours of the HVAC system.

This proposal resulted in modifications to Sections 120.2 of Title 24. The proposal did not result in changes to the Reference Appendices. CEC adopted the 2016 Standards and Reference Appendices on June 10, 2015.

The compliance manuals and compliance forms will be updated to reflect the changes to the standards. This change does not require changes to the Alternative Calculation Manual (ACM) Reference Manuals or the compliance software.

2.1.4 Operable Window/Door Switch Measure

The intent of the Operable Window/Door Switch Measure is to prevent unnecessary use of energy for heating or cooling of additional un-tempered air if an operable window is left open outside of times when it is beneficial to leave it open. This measure updated Title 24 to require new buildings that have operable windows to install a simple mechanical interlock that disables mechanical heating/cooling when any window in the room with the thermostat is left open for more than 5 minutes. It is important to note that mechanical ventilation would not be required to be disabled. For example, this requirement could be met by resetting the active heating setpoint to 30°F and the active cooling setpoint to 100°F still providing minimum ventilation to a zone with open windows.

This measure will reduce unnecessary mechanical heating or cooling demand in spaces with operable windows and doors, which will save not only heating and cooling energy, but fan energy as well. A building with both mechanical heating/cooling and operable windows is more likely to have a higher annual heating/cooling energy than a building without operable windows. This is because operable windows are often left open when conditions are not favorable, resulting in high infiltration loads on the mechanical system. There are many reasons why windows end up open in unfavorable conditions, including:

- Occupant wants more fresh air and does not know or care about heating/cooling energy penalty. This is particularly true when the space temperature can be maintained at setpoint despite the extra infiltration load.
- Occupant does not know the zone mode (heating/cooling) or outside temperature so cannot gauge if opening the window will reduce or increase energy use.
- Occupant opened the window under favorable conditions but left the room (with the window open) and conditions changed to unfavorable.
- Occupant A's office has the thermostat for a zone that includes Occupant B's office. Occupant A opens the window on a brisk day causing the zone to go to full heating. Occupant B is then forced to open the window to prevent from overheating.

This proposal resulted in the addition of subsection (n) to Section 140.4 of the 2016 Title 24 Building Energy Efficiency Standards. The proposal also resulted in an additional acceptance test procedure. CEC adopted the 2016 Standards and Reference Appendices on June 10, 2015.

The compliance manuals and compliance forms will be updated to reflect the changes to the standards. This change requires changes to the Alternative Calculation Manual (ACM) Reference Manuals and the compliance software.

2.2 Summary of Revisions that Occurred during CEC Pre-rulemaking and Rulemaking

The Statewide CASE Team solicited feedback from a variety of stakeholders when developing the version of the CASE Report that CEC used as a “document relied upon” is their rulemaking package (see Appendix A: Docketed Version of CASE Report). In addition to personal outreach to key stakeholders, the Statewide CASE Team conducted a public stakeholder meeting to discuss the proposal on May 20, 2014. Feedback that stakeholders provided during

the utility-sponsored stakeholder meeting is summarized in Section 2.4 of the report presented in Appendix A.

The following changes occurred between CEC's pre-rulemaking workshop in November of 2014 and the adoption in June of 2015:

- The elevator measure's lighting requirement was changed from limit of 35 lumens per watt to a lighting power density requirement of no more than 0.6 LPW.
- The escalator and moving walkway measure was limited in scope from all escalators and moving walkways in California to only those that are located in California airports, hotels, and transit areas.
- The DDC measure was modified to include the language "to the zone level" to match up with other Title 24 measures that are triggered when DDC is installed to the zone level.
- The qualifications for DDC Applications and Qualifications Table were modified to replace the air handling fan systems braking horsepower criteria with the heating and cooling design capacity of the plant.
- The Optimum Start/Stop requirements for DDC system was modified to clarify the parameters for the control algorithm and to include mass radiant floor slab systems in the optimum start algorithm.
- The language for door/window switch controls measure was modified to clarify the exemption of alterations to existing buildings. **EXCEPTION 3 to Section 140.4(n)** was deleted because the same exception was added to Section 141.

See Section 3 for additional information about changes that occurred during CEC's pre-rulemaking and rulemaking process.

2.3 Energy Savings

The first year statewide impacts of this code proposal are 16.86 gigawatt-hours per year and 1.54 MMTherms per year of energy, and 2.556 megawatts of electrical demand. The methodology used to estimate energy savings is described in detail in Section 5.

Table 1: First Year Statewide Energy Impacts Estimate

Measure	First Year Statewide Savings			Statewide TDV Energy Savings (Million kBTU)
	Electricity Savings (GWh)	Power Demand Reduction (MW)	Natural Gas Savings (MMtherms)	
Elevator	3.65	0.130	0	39.24
Escalator	0.94	0.004	0	15.65
DDC	10.91	2.391	1.34	272.91
Window/Door	1.36	0	0.20	25.80
TOTAL	16.86	2.525	1.54	353.6

3. EVOLUTION OF REQUIREMENTS

The Statewide CASE Team solicited feedback from a variety of stakeholders when developing the version of the CASE Report that is presented in Appendix A. In addition to personal outreach to key stakeholders, the Statewide CASE Team conducted a public stakeholder meeting to discuss the proposal on May 20, 2014. Section 2.4 of the report presented in Appendix A summarizes issues that were addressed between the time the Statewide CASE Team commenced work on the project and the time the CASE Report was submitted to CEC. The following paragraphs summarize how the code change proposals evolved between the time the most recent version of the CASE Report was submitted to CEC and the time the standards were adopted. See Appendix B: Docketed Comments Log for a list of comments that were submitted to CEC throughout the pre-rulemaking and rulemaking process that are relevant to this measure.

3.1 Elevator Ventilation and Cab Lighting Measure

No changes were made to this measure between the submission of the docketed CASE Report and the June 2015 adoption.

3.2 Escalator and Moving Walkway Speed Control Measure

No changes were made to this measure between the submission of the docketed CASE Report and the June 2015 adoption.

3.3 Direct Digital Controls Measure

The Direct Digital Controls (DDC) Measure underwent three different changes between the submission of the docketed CASE Report and the June 2015 adoption. The following subsections detail these changes.

3.3.1 DDC to the Zone

The proposed code was amended after concerns were raised by multiple stakeholders during the CEC Pre-Rulemaking Workshop held on June 12, 2014. The concern was that the proposed

ASHRAE language did not match the Title 24 measures that were intended to be triggered when DDC was installed, specifically to the zone level. The already established energy saving measures in Title 24 (2008), such as demand control ventilation and automatic demand shed controls, are conditionally triggered based on whether DDC is installed to the zone level. The main concern was that DDC would not be installed to the zone level and would allow builders to avoid implementing some of the energy saving measures in Title 24. The CASE Team recommended including “to the zone” language in the proposed language to explicitly specify how DDC should be installed.

Direct Digital Controls (DDC). Direct Digital Controls to the zone shall be provided as specified by Table 120.2-A.

When the 45-Day Language was published, CEC omitted the “to the zone” language from the measure. The CASE Team disagreed with the omission given the same concerns expressed by stakeholders, that DDCs would not be installed to the zone level; therefore, the team recommended its reinsertion in to the code.

CEC did reinsert the “to the zone” language into the 15-Day Language. After the 15-day review period, CEC accepted and adopted the new language on June 10, 2015.

The day before adoption, docketed on June 9, 2015, Taylor Engineering submitted comments regarding the 15-Day Language. In their comments, they recommended deleting “to the zone” language based on the rationale that the requirement does not apply to all controls. That is, new chilled water plants do not directly involve zone level controls. CEC adopted the “to the zone” language on June 10, 2015. The Statewide CASE Team has recommended that Taylor Engineering’s concerns be addressed in the Compliance Manual.

3.3.2 DDC Qualifications for Air Handling Systems

CEC sent the CASE Team an email on May 12, 2015 questioning the qualification of air handling systems in the DDC Applications and Qualifications Table (Table 120.2-A) introduced by the DDC measure. They questioned the qualifying criteria of fan system brake horsepower in determining the minimum size of the plant to guarantee the cost-effectiveness of the DDC installation. CEC suggested that using the design heating or cooling capacity of the plant would be the most appropriate qualifying criteria.

TABLE 120.2-A DDC Applications and Qualifications

<u>BUILDING STATUS</u>	<u>APPLICATIONS</u>	<u>QUALIFICATIONS</u>
<u>Newly Constructed Buildings</u>	<u>Air handling system and all zones served by the system</u>	<u>Individual systems supplying more than three zones and with design heating or cooling capacity of 300 kBtu/h with fan system bhp of 10 hp (7.45 kW) and larger</u>
<u>Newly Constructed Buildings</u>	<u>Chilled water plant and all coils and terminal units served by the system</u>	<u>Individual plants supplying more than three zones and with design cooling capacity of 300 kBtu/h (87.9 kW) and larger</u>
<u>Newly Constructed Buildings</u>	<u>Hot water plant and all coils and terminal units served by the system</u>	<u>Individual plants supplying more than three zones and with design heating capacity of 300 kBtu/h (87.9 kW) and larger</u>

<u>Additions or Alterations</u>	<u>Zone terminal unit such as VAV box</u>	<u>Where existing zones served by the same air handling, chilled water, or hot water systems that have DDC</u>
<u>Additions or Alterations</u>	<u>Air handling system or fan coil</u>	<u>Where existing air handling system(s) and fan coil(s) served by the same chilled or hot water plant have DDC</u>
<u>Additions or Alterations</u>	<u>New air handling system and all new zones served by the system</u>	<u>Individual systems with design heating or cooling capacity of 300 kBtu/h with fan system bhp of 10 hp (7.45 kW) and larger and supplying more than three zones and more than 75% percent of zones are new</u>
<u>Additions or Alterations</u>	<u>New or upgraded chilled water plant</u>	<u>Where all chillers are new and plant design cooling capacity is 300 kBtu/h (87.9 kW) and larger</u>
<u>Additions or Alterations</u>	<u>New or upgraded hot water plant</u>	<u>Where all boilers are new and plant design heating capacity is 300 kBtu/h (87.9 kW) and larger</u>

The proposed code for the DDC measure was based on ASHRAE 90.1 (2013), which used the capacity of the fan system brake horsepower for qualifying the installation of DDC. These qualifications were established to guarantee that smaller buildings with limited HVAC savings potential would not be required to install DDC, as it would not be cost-effective. In this case for air handling systems, the qualification was based on brake horsepower of the fan system.

In response, the Statewide CASE Team agreed that basing the qualification on the design heating and cooling capacity of the plant is more appropriate criteria and proposed new language to use the plant's design capacity.

CEC accepted the new code language and the adopted language includes this new language.

3.3.3 Optimum Start/Stop for DDCs

The proposed code for the Optimum Start/Stop Controls was based on a general definition of optimum start/stop controls since ASHRAE only defines optimum start controls; ASHRAE does not define optimum stop controls:

- (k) Optimum Start/Stop Controls. HVAC systems with DDC to the zone level shall have optimum start and optimum stop controls. These controls shall have access to space temperature, ambient air temperature and historical thermal lag profiles of each controlled zone.

After the 45-Day Language was published, CEC received comments from Taylor Engineering on March 27, 2015 regarding Optimum Start/Stop Controls (see letter number 7 in Appendix C). Taylor Engineering recommended using the ASHRAE description since it is more explicit on how to implement the control algorithm and most HVAC manufacturers are familiar with its implementation. They also recommended adding language that required the optimum start algorithm to take into account any mass radiant floor slab systems. The revised measure:

- (k) Optimum Start/Stop Controls. Space conditioning systems with DDC to the zone level shall have optimum start/stop controls. The control algorithm shall, as

a minimum, be a function of the difference between space temperature and occupied setpoint, the outdoor air temperature, and the amount of time prior to scheduled occupancy. Mass radiant floor slab systems shall incorporate floor temperature onto the optimum start algorithm.

The CEC accepted these recommendations and included them in the 15-Day Language of Title 24. The CASE Team was not involved in this decision, however we do agree with the new language since it does not alter the measure and the inclusion of mass radiant floor slab is acceptable since this could potentially impact the optimum start algorithm.

CEC accepted the new code language and the adopted language includes this new language.

3.4 Operable Window/Door Switch Measure

Exception 3 to Section 140.4(n) exempted alterations to existing buildings from the window/door switch measure. This exception was deleted, because the same exception was added to Section 141. This change was made by CEC staff to maintain the consistency and structure of the Standard. The CASE Team supported this editorial change as it was not a substantive change to the new requirement.

4. ADOPTED STANDARDS

The adopted 15-Day Language and Reference Appendices are presented in the following sections. Additions released in the 45-Day Language Express Terms double underlined and deletions are struck with double lines. Revisions included in the 15-Day Language are in red font and are also underlined if the language was added or struck with double lines if the language was deleted.

4.1 Building Energy Efficiency Standards Code Language

4.1.1 Elevator Ventilation and Cab Lighting Measure

4.1.1.1 Section 120.6(f) Mandatory Requirements for Elevators

(f) Mandatory Requirements for Elevators

1. The light power density for the luminaires inside the elevator cab shall be no greater than 0.6 watts per square foot.
2. Elevator cab ventilation fans for cabs without space conditioning shall not exceed 0.33 watts per CFM as measured at maximum speed.
3. When the elevator cab is stopped and unoccupied with doors closed for over 15 minutes, the cab interior lighting and ventilation fans shall be switched off until elevator cab operation resumes.
4. Lighting and ventilation shall remain operational in the event that the elevator cabin gets stuck when passengers are in the cabin.
5. Elevator Lighting and Ventilation Control Acceptance. Before an occupancy permit is granted for elevators subject to 120.6(f), the following equipment and systems shall be certified as meeting the Acceptance Requirement for Code Compliance, as specified by the Reference Nonresidential Appendix NA7. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in NA7.14.

EXCEPTION 1 to Section 120.6(f)1: Interior signal lighting and interior display lighting are not included in the calculation of lighting power density.

4.1.1.2 Section 140.6(a)-3 Lighting Wattage Excluded

3. **Lighting wattage excluded.** The watts of the following indoor lighting applications may be excluded from actual indoor Lighting Power Density. (Indoor lighting not listed below shall comply with all applicable nonresidential indoor lighting requirements in Part 6.):

✓U. Lighting in elevators where the lighting meets the requirements of ASHRAE/IESNA Standard 90.1, 2010 in Section 120.6(f).

4.1.2 Escalators and Moving Walkway Speed Control Measure

4.1.2.1 Section 120.6(g) Mandatory Requirements for Escalators and Moving Walkways

(g) Mandatory Requirements for Escalators and Moving Walkways

1. Escalators and moving walkways located in airports, hotels, and transportation function areas shall automatically slow to the minimum permitted speed in accordance with ASME A17.1/CSA B44 when not conveying passengers.
2. Escalators and Moving Walkways Acceptance. Before an occupancy permit is granted for escalators and moving walkways subject to 120.6(g), the following equipment and systems shall be certified as meeting the Acceptance Requirement for Code Compliance, as specified by the Reference Nonresidential Appendix NA7. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements specified in NA7.15.

4.1.3 Direct Digital Controls Measure

4.1.3.1 Section 120.2(j) Direct Digital Controls (DDC)

(j) **Direct Digital Controls (DDC).** Direct Digital Controls to the zone shall be provided as specified by Table 120.2-A.

The provided DDC system shall meet the control logic requirements of Sections 120.1(c) and 120.2(h), and be capable of the following:

1. Monitoring zone and system demand for fan pressure, pump pressure, heating and cooling;
2. Transferring zone and system demand information from zones to air distribution system controllers and from air distribution systems to heating and cooling plant controllers;
3. Automatically detecting the zones and systems that may be excessively driving the reset logic and generate an alarm or other indication to the system operator;
4. Readily allow operator removal of zones(s) from the reset algorithm;
5. For new buildings, trending and graphically displaying input and output points; and
6. Resetting heating and cooling setpoints in all non-critical zones upon receipt of a signal from a centralized contact or software point as described in Section 120.2(h)

TABLE 120.2-A DDC Applications and Qualifications

<u>BUILDING STATUS</u>	<u>APPLICATIONS</u>	<u>QUALIFICATIONS</u>
<u>Newly Constructed Buildings</u>	<u>Air handling system and all zones served by the system</u>	<u>Individual systems supplying more than three zones and with design heating or cooling capacity of 300 kBtu/h with fan systems bhp of 10 hp (7.45 kW) and larger</u>
<u>Newly Constructed Buildings</u>	<u>Chilled water plant and all coils and terminal units served by the system</u>	<u>Individual plants supplying more than three zones and with design cooling capacity of 300 kBtu/h (87.9 kW) and larger</u>
<u>Newly Constructed Buildings</u>	<u>Hot water plant and all coils and terminal units served by the system</u>	<u>Individual plants supplying more than three zones and with design heating capacity of 300 kBtu/h (87.9 kW) and larger</u>
<u>Additions or Alterations</u>	<u>Zone terminal unit such as VAV box</u>	<u>Where existing zones served by the same air handling, chilled water, or hot water systems that have DDC</u>
<u>Additions or Alterations</u>	<u>Air handling system or fan coil</u>	<u>Where existing air handling system(s) and fan coil(s) served by the same chilled or hot water plant have DDC</u>
<u>Additions or Alterations</u>	<u>New air handling system and all new zones served by the system</u>	<u>Individual systems with design heating or cooling capacity of 300 kBtu/h with fan system bhp of 10 hp (7.45 kW) and larger and supplying more than three zones and more than 75% percent of zones are new</u>
<u>Additions or Alterations</u>	<u>New or upgraded chilled water plant</u>	<u>Where all chillers are new and plant design cooling capacity is 300 kBtu/h (87.9 kW) and larger</u>
<u>Additions or Alterations</u>	<u>New or upgraded hot water plant</u>	<u>Where all boilers are new and plant design heating capacity is 300 kBtu/h (87.9 kW) and larger</u>

4.1.3.2 Section 120.2(k) Optimum Start/Stop Controls

(k) Optimum Start/Stop Controls. Space conditioning systems with DDC to the zone level shall have optimum start/stop controls. ~~These controls shall have access to space temperature, ambient air temperature and historical thermal lag profiles of each controlled zone.~~The control algorithm shall, as a minimum, be a function of the difference between space temperature and occupied setpoint, the outdoor air temperature, and the amount of time prior to scheduled occupancy. Mass radiant floor slab systems shall incorporate floor temperature onto the optimum start algorithm.

4.1.4 Operable Window/Door Switch Measure

4.1.4.1 Section 140.4(n) Mechanical System Shut-off

(n) Mechanical System Shut-off. Any directly conditioned space with operable wall or roof openings to the outdoors shall be provided with interlock controls that disable or reset the temperature setpoint to 55°F for mechanical heating and disable or reset the temperature setpoint to 90°F for mechanical cooling to that space when any such opening is open for more than 5 minutes.

EXCEPTION 1 to Section 140.4(n): Interlocks are not required on doors with automatic closing devices.

EXCEPTION 2 to Section 140.4(n): Any space without a thermostatic control (thermostat or a space temperature sensor used to control heating or cooling to the space).

~~EXCEPTION 3 to Section 140.4(n): Alterations to existing buildings~~

4.2 Reference Appendices Code Language

4.2.1 Elevator Ventilation and Cab Lighting Measure

4.2.1.1 NA7.14 Elevator Lighting and Ventilation Controls

NA7.14 Elevator Lighting and Ventilation Controls

NA7.14.1 Construction Inspection

Verify and document the following prior to functional testing:

- (a) Occupancy sensor has been located to minimize false signals.
- (b) PIR sensor pattern does not enter into the elevator lobby.
- (c) Occupancy sensors do not encounter any obstructions that could adversely affect desired performance.
- (d) Ultrasonic occupancy sensors do not emit audible sound.

NA7.14.2 Functional Testing

For each elevator cab being tested, confirm the following:

- (a) Verify that the lighting and ventilation controlled inside the elevator cab turn off after 15 minutes from the start of an unoccupied condition.
- (b) Verify that the signal sensitivity is adequate to achieve desired control. The sensor should not detect motion in the elevator lobby.
- (c) Verify that lighting and ventilation immediately turn "on" when an unoccupied condition becomes occupied.
- (d) Verify that the lighting and ventilation will not shut off when occupied. Stand in the elevator with the door closed and wait 15 minutes to confirm that the lighting and ventilation remain on.

4.2.2 Escalator and Moving Walkway Speed Control Measure

4.2.2.1 NA7.15 Escalator and Moving Walkway Speed Control

NA7.15 Escalator and Moving Walkway Speed Control

NA7.15.1 Construction Inspection

Verify and document the following prior to functional testing:

- (a) Variable speed drive is installed on the escalator.
- (b) Occupancy sensor has been located to minimize false signals.
- (c) Occupancy sensors do not trigger from pedestrians on adjacent escalators.
- (d) Occupancy sensors do not encounter any obstructions that could adversely affect desired performance.
- (e) Ultrasonic occupancy sensors do not emit audible sound

NA7.15.2 Functional Testing

For each escalator or moving walkway being tested, confirm the following:

- (a) Verify the amount of time necessary to ride the entire length of the escalator while standing still.
- (b) Stand away from the escalator. After being in an unoccupied condition for more than three times the length of time for a full ride, the escalator should slow down.
- (c) Approach the escalator entrance while in an unoccupied condition from multiple angles to ensure passenger detection cannot be bypassed.
- (d) Verify the slow speed setting is above 10 ft/min.
- (e) Verify the full speed setting is below 100 ft/min.
- (f) Verify the acceleration and deceleration of speed changes. The acceleration shall not exceed 1 ft/sec sq.
- (g) Approach the escalator in an unoccupied condition at an average walking pace. The escalator should reach full speed before boarding.
- (h) Approach the escalator in an unoccupied condition at an average walking pace. The escalator should reach full speed before boarding. An alarm should signal to alert that the pedestrian is approaching in the wrong direction.

4.2.3 Direct Digital Controls Measure

No new language was added to the Reference Appendices.

4.2.4 Operable Window/Door Switch Measure

No new language was added to the Reference Appendices.

4.2.5 Compliance Manual

In May 2015, the Statewide CASE Team provided CEC with proposed revisions to the Nonresidential Compliance Manual to describe how to comply with the code change outlined in this CASE Report. The revisions that the Statewide CASE Team provided served as the first draft of CEC's revisions to the Compliance Manual. At the time of writing CEC has not released a version of the Compliance Manual for public review. The Compliance Manuals are scheduled to be approved during the November 2015 CEC Business Meeting. The Statewide CASE Team recommended revisions to the following sections of the Compliance Manual:

- Chapter 4 – New section for Direct Digital Controls

- Chapter 4 – New section for optimum start/stop controls
- Chapter 4 – New section for window/door switch measure
- Chapter 10 – New section for elevators added (10.10)
- Chapter 10 – New section for escalators and moving walkways added (10.11)
- Chapter 13 – Modified Direct Digital Controls section
- Chapter 13 – New section for elevator lighting and ventilation acceptance testing.
- Chapter 13 – New section for escalator and moving walkway speed control acceptance testing
- Chapter 13 – New section for window/door switch measure acceptance testing

5. FINAL COST-EFFECTIVENESS RESULTS

5.1 Energy Savings Estimates

The energy savings calculation methodology, results, and assumptions have not changed since the CASE Report was submitted to CEC.

Statewide impacts from these measures are presented in the docketed CASE Report, presented as Appendix A of this report.

Table 2: Estimated First Year Energy Savings

Measure	First Year Statewide Savings			Statewide TDV Energy Savings (Million kBTU)
	Electricity Savings (GWh)	Power Demand Reduction (MW)	Natural Gas Savings (MMtherms)	
Elevator	3.65	0.130	0	39.24
Escalator	0.94	0.004	0	15.65
DDC	10.91	2.391	1.34	272.91
Window/Door	1.36	0	0.20	25.80
TOTAL	16.86	2.525	1.54	353.6

5.2 Final Cost-effectiveness Estimates

As shown in Table 3 through Table 5, the code changes are cost-effective. The cost-effectiveness estimates have not changed since submitting the CASE Report to CEC in September 2014. The latest version of the CASE Report is included, in its entirety in Appendix A of this report.

Table 3: Elevator and Escalator Cost-effectiveness Summary¹

All Climate Zones	Benefit: TDV Energy Cost Savings + Other Cost Savings² (2017 PV\$)	Cost: Total Incremental Cost³ (2017 PV\$)	Change in Lifecycle Cost⁴ (2017 PV\$)	Benefit-to-Cost Ratio⁵
Elevators	3,491	1,478	(2,012)	2.4
Escalators	25,324	4,354	(20,970)	5.8

1. Relative to existing conditions. All cost values presented in 2017 dollars.
2. Present value of TDV cost savings equals TDV electricity savings plus TDV natural gas savings; $\Delta\text{TDV}\$ = \Delta\text{TDV}\$\text{E} + \Delta\text{TDV}\G .
3. Total incremental cost equals incremental construction cost (post adoption) plus present value of incremental maintenance cost; $\Delta\text{C} = \Delta\text{CI}_{\text{PA}} + \Delta\text{CM}$.
4. Negative values indicate the measure is cost-effective. Change in lifecycle cost equals cost premium minus TDV energy cost savings; $\Delta\text{LCC} = \Delta\text{C} - \Delta\text{TDV}\$$
5. The Benefit-to-Cost Ratio is the TDV energy costs savings divided by the total incremental costs; $\text{B/C} = \Delta\text{TDV}\$ \div \Delta\text{C}$. The measure is cost-effective if the B/C ratio is greater than 1.0.

Table 4: DDC Cost-effectiveness Summary per Square Foot¹

Climate Zone	Benefit: TDV Energy Cost Savings + Other Cost Savings ² (2017 PV\$)	Cost: Total Incremental Cost ³ (2017 PV\$)	Change in Lifecycle Cost ⁴ (2017 PV\$)	Benefit-to-Cost Ratio ⁵
Climate Zone 1	2.11	0.18	(1.93)	11.809
Climate Zone 2	1.28	0.18	(1.10)	7.147
Climate Zone 3	1.65	0.18	(1.47)	9.254
Climate Zone 4	1.54	0.18	(1.36)	8.607
Climate Zone 5	1.31	0.18	(1.13)	7.359
Climate Zone 6	1.15	0.18	(0.97)	6.466
Climate Zone 7	1.14	0.18	(0.96)	6.359
Climate Zone 8	0.93	0.18	(0.75)	5.192
Climate Zone 9	1.04	0.18	(0.86)	5.815
Climate Zone 10	0.79	0.18	(0.61)	4.448
Climate Zone 11	1.34	0.18	(1.16)	7.517
Climate Zone 12	1.42	0.18	(1.24)	7.934
Climate Zone 13	1.25	0.18	(1.07)	6.998
Climate Zone 14	1.12	0.18	(0.94)	6.257
Climate Zone 15	0.98	0.18	(0.80)	5.481
Climate Zone 16	1.36	0.18	(1.18)	7.630

1. Relative to existing conditions. All cost values presented in 2017 dollars.

2. Present value of TDV cost savings equals TDV electricity savings plus TDV natural gas savings; $\Delta TDV\$ = \Delta TDV\$\text{E} + \Delta TDV\$\text{G}$.

3. Total incremental cost equals incremental construction cost (post adoption) plus present value of incremental maintenance cost; $\Delta C = \Delta C I_{PA} + \Delta C M$.

4. Negative values indicate the measure is cost-effective. Change in lifecycle cost equals cost premium minus TDV energy cost savings; $\Delta LCC = \Delta C - \Delta TDV\$$

5. The Benefit-to-Cost Ratio is the TDV energy costs savings divided by the total incremental costs; $B/C = \Delta TDV\$ \div \Delta C$. The measure is cost-effective if the B/C ratio is greater than 1.0.

Table 5: Door Switch Cost-effectiveness Summary per Square Foot¹

Climate Zone	Benefit: TDV Energy Cost Savings + Other Cost Savings ² (2017 PV\$)	Cost: Total Incremental Cost ³ (2017 PV\$)	Change in Lifecycle Cost ⁴ (2017 PV\$)	Benefit-to-Cost Ratio ⁵
Climate Zone 3	0.54	0.15	(0.39)	3.6
Climate Zone 6	0.47	0.15	(0.32)	3.2
Climate Zone 12	0.41	0.15	(0.26)	2.7
All Other Climate Zones	N/A	N/A	N/A	N/A

6. Relative to existing conditions. All cost values presented in 2017 dollars.
7. Present value of TDV cost savings equals TDV electricity savings plus TDV natural gas savings; $\Delta TDV\$ = \Delta TDV\$E + \Delta TDV\$G$.
8. Total incremental cost equals incremental construction cost (post adoption) plus present value of incremental maintenance cost; $\Delta C = \Delta CI_{PA} + \Delta CM$.
9. Negative values indicate the measure is cost-effective. Change in lifecycle cost equals cost premium minus TDV energy cost savings; $\Delta LCC = \Delta C - \Delta TDV\$$
10. The Benefit-to-Cost Ratio is the TDV energy costs savings divided by the total incremental costs; $B/C = \Delta TDV\$ \div \Delta C$. The measure is cost-effective if the B/C ratio is greater than 1.0.

6. ACKNOWLEDGMENTS

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APPENDIX A: DOCKETED VERSION OF CASE REPORT

APPENDIX B: DOCKETED COMMENTS LOG

CEC administered a public pre-rulemaking and rulemaking process to update the Title 24 Standards. The table below lists comments that were submitted to CEC through the pre-rulemaking and rulemaking process that are pertinent to this measure. The version of the CASE Report that is presented in Appendix A was developed taking comments that were submitted to CEC in response to the Scoping Workshops held April – August 2014 into account. See Section 3 of this report for a discussion of issues that stakeholders raised in comments that were submitted to CEC after the Statewide CASE Team submitted the CASE Report to CEC (comments submitted in response to the November 3, 2014 Scoping Workshop, the 45-Day Language, and the 15-Day Language).

Comment Letter #	Comment Letter ID	Link
Comments Submitted to CEC Response to Scoping Workshops Held April - August 2014		
1	NRDC	Natural Resources defense Councils Comments on the Title 24 2016 Pre-Rulemaking Workshops 2014-08-07 TN-73569.pdf
Comments Submitted to CEC in Response to Scoping Workshops Held November 3, 2014		
2	RNM (2)	RNM Engineering - Rick Miller proposed revisions to 2016 Title 24 Part 6 2015-01-08 TN-74263.pdf
Comments Submitted to CEC in Response to 45-Day Language and 45-day Hearings Held March 2-3, 2015		
3	CA Business Properties Association (1)	California Business Properties Association - Matthew Hargrove Comment on Title 24 45-Day Language 2015-02-26 TN-75237.pdf
4	Consol/CPBA (2)	Consol - Ignacio Robles - CPBA percent27s Comments on Nonresidential Building Energy Efficiency Standards 2015-03-18 TN-75501.pdf
5	Flamm Consulting (1)	Gary R- Flamm Consulting Comment Regarding Title 24 Building Energy Efficiency Standards 2015-03-01 TN-75236.pdf
6	Taylor Engineering (2)	Taylor Engineering - Jeff Stein Comments on 45 Day Language 2015-03-27 TN-75539.pdf
Comments Submitted to CEC in Response to 15-Day Language		
7	Taylor Engineering	Taylor Engineering Comments on 15 Day Language 2015-06-09 TN-75918.pdf