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Codes and Standards Enhancement (CASE) Initiative

2019 California Building Energy Efficiency Standards

Demand Response Cleanup (Including Changes to Space Conditioning, Lighting, Energy Management, Power Distribution, and Solar Ready Sections) – Final Report

Measure Number: 2019-ALL-DR-F

Residential and Nonresidential Demand Responsive Controls

September 2017

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EXECUTIVE SUMMARY

Introduction

The Codes and Standards Enhancement (CASE) initiative presents recommendations to support California Energy Commission's (Energy Commission) efforts to update California's Building Energy Efficiency Standards (Title 24, Part 6) to include new requirements or to upgrade existing requirements for various technologies. The four California Investor Owned Utilities (IOUs) – Pacific Gas and Electric Company, San Diego Gas and Electric, Southern California Edison, and SoCalGas® – and two Publicly Owned Utilities (POUs) – Los Angeles Department of Water and Power and Sacramento Municipal Utility District – sponsored this effort. The program goal is to prepare and submit proposals that will result in cost-effective enhancements to improve energy efficiency and energy performance in California buildings. This report and the code change proposals presented herein is a part of the effort to develop technical and cost-effectiveness information for proposed requirements on building energy efficient design practices and technologies.

The Statewide CASE Team submits code change proposals to the Energy Commission, the state agency that has authority to adopt revisions to Title 24, Part 6. The Energy Commission will evaluate proposals submitted by the Statewide CASE Team and other stakeholders. The Energy Commission may revise or reject proposals. See the Energy Commission's 2019 Title 24 website for information about the rulemaking schedule and how to participate in the process: http://www.energy.ca.gov/title24/2019standards/.

Measure Description

The objective of this code change proposal is to clean up and clarify the existing demand response (DR) requirements so that all sections of the standards use consistent terminology and approach. The goal is to improve comprehension of and compliance with the existing requirements. The Statewide CASE Team also strives to make it easier for occupants of compliant buildings to realize the economic benefits of their buildings' demand responsive controls by enrolling in DR programs.

The Statewide Utility Team recommends improvements to the language in the Standards, Reference Appendices, Compliance Manuals, and compliance documents to:

1. Improve the clarity of the code language without changing the stringency of the standards;
2. Harmonize the demand responsive control requirements, including requirements related to the application of open or standards-based communications protocols;
3. Clarify and improve the compliance and enforcement process; and
4. Establish a foundation within the Title 24, Part 6 Standards, Appendices, Alternative Calculation Method Reference Manuals, and Compliance Manuals upon which additional measures that have load reshaping and ancillary service benefits can be added in future code cycles.

The modifications aim to align the terminology used in Title 24, Part 6 with terminology used by industry, model codes, utility programs, and other regulating bodies such as the Federal Energy Regulatory Commission and the California Independent System Operator (CAISO). Revisions also aim to provide sufficient detail on how to comply with the standards while maintaining the appropriate level of leeway to allow for continued market innovation and transformation.

Scope of Code Change Proposal

Table 1 summarizes the scope of the proposed changes and which sections of the Standards, Reference Appendices to the Standards, and compliance documents will be modified.

Table 1: Scope of Code Change Proposal

Measure Name	Type of Requirement	Modified Section(s) of Title 24, Part 6	Modified Title 24, Part 6 Appendices	Will Compliance Software Be Modified	Modified Compliance Document(s)
Demand Response Cleanup	Mandatory (not changing stringency of standards – cleaning up existing requirements)	• 10-103(b)2 • 100.1 • 110.2(c) • 110.10 • 110.X (new section) • 110.Y (new section) • 120.2 • 130.0 (e) • 130.1(e) • 130.3 • 130.5(e) • 141.0(b)2E • 150.0(i) and (k) • 150.2(b)1F	• NA7.5.10: Automatic Demand Shed Control Acceptance • NA7.6.3 Demand Responsive Controls Acceptance Tests • JA5: Technical Specifications for Occupant Controlled Smart Thermostats	No	• Occupant Controlled Smart Thermostat Declaration[a] • NRCC-CXR-02-E • NRCC-LTS-01-E • NRCC-PRF-01-E • NRCI-LTI-02-E • NRCI-LTO-02-E • NRCA-LTI-04-A • NRCA-MCH-11-A

a. The Occupant Controlled Smart Thermostat Declaration is the document that manufacturers use to submit information to the Energy Commission to declare that thermostats or thermostatic control systems are compliant with Joint Appendix 5 (JA5). The document for 2016 standards is available here: http://www.energy.ca.gov/title24/equipment_cert/ocst/OCST_Declaration_2016.pdf.

Market Analysis and Regulatory Impact Assessment

The California DR marketplace consists of three types of participants – market administrators, third-party providers, and utility customers. The wholesale market administrator is the CAISO, while IOUs and a number of municipal utilities administer retail markets. Each administrator maintains a variety of DR programs that can vary by utility territory or customer size, type, or end-use. Beyond market participants, a wide variety of manufacturers, contractors, and organizations play an integral role in the DR landscape.

Overall, this cleanup proposal does not increase or decrease the wealth of the State of California since this code change proposal will not modify the stringency of the existing building standards. However, improved compliance to existing DR measures in the existing building standards were determined to be cost-effective in previous code change cycles.

The proposed changes to Title 24, Part 6 reduce the complexity of the standards and could reduce the cost of enforcement. When developing this code change proposal, the Statewide CASE Team interviewed building officials, Title 24 energy analysts, and others involved in the code compliance process to simplify and streamline the compliance and enforcement of this proposal.

Cost-Effectiveness

The code change proposal does not modify the stringency of the existing building standards related to demand responsive controls or add new DR requirements, so a cost-effectiveness analysis is not required for this proposal.

Statewide Energy Impacts

Table 2 shows the estimated energy savings over the first 12 months the proposed code changes are in effect. All 2019 CASE Reports present statewide savings without accounting for naturally occurring market adoption or code compliance. The Statewide CASE Team anticipates that compliance will improve because of this code change proposal, but the statewide savings from improved compliance are not quantified as part of CASE analyses. The proposed changes will not modify the stringency of existing requirements or add new requirements, so there are no expected statewide savings from more stringent standards. See Section 6 for more details.

Table 2: Estimated Statewide First Year[a] Energy and Water Savings

First-Year Electricity Savings (GWh/yr)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Water Savings (million gallons/yr)	First-Year Natural Gas Savings (million therms/yr)
0	0	0	0

a. First-year savings from all buildings completed statewide in 2020.

Compliance and Enforcement

The Statewide CASE Team worked with stakeholders to understand how this proposed cleanup measure could simplify the compliance process for various market actors. The compliance process is described in Section 2.5. The impacts the proposed measure could have on various market actors are described in Section 3.4 and Appendix B. The key issues related to compliance and enforcement are summarized below:

- Aggregating demand responsive control requirements into a new section will help designers understand the capabilities controls systems for HVAC systems, thermostatic controls, indoor lighting, electronic messaging system lighting, and electrical power distribution systems will need to have to comply with Title 24, Part 6. Leaving project triggers and exceptions within the existing sections of the standards will help designers understand when the requirements in the new section apply to their projects.
- The Statewide CASE Team has received feedback that inconsistent and undefined terminology used in the standards, compliance documents and acceptance testing procedures within NA7 causes misinterpretations of what is required to comply with the demand responsive control requirements. For example, to pass the acceptance tests for nonresidential lighting and HVAC systems with direct digital control (DDC) to the zone level, the control system needs to be programmed/configured to implement the specified control strategy. Currently, many designers think that they just have to specify a control system with demand responsive capability, but do not need to do anything else to the control system. Acceptance testers understand that the control system needs to be configured/programmed and tested. This needs to be clarified. Cleaning up code language and harmonizing terminology as part of this proposal will alleviate these issues.
- Differing technologies used to meet thermostatic control requirements within the standards (energy management control systems [EMCS], Occupant Controlled Smart Thermostats [OCSTs], and setback thermostats) causes confusion for market actors about which technology

is appropriate for their project application. Summarizing common technologies and their applications in relation to compliance will be a helpful reference for market actors.

- Building occupants are not always aware of a building's demand responsive controls and how the controls can be used to participate in DR programs.

This report proposes modifications to code language and associated compliance manuals and compliance documents that the Energy Commission can modify as part of the 2019 code cycle to improve compliance and enforcement. Throughout the code development cycle, stakeholders have recommended opportunities to improve understanding of DR requirements and/or increase participation in DR programs that go beyond improvements to the code language (such as improved trainings for builders and code officials). The Statewide CASE Team has included these opportunities that go beyond updates to the code language knowing that some suggestions are outside of the scope of the 2019 code cycle updates.

Although a needs analysis was conducted with the affected market actors while developing the code change proposal, the code requirements may change between the time the final CASE Report is submitted and the time the 2019 Standards are adopted. The recommended compliance process and compliance documentation may also evolve with the code language. To effectively implement the adopted code requirements, a plan should be developed that identifies potential barriers to compliance when rolling-out the code change and approaches that should be deployed to minimize the barriers.

1. INTRODUCTION

The Codes and Standards Enhancement (CASE) initiative presents recommendations to support California Energy Commission's (Energy Commission) efforts to update California's Building Energy Efficiency Standards (Title 24, Part 6) to include new requirements or to upgrade existing requirements for various technologies. The four California Investor Owned Utilities (IOUs) – Pacific Gas and Electric Company, San Diego Gas and Electric, Southern California Edison and SoCalGas® and two Publicly Owned Utilities (POUs) — Los Angeles Department of Water and Power and Sacramento Municipal Utility District 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 requirements on building energy efficient design practices and technologies.

The Statewide CASE Team submits code change proposals to the Energy Commission, the state agency that has authority to adopt revisions to Title 24, Part 6. The Energy Commission will evaluate proposals submitted by the Statewide CASE Team and other stakeholders. The Energy Commission may revise or reject proposals. See the Energy Commission's 2019 Title 24 website for information about the rulemaking schedule and how to participate in the process: http://www.energy.ca.gov/title24/2019standards/.

The overall goal of this CASE Report is to propose improvements to the language to clarify the existing demand response (DR) requirements the Title 24, Part 6 Standards, Reference Appendices to the Standards, Compliance Manuals, and compliance documents. The report contains pertinent information supporting the code change.

When developing the code change proposal and associated technical information presented in this report, the Statewide CASE Team worked with a number of industry stakeholders including building officials, manufacturers, builders, utility incentive program managers, Title 24 energy analysts, and others involved in the code compliance process. The proposal incorporates feedback received during two public stakeholder workshops that the Statewide CASE Team held on October 11, 2016 and March 28, 2017.

Section 2 of this CASE Report provides a description of the measure and its background. This section also presents a detailed description of how this change is accomplished in the various sections and documents that make up the Title 24, Part 6 Standards.

Section 3 presents the market analysis, including a review of the current market structure. Section 3.2 describes the feasibility issues associated with the code change, such as whether the proposed measure overlaps or conflicts with other portions of the building standards including fire, seismic, and other safety standards and whether technical, compliance, or enforceability challenges exist.

The code change proposal will not modify the stringency of the existing demand responsive control requirements in the building standards. Thus, Sections 4, 5, and 6, which typically present analysis on the lifecycle cost-effectiveness and the energy impacts of the proposed code change, are not included in this CASE Report.

Section 7 concludes the report with specific recommendations with ~~strikeout~~ (deletions) and underlined (additions) language for the Standards, Reference Appendices, Alternative Calculation Manual (ACM) Reference Manual, Compliance Manual, and compliance documents.

2. MEASURE DESCRIPTION

2.1 Measure Overview

The 2008 Title 24, Part 6 Standards, which took effect in January 2010, included the first mandatory requirements for demand responsive controls. During the 2013 and 2016 code cycles, DR requirements were added and/or revised. Parties advocating for changes to unique sections of the standards worked independently and there was an insufficient effort to harmonize the demand responsive control requirements throughout the standards. Since DR requirements were added to the standards over multiple code cycles (as DR markets were evolving), the current Title 24, Part 6 Standards include a patchwork of DR requirements for a variety of buildings systems and building types. Each section uses different terminology and approaches to describe the requirements. The existing DR requirements were established with good intention, were adopted on solid grounds, and have resulted in significant benefit to utility customers and the state (Southern California Edison 2006, Pacific Gas and Electric 2006, California Statewide Utility Codes and Standards Program 2011, California Statewide Utility Codes and Standards Program 2011). As written, however, the requirements are not as effective as they could be. There are reports that compliance with DR requirements is low, and too few customers who occupy buildings that have Title 24, Part 6-compliant demand responsive controls are enrolled in DR programs.[1] The objective of this code change proposal is to clean up and clarify the existing demand responsive control requirements so all sections of the standards us consistent terminology and approach. The goal is to improve comprehension of and compliance with the requirements. The Statewide CASE Team is also striving to make it easier for occupants of compliant buildings to realize the economic benefits of their buildings' demand responsive controls by enrolling in DR programs.

The Statewide Utility Team recommends improvements to the language in the Standards, the Reference Appendices, the Compliance Manuals, and the compliance documents to:

1. Improve the clarity of the code language without changing the stringency of the standards;
2. Harmonize the demand responsive control requirements, including requirements related to the application of open or standards-based communications protocols;
3. Clarify and improve the compliance and enforcement process;
4. Establish a foundation within the Standards, Appendices, ACM Reference Manuals, and Compliance Manuals upon which additional measures that have benefits pertaining to load reshaping and ancillary services can be added in future code cycles.

The modifications will aim to align the terminology used in Title 24, Part 6 with modern terminology used by industry, utility programs, and other regulating bodies such as the Federal Energy Regulatory Commission and the California Independent System Operator (CAISO). Revisions will also aim to provide sufficient detail on how to comply with the standards while maintaining the appropriate level of leeway to allow for continued market innovation and transformation.

The Statewide CASE Team recommends consolidating the requirements for demand responsive controls into a new section (section 110.X) and consolidating requirements for energy management control systems (EMCS) into a second new section (section 110.Y). Since the revisions move existing language from many sections of the 2016 Standards, the changes to the existing language appear extensive (see Section 7 for marked code language), but the intent is to keep the stringency of the requirements

[1] Throughout this report, the term "DR program" is used to refer to any means in which a customer can participate in DR events. This includes offerings (e.g., incentive programs or tariffs) offered by a utility, DR aggregator, wholesale markets, or others.

unchanged. Table 3 presents a summary of the proposed revisions to each section of the standards and identifies which sections of language have been moved to a new section.

Table 3: Summary of Proposed Revisions to Standards

Section of Existing Standards	Summary of Proposed Revision(s)
10-103(b)2	Adds language to clarify that building owner/occupant should receive information about the buildings' control systems, including the DR control systems.
100.1	Updates and adds definitions.
110.2(c)	Revises wording of requirements for thermostatic controls to improve clarity.
110.10	• Revises wording of solar-ready tradeoffs that allow the use of thermostatic controls that comply with Joint Appendix 5 (JA5) improve clarity. • Replaces the phrase "home automation system," which is not defined, with the defined term "energy management control system," which is defined.
110.X (new section)	• Adds new section that contains all requirements for demand responsive controls. • Content was removed from the following sections and added to this new section: 120.2, 130.1(e), 130.3, 130.5(e). • The original language was reworded to improve clarity. • Clarifies and harmonizes communications protocol requirements for all demand responsive controls other than thermostatic controls that comply with JA5 (revisions to JA5 include modifications to communications protocol requirements that harmonize with the communication protocol requirements for all other demand responsive control systems required by the standards).
110.Y (new section)	• Adds new section that contains all requirements relating to when an Energy Management Control System can be used to comply with building control requirements. • Content was removed from the following sections and added to this new section: 130.0(e), 150.0.
120.2	• Revises section heading name to be consistent with all other sub-sections with in Section 120. • Revises wording of requirements for thermostatic controls to improve clarity. • Moves demand responsive control requirements from this section to section 110.X. This section direct readers to section 110.X
130.0(e)	Moves requirements that indicate when EMCS can be used from this section to section 110.Y. This section keeps a reference to direct readers to section 110.Y
130.1(e)	Moves demand responsive control requirements from this section to section 110.X. This section direct readers to section 110.X.
130.3	• Revises section heading name to be consistent with all other sub-sections with in Section 130. • Moves demand responsive control requirements from this section to section 110.X. This section direct readers to section 110.X.
130.5(e)	• Revises section heading name to be consistent with all other sub-sections with in Section 130. • Moves demand responsive control requirements from this section to section 110.X. This section direct readers to section 110.X.
141.0(b)2E	Revises wording of requirements for thermostatic controls to improve clarity.
150.0(i) and (k)	• Revises wording of requirements for thermostatic controls to improve clarity. • Moves requirements that indicate when EMCS can be used from this section to section 110.Y. This section keeps a reference to direct readers to section 110.Y
150.2(b)1F	Revises wording of requirements for thermostatic controls to improve clarity.

Requirements for communications protocols have been debated every code cycle since demand responsive control requirements were first added to the standards for the 2008 Standards. There are many factors to consider when evaluating potential requirements for the communications protocols. See Appendix B for a detailed discussion of the proposed communications requirements.

2.2 Measure History

Title 24, Part 6 first included DR requirements in the 2008 Standards. Definitions of “demand response” and other DR-related terms were included in this version of the code. The following requirements were also adopted for the 2008 Standards: automatic demand shed controls for heating, ventilation, and air conditioning (HVAC) systems with direct digital control (DDC) to the zone level; DR lighting controls for retail buildings and sales floors over 50,000 square feet; DR controls for electronic messaging centers (EMCs); and acceptance testing for DR HVAC controls. The acceptance testing requirement for DR controls for HVAC systems was included in the 2008 Standards. During the 2008 rulemaking process, there was also a debate about how communications across the smart grid infrastructure would work, including concerns about consumers’ privacy, data security, and ability to opt out of automatic demand response (ADR) transactions (Gonzalez, et al. 2014).

The 2013 Standards expanded DR lighting control requirements to all nonresidential buildings over 10,000 square feet. The 2013 Standards also added requirements for thermostatic controls that were compliant with Joint Appendix 5 (JA5): Technical Specifications for Occupant Controlled Smart Thermostats (OCSTs), including requirements to install OCSTs in nonresidential buildings with specific HVAC systems, requirements to install OCSTs in certain alterations to HVAC systems in nonresidential buildings, and trade-offs in residential buildings that allow the use of OCSTs along with other measures instead of meeting solar-ready building requirements or instead of the using the standard refrigerant charge test method. Requirements that DR controls use a “standards-based messaging protocol” were also added in 2013 as was the acceptance testing requirement for DR lighting controls. Some existing DR-related provisions were also refined or expanded slightly.

The updates made during the 2016 code cycle were relatively minor and included minor clarifications to JA5 and limited cleanup revisions to the DR requirements for lighting controls and the DR lighting control acceptance test. During the 2016 cycle, requirements were also added requiring DDC to the zone level in certain nonresidential buildings. Since DR controls are required when HVAC systems have DDC to the zone level, the revisions to the DDC requirements resulted in more medium-sized buildings having DDC to the zone level and thus more medium-sized buildings having DR controls (other than thermostatic controls that comply with JA5).

As mentioned, since DR requirements were added to the standards over multiple code cycles (as DR markets were evolving), the current Title 24, Part 6 Standards include a patchwork of DR requirements for a variety of buildings systems and building types, with each section using different terminology and approaches to describe the requirements.

See Section 2.4.2 and Appendix D for more information on the existing DR control requirements in Title 24, Part 6.

2.3 Summary of Proposed Changes to Code Documents

The sections below provide a summary of how each Title 24, Part 6 document will be modified by the proposed change. See Section 7.1 of this report for detailed proposed revisions to code language.

2.3.1 Standards Change Summary

This proposal will modify the following sections of the Building Energy Efficiency Standards as shown below. See Section 7.1 of this report for the detailed proposed revisions to the code language.

Section 10-103 – Permits, Certificate, Informational, and Enforcement Requirements for Designers, Installers, Builders, Manufacturers, and Suppliers: Recommends adding clarification that the builder must leave operating information for all applicable features—including the building control systems—in the building so they are accessible to the building owner at occupancy. Previously, the language did not explicitly state that information about building control systems must be provided to the building owner.

Section 100.1 – Definitions and Rules of Construction: Recommends new or revised definitions for the following terms:

- New definitions:
  - "automatic control system" – harmonizes with definition in ASHRAE 90.1-2016 with a revision to clarify that automatic controls can be systems of devices as opposed to a stand-alone device and to clarify that the controls are not just intended for on/off functions.
  - (lighting definitions) "Design Full Output" – allows for the use of one term to replace instances of multiple terms being used to convey the same meaning in the acceptance test for demand responsive controls for lighting systems.
  - "thermostatic controls" – harmonizes with definition in ASHRAE 90.1-2016 to differentiate between an independent "thermostat" and a control system.
  - "OpenADR 2.0a" – necessary to clarify the communications protocol requirements for demand responsive controls
  - "OpenADR 2.0b" – necessary to clarify the communications protocol requirements for demand responsive controls
  - "Virtual End Node (VEN)" – necessary to clarify the communications protocol requirements for demand responsive controls
- Revised definitions:
  - "demand responsive control" – updates definition to improve clarity.
  - "demand response signal" – removes unnecessary language indicating where the DR signal is initiated.
  - "energy management control system" – removes outdated terminology and removes ambiguity on what an EMCS *must* be capable of doing versus what an EMCS *could* be capable of doing.
  - "thermostats" – harmonizes with definition in ASHRAE 90.1-2016 to differentiate between an independent "thermostat" and a thermostatic control system.

Section 110.2 – Mandatory Requirements for Space Conditioning Equipment: Revises wording of requirements for thermostatic controls to improve clarity without modifying the intent or stringency of the requirements.

Section 110.10 – Mandatory Requirements for Solar Ready Buildings: Revises wording of exceptions that call for installation of thermostatic controls that are compliant with JA5 to improve clarity without modifying the intent or stringency of the requirements. Replaces the term "home automation system," which is not defined, with the defined term "Energy Management Control System," which is defined.

Section 110.X – Required Automatic Demand Responsive Controls: Creates a new section (Section 110.X) so all mandatory demand responsive control requirements are in one section. Requirements that were previously located in Sections 120.2, 130.1 and 130.5 now appear in the new section. This section applies to building types where DR controls are required in the 2016 Standards, that is; nonresidential, multifamily, and hotel/motel applications (Section 110.X(a)). If mandatory demand responsive control requirements are adopted for residential building during future code cycles, this section could be expanded to cover mandatory requirements for residential buildings. In addition to locating all demand responsive control requirements in one section, the proposed language aims to clarify and simplify the existing requirements in the following ways:

- Applies the same minimum capabilities requirements for all demand responsive controls, regardless of the building system to which the control is connected (section 110.X(b) through section 110.X(d)). The 2016 standards have different minimum capabilities requirements for demand responsive controls for HVAC and lighting systems. Applying the same minimum capabilities requirements for all DR controls will simplify and make it easier for market actors to understand and comply with the requirements.
- Harmonizes and clarifies the external communications requirements for all required demand responsive controls; requires all systems to have an OpenADR 2.0a or OpenADR 2.0b certified VEN. See Appendix B for a detailed discussion of the proposed external communications requirements.
- Harmonizes and clarifies the interior communications requirements for all required demand responsive controls; requires systems to be capable of using either wired or wireless communication standards for communication within the building. Allowable wireless protocols include WiFi, ZigBee, or BACnet. Allowable wired protocols include Ethernet or hard-wiring. Removes language that implies the DR signal must be routed through an EMCS. See Appendix B for a detailed discussion of the proposed external communications requirements.
- Presents requirements for demand responsive controls, minimum control strategies, and acceptance test requirements in various building systems in a new table (Table 110.X-A). This format is easier to read and comprehend than requirements presented in paragraph format.
- Revises wording of required control strategies without modifying the intent or stringency of the requirements.

Section 110.Y – Requirements for Energy Management Control Systems: Creates a new section (Section 110.Y) so all requirements related to the EMCS are in one section. Moves requirements that are previously located in Sections 120.2(a), 130.0(e) and 150.0(k)2 into the new section.

Section 120.2 – Required Controls for Space-conditioning Systems: Revises wording of requirements for thermostatic controls to improve clarity without modifying the intent or stringency of the requirements. Moves language that explains when demand responsive controls are required and the required control strategies into a new section (Section 110.X) so all demand responsive control requirements for nonresidential buildings are in one section.

Section 130.0 – Lighting Systems and Equipment– General: Moves requirements that identify when and EMCS can be used to comply with nonresidential lighting control requirements from Section 130.0(e) to a new section (Section 110.Y) so all requirements for EMCSs are in one location.

Section 130.1 – Mandatory Indoor Lighting Controls: Moves language that explains when demand responsive controls are required and the required control strategies into a new section (Section 110.X) so all demand responsive control requirements for nonresidential buildings are in one section. The 2019 CASE Report titled, *Nonresidential Indoor Controls (Alignment with ASHRAE 90.1)* recommends eliminating the requirement that DR lighting controls comply with the uniformity requirements in Table 130.1. The proposed code language presented in this CASE Report incorporates this revision, but the justification for the revision is included in the *Nonresidential Indoor Controls (Alignment with ASHRAE 90.1)* CASE Report.

Section 130.3 – Sign Lighting Controls: Moves language that explains when demand responsive controls are required and the required control strategies into a new section (Section 110.X) so all demand responsive control requirements for nonresidential buildings are in one section.

Section 130.5 – Electrical Power Distribution Systems: Moves language that explains when demand responsive controls are required and the required control strategies into a new section (Section 110.X) so all demand responsive control requirements for nonresidential buildings are in one section.

Section 141.0 – Additions, Alterations, and Repairs to Existing Nonresidential, High-Rise Residential, and Hotel/Motel Buildings, to Existing Outdoor Lighting, and to Internally and Externally Illuminated Signs: Revises wording of requirements for thermostatic controls to improve clarity without modifying the intent or stringency of the requirements.

Section 150.0 – Mandatory Features and Devices: Revises wording of requirements for thermostatic controls to improve clarity without modifying the intent or stringency of the requirements. Moves requirements that identify when EMCS can be used to meet residential lighting control requirements from Section 150.0(k)2 to a new section (Section 110.Y) so all requirements for EMCSs are in one location.

Section 150.2 – Energy Efficiency Standards for Additions and Alterations to Existing Low-rise Residential Buildings: Revises wording of requirements for thermostatic controls to improve clarity without modifying the intent or stringency of the requirements.

2.3.2 Reference Appendices Change Summary

This proposal modifies the sections of the Standards Reference Appendices shown below. See Section 7.2 of this report for the detailed proposed revisions to the text of the reference appendices.

Joint Appendix 5: Technical Specifications for Occupant Controlled Smart Thermostats: Proposes a rewrite of JA5 with the goals of maintaining the stringency of the requirements but improving clarity and using terminology that is consistent with current industry standard practices. Harmonizes the external and internal communications requirements with requirements that apply to other demand responsive controls that the code requires.

Nonresidential Appendix 7 Section NA7.5.10 Automatic Demand Shed Control Acceptance: Current code language uses multiple terms that are intended to have the same meaning. The proposed change simplifies code language by eliminating the terms “total lighting power,” “design illuminance,” and “full output,” and using the term “design full output,” which is now defined in Section 100.1, instead. Revises wording of requirements improve clarity and harmonize terminology without modifying the intent of the acceptance test.

Nonresidential Appendix 7 Section NA7.6.3 Demand Responsive Controls Acceptance Tests: Revises wording of requirements improve clarity and harmonize terminology without modifying the intent of the acceptance test.

2.3.3 Alternative Calculation Method (ACM) Reference Manual Change Summary

The proposed code change will not modify the ACM Reference Manuals.

2.3.4 Compliance Manual Change Summary

The proposed code change will modify the following section of the Title 24, Part 6 Compliance Manuals:

- Residential Compliance Manual
    - Chapter 7 Solar Ready Buildings
- Nonresidential Compliance Manual:
    - Chapter 4 Mechanical Systems
    - Chapter 5 Nonresidential Indoor Lighting
    - Chapter 7 Sign Lighting
    - Chapter 8 Electrical Power Distribution

- Chapter 9 Solar Ready

The compliance manuals should include definitions of terms that are commonly used when discussing what is required to deploy the building systems and controls that are installed to be compliant with Title 24, Part 6 to enroll building occupants in DR programs. The Statewide CASE Team intends on recommending definitions to the following terms be added to compliance manuals:

- DR-capable: the building has curtailable loads, demand responsive controls are installed, and the controls have been programed/configured to pass the required acceptance tests;
- DR-enabled: the connection between the entity that sends the Demand Response Signal and the demand responsive control in the building has been tested and communications have been allowed or “enabled”; and
- DR-enrolled: building occupant is enrolled in a DR program.

The compliance manuals currently do not cover material presented in the Reference Appendices to the Standards, including content in JA5 and the acceptance tests required to verify compliance with the demand responsive control requirements for HVAC (NA7.5.10) and lighting (NA7.6.3). This has caused confusion. Buildings must comply with requirements in the appendices, but there is not currently a single location where market actors can go to get further explanations of the requirements in the appendices. The Statewide CASE Team recommends developing audience-appropriate manuals, training materials and resources to provide further explanation of the requirements in JA5 and the DR acceptance tests. The audience-appropriate material could include adding new content to the existing compliance manuals, developing fact sheets or frequently asked questions documents, or updating training materials that the IOUs and others use when delivering Title 24, Part 6 compliance and enforcement trainings.

2.3.5 Compliance Documents Change Summary

The proposed code changes will require modifications to the compliance documents listed below. The documents will be updated, and section numbers and terminology will be updated to be consistent with numbering and terminology in the standards and appendices

- JA5 Thermostatic Control Declaration – The proposed code changes will require modifications to the declaration document that manufacturers submit information to the Energy Commission to certify that thermostats are compliant with JA5. The declaration should include information regarding preset settings.
- NRCC-CXR-02-E: Commissioning – Construction Documents – General
- NRCC-LTS-01-E: Sign Lighting
- NRCC-PRF-01-E: Nonresidential Performance
- NRCI-LTI-02-E: Energy Management Control System or Lighting Control System
- NRCI-LTO-02-E: Energy Management Control System or Lighting Control System
- NRCA-LTI-04-A: Demand Responsive Lighting Control Acceptance Document
- NRCA-MCH-11-A: Automatic Demand Shed Control Acceptance

To be consistent with the proposed changes to the code language, the Statewide CASE Team recommends that the Energy Commission search all compliance documents for the term “setback thermostats” and replace with “thermostatic control compliant with Section 110.2(c),” where applicable.

2.4 Regulatory Context

2.4.1 General Policy Context

Current state and federal policies ensure energy is used efficiently and the electricity grid is safe and reliable. Both the Energy Commission and the U.S. Department of Energy (DOE) have been administering initiatives that support these goals for decades. For many years, demand-side policy has been focused primarily on energy efficiency and reducing peak demand. California's loading order requires the electric utilities to develop energy efficiency programs. Next in the loading order are DR programs to "reduce or curtail loads during times of high demand and emergencies" (California Energy Commission 2005).

As California approaches its various goals for energy efficiency, renewable generation, energy storage, greenhouse gas reductions, and zero net energy (ZNE) buildings, the relationship between electricity supply and demand is evolving and increasing in importance. There is now a need to manage loads in more innovative ways that go beyond deploying demand response to reduce peak demand. The system-wide "duck curve"—the occurrence of net load dips in the non-summer months during the midafternoon followed by a dramatic ramp up—is an emerging grid operating condition resulting from increased use of photovoltaics generation and increased use of photovoltaics by utilities to meet their renewable portfolio standard (RPS) mandates. Grid operators are looking for new mechanisms to manage supply and demand to maintain grid reliability including using electricity when it is available in the middle of the day and controlling loads to manage the steep evening ramp.

It is increasingly important for newly constructed buildings to be designed to consider *when* electricity is being pulled from the grid and when electricity is being fed into the grid. For buildings with on-site solar photovoltaic systems, this means using building controls (or battery systems when cost-effective) to self-utilize electricity that is generated on site and minimize electricity exports to the grid at times when there is risk for over-generation. It is becoming increasingly cost-effective and feasible for buildings to deploy strategies that integrate energy efficiency, on-site renewables, on-site storage, DR capabilities, and/or innovative building controls (Hauenstein, et al. 2016). Although this CASE Report does not recommend increasing the stringency of the DR control requirements, the intention is to clean up the existing requirements, improve compliance, and establish a foundation upon which new code requirements can be added during a future code cycle.

Policy has provided clear direction that building codes should cover integrated distributed energy resource strategies like load shifting and integrated controls.

The 2015 California Integrated Energy Policy Report states, "Load shifting is likely to be a valuable strategy for achieving zero-net-energy code buildings, and the Energy Commission can develop compliance options that provide TDV [Time Dependent Valuation] credit for such technologies," (California Energy Commission 2005).

State and regional regulatory structure and market drivers, such as regional energy availability, grid operation and grid reliability issues, are leading to variability in how DR markets are evolving within the seven primary Independent System Operators and Regional Transmission Organizations in the United States (U.S.). It is anticipated that DR markets will move towards including DR as a component of long-term capacity planning and as a potential solution for short-term reliability needs.

2.4.2 Existing Title 24, Part 6 Standards

In the 2005 Title 24 Standards, California introduced Time Dependent Valuation (TDV) to assess the energy and cost impacts of potential code changes and to quantify the energy impacts of building systems and equipment when using the performance approach (whole-building energy simulation) to compliance. TDV assigns a unique cost and energy valuation factor to energy savings that occur during each hour of the year. Savings that occur during peak periods are valued more than savings that occur off-peak. Introducing TDV enabled the Energy Commission to quantify the value of measures that curtail loads during peak periods or shift loads away from peak times

The history of DR measures in the Title 24, Part 6 Standards is outlined in Section 2.2 of this report. The current 2016 Title 24, Part 6 Standards include mandatory requirements that apply to HVAC systems (with and without DDC to the zone level) in nonresidential buildings, nonresidential indoor lighting systems, and electronic message centers. These building systems must have controls that are capable of receiving a Demand Response Signal and automatically implementing a control strategy that modifies energy consumption for a limited time period. The control strategy for each building system is as follows:

- HVAC systems (with DDC to the zone level): adjust temperature setpoints to non-critical zones by at least four degrees Fahrenheit.
- Lighting systems: reduce interior lighting power (or light level) by at least 15 percent
- Electronic Messaging Systems: reducing lighting power by at least 30 percent.

There is a prescriptive requirement that thermostatic controls that comply with JA5 must be installed when completing when space conditioning systems in nonresidential buildings are altered. This alterations requirement applies to many nonresidential alterations (see Table 4 for details). Finally, if DR controls or equipment are installed on the circuit-level (e.g., DR controls for all loads on a circuit), the controls must be “capable of receiving and automatically responding to at least one standards-based messaging protocol,” (Section 130.5(c)).

For residential buildings, thermostatic controls that comply with JA5 can be installed in combination with other measures, as a tradeoff exception to the solar ready requirements for single family and multifamily buildings. Thermostatic controls that comply with JA5 can also be installed in conjunction with completing an alternate refrigerant charge test if temperatures are low, a tradeoff exception that is available for new construction and alterations.

Table 4 summarizes these DR-related requirements and Appendix D provides more details on the requirements.

The DR-related requirements in Title 24, Part 6 are found in several different sections of the standards, and appendices. These requirements are described in multiple locations within the Compliance Manuals as well. Table 4 also presents a summary of the locations of the primary DR requirements pertaining to indoor lighting, HVAC, and sign lighting (Energy Solutions; ASWB Engineering 2014). As mentioned previously, given the patchwork of requirements and terminology used throughout the standards, there have been reports that compliance with DR requirements is low, and too few customers who occupy buildings that have Title 24-compliant demand responsive controls are enrolled in DR programs.

Table 4: Summary of Mandatory DR-Related Requirements for Nonresidential Buildings in Title 24, Part 6

Building System	New Construction or Alteration	When DR Requirement Applies	Required Automatic Response to DR Signal	Equipment Needed for Compliance	Relevant Section(s) of 2016 Title 24, Part 6 Standards		Relevant Section(s) of 2016 Compliance Manual		Compliance Document
					Standards	Appendices	Standards	Acceptance Test	
Lighting	New construction	• Building area > 10,000 square feet • Spaces where lighting power density > 0.5 watts/square foot	Reduce lighting power ≥ 15%	• Lighting control system or EMCS with appropriate programming • Dimmable lighting system	• 100.1 (definitions) • 130.1(e) • 140.6(a)(2)(K)	• NA7.6.3 • NA7.7.2 (EMCS)	5.4 – 5.6	13.8.4	NRCI-LTI-02-E
HVAC (*with DDC to zone level)*	New construction	Non-critical zones	Adjust temperature setpoints ≥ 4° F	EMCS with appropriate programming and interface or dry contact	• 100.1 (definitions) • 120.2(b) • 120.2(h)	NA7.5.10	4.5.1.7	13.7.22	NRCA-MCH-11-A
HVAC (*without DDC)*	New construction	Non-temperature-sensitive processes		DR Thermostat (JA5-compliant) or EMCS with appropriate programming	• 100.1 (definitions) • 110.10(b)(1) • 110.2(c) • 120.2(b)	JA5	• 4.2.5 • 4.5.1.1	N/A	• For project compliance: N/A • For manufacturers certifying JA5-compliant thermostats: JA5 declaration document
HVAC	Alterations (prescriptive)	When a space-conditioning system is altered by the installation or replacement of space-conditioning system equipment (including replacement of the air handler, outdoor condensing unit of a split system air conditioner or heat pump, or cooling or heating coil)	Defined in JA5	• Altered units: must install DR Thermostat (JA5-compliant) • New units that require thermostats: Thermostat (JA5-compliant)	• 100.1 (definitions) • 141.0(b)2E	JA5	4.9.4.3	N/A	

Building System	New Construction or Alteration	When DR Requirement Applies	Required Automatic Response to DR Signal	Equipment Needed for Compliance	Relevant Section(s) of 2016 Title 24, Part 6 Standards		Relevant Section(s) of 2016 Compliance Manual		Compliance Document
					Standards	Appendices	Standards	Acceptance Test	
Electronic Messaging Centers	New construction	• Electronic Message Centers only • Connected load ≥ 15kW	Reduce lighting ≥ 30%	Lighting control system or EMCS with appropriate programming	• 100.1 (definitions) • 130.3(a)(3)	N/A	7.3.3	N/A	NRCC-LTS-01-E
Electrical Power Distribution Systems	New construction	DR controls for electrical distribution systems	If installed, DR control system must use standards-based messaging protocol	N/A	130.5(e)	N/A	8.5.2	N/A	N/A

Source: (Energy Solutions; ASWB Engineering 2014)

The 2019 CASE Report titled, *Nonresidential Indoor Controls (Alignment with ASHRAE 90.1)*, recommends eliminating the requirement that DR controls for lighting systems reduce lighting power in accordance with the uniformity requirements presented in Table 130.1-A. The code language presented in this CASE Report assumes that lighting power can be reduced without meeting uniformity requirements, but this report does not include an explanation for this for this proposed revision because the explanation is included in the *Nonresidential Indoor Controls (Alignment with ASHRAE 90.1)* CASE Report.

The Statewide CASE Team has received comments that the existing code language that explains the DR controls requirements for nonresidential lighting alterations projects is not clear and is causing confusion. There is confusion about whether the demand responsive controls requirements apply if the entire building has enclosed space over 10,000 square feet or whether they only apply if the altered enclosed space is over 10,000 square feet. There is also confusion about how the 0.5 watts per square foot threshold applies. The Energy Commission issued clarification on this in Blueprint Issue 113, which states:

> For alterations, demand responsive controls are triggered when all of the following conditions are met:
>
> 1. Any number of existing luminaires are altered (TABLE 141.0-E).
>
> 2. There is a change in the area of the enclosed space, space type, or increase in lighting power (TABLE 141.0-E).
>
> 3. The area of all altered enclosed spaces is greater than 10,000 square feet, excluding spaces with a lighting power density of 0.5 watts per square foot or less (Section 130.1(e)).
>
> Demand responsive control requirements apply only to the enclosed space(s) being altered as indicated on the building permit. The Energy Standards apply only to those portions of the systems being altered. These controls are not required if the area of all altered enclosed spaces is 10,000 square feet or less. (California Energy Commission 2016)

This CASE Report does not recommend revisions to the code language to clarify requirements for nonresidential lighting alterations, but the 2019 CASE Report titled, *Nonresidential Indoor Lighting Alterations* will address this code language.

2.4.3 Relationship to Other Title 24 Requirements

There are no relevant requirements in other parts of the California Building Code.

2.4.4 Relationship to State or Federal Laws

There are no relevant state or federal laws.

2.4.5 Relationship to Industry Standards

There are a number of model building codes and rating systems that recognize the importance of DR and include provisions to facilitate the participation in DR transactions. These model codes and rating systems include, but are not limited to, ASHRAE 90.1, ASHRAE 189.1, the International Energy Conservation Code (IECC), and Leadership in Energy and Environmental Design (LEED). Model building codes include requirements that support DR using the following strategies: (1) ensure buildings have curtailable load, (2) ensure loads are equipped with DR controls, (3) require that DR systems have been commissioned and certified to confirm they are capable of responding to DR signals as designed, (4) require participation in DR transactions, and (5) require building energy use to be measured to enable better demand-side management in the future. These building codes and rating systems requirements can be either voluntary or mandatory.

Title 24, Part 6 has more robust and detailed DR requirements than most other mandatory model codes. This is, in part, because California has both robust DR markets and building energy efficiency code that is tailored to buildings, weather, and utility markets in California.

On the voluntary side, ASHRAE 189.1-2014 outlines that buildings shall contain automatic systems, such as demand limiting or load shifting, that are capable of reducing electric peak demand of the building by not less than ten percent of the projected peak demand. The U.S. Green Building Council (USGBC) included a pilot credit for DR in LEED Version 4 rating system with the requirement of ADR enabled systems.

2.4.6 Demand Response in Appliance Standards and Specifications

The U.S. Environmental Protection Agency's (EPA's) voluntary ENERGY STAR® Program does reward smart grid features for clothes dryers, clothes washers, dishwashers, freezers, refrigerators, pool pumps and room air conditioners. ENERGY STAR gives a five percent allowance, or energy credit, for products that meet "connected criteria" requirements that specify the product can provide feedback on energy consumption, alerts, remote management, interoperability, and DR functionality (see Figure 1). To receive the credit, the product must use an open communication standard developed by any of a number of listed standard-setting entities, including but not limited to the National Institute of Standards and Technology (NIST) and the Smart Grid Interoperability Panel (SGIP). EPA's intent in establishing the DR credit was to help drive near-term, consumer value through the availability of new energy savings and convenience features.

In December 2016, EPA finalized the Version 1.0 ENERGY STAR Connected Thermostat Products specification. This specification is novel in that it grants ENERGY STAR recognition to a product incorporating both hardware and service elements. It also relies on analysis and aggregation of field data from thermostats that are installed and operational in consumers' homes, rather than a laboratory test, to demonstrate that products save energy.

ENERGY STAR Connected Criteria

	Connected Thermostats*	Refrigerators & Freezers	Clothes Washers	Clothes Dryers	Room A/C	Dish-washers	EVSE*	Light Fixtures	Pool Pumps
Energy Consumption Reporting		✓	✓	✓	✓	✓		✓	✓
Operational Status Reporting		✓	✓	✓	✓	✓		✓	✓
Remote Management		✓	✓	✓	✓	✓		✓	✓
Demand Response	✓	✓	✓	✓	✓	✓	✓		✓
Open Access	✓	✓	✓	✓	✓	✓	✓	✓	✓
DR override by Consumers	✓	✓	✓	✓	✓	✓	✓		✓
Connected Capability not Optional	✓								

Figure 1: ENERGY STAR connected criteria

Source: (Environmental Protection Agency 2016)

* Product Specifications still in draft form.

2.5 Compliance and Enforcement

The Statewide CASE Team collected input during the stakeholder outreach process on what compliance and enforcement issues may be associated with these measures. This section summarizes how the proposed code change will modify the code compliance process. Appendix B presents a detailed description of how the proposed code changes could impact various market actors. When developing this proposal, the Statewide CASE Team considered methods to streamline the compliance and enforcement process and how negative impacts on market actors who are involved in the process could be mitigated or reduced.

Improving compliance and enforcement was a key driver of this CASE effort. Throughout the 2013 code cycle and during the first parts of the 2016 code cycle, the utility team has heard numerous comments that the DR requirements are causing confusion and there is suspected non-compliance as a result of this confusion. Table 5 presents the compliance issues that the Statewide CASE Team received with the proposed resolution to each issue.

The Statewide CASE Team gathered input during utility-sponsored stakeholder meetings and from the IOU Compliance Improvement sub-program that works closely with the Energy Commission to address questions about code compliance. In addition, the Statewide CASE Team considered feedback from *The Automated Demand Response in Title 24, Part 6: Stakeholder Outreach Assessment*, an initiative that Pacific Gas and Electric Company (PG&E) led in 2016 and 2017 to gain a better understanding of the level of awareness of the DR requirements in Title 24, Part 6 and to identify stakeholder preferences for outreach communications and trainings (Bruceri, Alxugaray and Pearson 2017).

Table 5: Compliance and Enforcement Issues with Existing DR Requirements and Proposed Resolution for 2019 Code Cycle

Stakeholder Compliance or Enforcement Issue	Statewide CASE Team Proposed Resolution
1) The Energy Commission publishes a list thermostats that comply with JA5, this list is not part of the official documentation in the standards or the compliance manuals, and there appears to be little to no awareness of its existence.	• The compliance manuals do not currently cover material presented in the Reference Appendices to the Standards, including content in JA5. This has caused confusion. The Statewide CASE Team recommends developing audience-appropriate manuals, training materials, and resources to provide further explanation of the requirements in JA5 and the DR acceptance tests. The audience-appropriate material could include adding new content to the existing Compliance Manuals, developing fact sheets, frequently asked questions documents, or updating training materials that the IOUs and others use when delivering Title 24, Part 6 compliance and enforcement trainings. • Update language in JA5 to explain the manufacturer self-certification process. • Recommend adding materials related to compliance with DR requirements to Energy Code Ace.

Stakeholder Compliance or Enforcement Issue	Statewide CASE Team Proposed Resolution
2) Some nonresidential builders/designers think that if they specify a thermostat that is compliant with JA5 that is on the Energy Commission list of approved products list, they are in compliance with all thermostat requirements in Title 24, Part 6 requirements. This is not the case. The list of JA5-compliant thermostatic controls certifies that thermostats meet the DR requirements. If the thermostatic control is used for a nonresidential building, the thermostat must also comply with additional functional requirements that are specified in Section 120.2.	Update language in JA5 to clearly state that thermostats must comply with the applicable requirements in Section 110.2 and 120.2 in addition to the requirements in JA5.
3) The required communication protocols are vague and unclear. For example: • Do OCSTs have to be *certified* to SEP 1.1 or OpenADR2.0? • Is an OCST compliant if it uses OpenADR to the cloud? • What is a "standards-based" messaging protocol?	The Statewide CASE Team has recommended code changes that make the requirements for communications protocols less vague. The recommended requirements are discussed in detail throughout this report.
4) There are many terms that mean the same thing, and it causes confusion. For example, the Standards, Reference Appendices, and compliance documents use the following three terms interchangeably: "total lighting power," "design illuminance," and "full output."	The Statewide CASE Team has reviewed all code language pertaining to DR and recommended simplifications, including eliminating duplicative terms.
5) Some of the terms are not intuitive. For example, JA5 is intended to require that thermostats have DR control capabilities, but JA5-compliant thermostats are called "occupant controlled smart thermostats" instead of something that highlights the key feature of JA5 (i.e., DR capabilities).	The Statewide CASE Team has reviewed all code language pertaining to DR and recommended simplifications to the language, including using more intuitive terminology.
6) What does it mean to be "capable" of ADR, have "enabled" ADR controls, and be "enrolled" in an ADR program?	The Statewide CASE Team intends on recommending definitions to the following terms be added to compliance manuals: • DR-capable: the building has curtailable loads, demand responsive controls are installed, and the controls have been programed/configured to pass the required acceptance tests; • DR-enabled: the connection between the entity that sends the Demand Response Signal and the demand responsive control in the building has been tested and communications have been allowed or "enabled"; and • DR-enrolled: building occupant is enrolled in a DR program.
7) Do the DR lighting control requirements apply to all building types or are any space function types that are excluded, specifically high-rise residential or hotels and motels?	The proposed code language attempts to clarify that the DR lighting requirements apply to all nonresidential building types including high-rise residential and hotel/motel spaces.

Stakeholder Compliance or Enforcement Issue	Statewide CASE Team Proposed Resolution
8) Building inspectors indicated it is difficult to visually determine if thermostats are compliant with JA5. Some stakeholders suggested requiring a standard label indicating compliance.	The Statewide CASE Team did not include this recommendation in the proposal for the 2019 cycle because the intent of this proposal is to clarify existing requirements. A labeling requirement would add a new requirement. This idea could be considered for a future code cycle, and it has been added to the list of potential code changes for a future code cycle, which is presented in Appendix E.
9) At the time the acceptance tests are completed, buildings typically do not have internet access or a utility account; building occupants are not enrolled in DR programs either. Therefore, the acceptance test cannot verify the ability to receive a Demand Response Signal.	This is a known limitation of the existing acceptance tests. The Statewide CASE Team did not recommend revisions to the existing tests for the 2019 code cycle because the intent of this proposal is to clarify existing requirements. Testing that a building control system receives a DR Signal would change the stringency of the standards. This idea could be considered for a future code cycle, and it has been added to the list of potential code changes for a future code cycle, which is presented in Appendix E.
10) Voluntary DR program staff have identified a potential implementation and customer satisfaction challenge regarding the potential for equipment incompatibility. Some thermostatic controls that comply with JA5 do not meet utility program eligibility requirements, meaning that a customer may be required to duplicate the purchase to participate in voluntary DR programs.	Updated language in JA5 to add a note that encourages the entity that specifies thermostats to work with the local utility or DR provider to select a control system that meets their eligibility criteria.
11) Awareness of the term "demand response" and the concept of ADR and demand flexibility appears to remain very low. Unlike energy efficiency programs, awareness of voluntary DR programs is very low.	• Update code language to clarify that the builder must leave operating information for all applicable features—including the building control systems—in the building so they are accessible to the building owner at occupancy. Previously, the language did not explicitly state that information about building control systems must be provided to the building owner. • Recommend that utilities and DR aggregators provide training and/or resources to help identify what DR controls capabilities buildings that Title 24-compliant have and the types of alterations projects trigger compliance with DR requirements. • Recommend utility programs and DR aggregators work with new construction to enroll new buildings in DR programs. • Recommend that utilities consider a new DR incentive program aimed at enrolling newly constructed buildings in DR programs.
12) There remain signs of "code fatigue" experienced by many during the 2013 code cycle transition. Many interviewees expressed their general frustration with the energy code and with the complexity of the current compliance process.	The Statewide CASE Team has recommended revised code language that aims to simplify the code and make the compliance process easier to understand.
13) There is a lack of familiarity with the Acceptance Test Training and Certification Providers (ATTCP) and the supporting infrastructure they have in place to support code.	Recommend updating training materials for ATTCPs so they received the necessary training to complete the DR acceptance tests correctly.

The compliance and enforcement process varies depending on the DR requirements that apply to the project. The following sections describe the process for various building types and building systems.

2.5.1 Compliance and Enforcement Process for Residential Buildings

There are no mandatory requirements for demand responsive controls for residential buildings. However, builders have the option of installing demand responsive thermostatic controls along with other measures instead of opting for compliance with the solar-ready requirements. The key steps to the compliance process for residential buildings are summarized below:

- **Equipment Certification:** Manufacturers of thermostatic controls must certify a declaration to the Energy Commission that devices or systems of devices are compliant with the requirements in JA5. Energy Commission staff review the declaration documents and publish a list of certified thermostats on the Energy Commission website.
- **Design Phase:** If a designer chooses to use demand responsive thermostatic controls to comply with the solar-ready requirements, they must specify the use of a certified thermostat during the design phase. The designer states their intent to use the JA5 option for compliance with the solar-ready requirements when completing the CF1R-SRA-01-E: Solar Ready Buildings New Construction document. The designer should also communicate this intent to the mechanical subcontractor because the mechanical subcontractor is usually responsible for selecting and installing thermostats. The mechanical subcontractor does not look at the CF1R-SRA-01-E document, so it is currently left to the designer to communicate the intent to use of thermostats that comply with JA5. This weakness in the current compliance process could be addressed by training designers (architects or designers for homebuilders) that if they want to take this exception there needs to be a note on the plans for the mechanical subcontractor to select a certified thermostat. Plans examiners could also be trained to look for this note if they see the DR Thermostat exception is specified in the CF1R-SRA-01-E document.
- **Permit Application Phase:** Plans examiner will review design documents.
- **Construction Phase**: The certified demand responsive thermostatic controls are installed during the construction phase. Installing a certified thermostat does not require any specialty training, construction considerations, or commissioning. The construction team is responsible for installing the system. As mentioned above, the mechanical subcontractor is usually responsible for specifying and installing thermostats. The mechanical subcontractor needs to receive instructions from the designer to specify and install certified thermostat.
- **Inspection Phase**: The only requirement in this phase is to confirm that a compliant demand responsive thermostatic control is used.

2.5.2 Compliance and Enforcement Process for Demand Responsive Controls for HVAC in Nonresidential Buildings

Most nonresidential buildings must comply with mandatory requirements for demand responsive controls of HVAC systems. Buildings that have DDC to the zone level are required to complete an acceptance test to validate the control is capable of initiating the required automatic control strategy after receiving a Demand Response Signal. Buildings that do not have DDC to the zone level and have certain types of HVAC systems (not packaged terminal or room systems), must have thermostatic controls that meet the requirements in JA5, but no acceptance test is required to demonstrate compliance. The key steps to the compliance process for nonresidential buildings are summarized below:

- **Equipment Certification:** Manufacturers of demand responsive thermostatic controls must certify a declaration to the Energy Commission that devices or systems of devices are compliant with the requirements in JA5. Energy Commission staff review the declaration documents and publish a list of certified thermostatic controls on the Energy Commission website.
- **Design Phase**: During the design phase, the HVAC designer determines how the building will comply with the demand responsive controls requirements. If the building does not have DDC to the zone level, thermostatic controls that comply with JA5 are required, and the designer

must specify the use of a certified thermostatic control that is on the Energy Commissions list of JA5-comliant products. If the building does have DDC to the zone level, the demand responsive controls must comply with the requirements that are presented in Section 110.X in the proposed language presented in 7.1 of this report. During design review, specifications are reviewed to confirm compliance with the demand responsive control requirements and documented by the NRCC-CXR-02-E: Commissioning Construction Documents and NRCC-MCH-03-E documents. These documents currently include a space to indicate whether there are DR controls for HVAC systems with DDC to the zone level. The document does not currently include space to indicate whether there are DR controls for single-zone HVAC systems where thermostatic controls that comply with JA5 are required. The Statewide CASE Team recommends modifying this document to add a space to indicate the selected thermostatic control for single-zone HVAC systems.

- **Permit Application Phase:** Plans examiner will review design documents and confirm that the design complies with the demand responsive control requirements.
- **Construction Phase**: The demand responsive controls are installed and commissioned during the construction phase. The construction team is responsible for installing the system per the design specifications. Installing thermostatic controls that comply with JA5 does not require any specialty training or construction considerations. In buildings where there is DDC to the zone level, the control system must be programmed/configured to ensure that the controls are operating correctly and so it can automatically implement the control strategy that is tested during the acceptance test (4^{o}F temperature setbacks to non-critical zones). A Field Technician must complete an acceptance test to confirm that the demand responsive control is capable of initiating the appropriate automatic control strategy upon receiving a Demand Response Signal. The field technician completes the NRCA-MCH-11-A: Automatic Demand Shed Control Acceptance document to document a passing score on the acceptance test.
- **Inspection Phase:** If the building does not have DDC to the zone level and thermostatic controls that meet the requirements in JA5 are used to comply, the only requirement in this phase is to confirm compliant thermostatic controls are installed. If the building does require acceptance testing, the building inspector checks the NRCA documents to verify acceptance testing has been performed and the project passes.

2.5.3 Compliance and Enforcement Process for Demand Responsive Controls for Indoor Lighting Controls in Nonresidential Buildings

Nonresidential buildings over 10,000 square feet must comply with mandatory requirements for demand responsive controls for indoor lighting systems. An acceptance test is required to validate the control is capable of initiating the required automatic control strategy after receiving a Demand Response Signal. The key steps to the compliance process for nonresidential buildings are summarized below:

- **Design Phase**: During the design phase, the lighting designer is responsible for ensuring that lighting that is controlled by the demand responsive controls is capable of curtailing power usage (or light levels) by 15 percent or more. The designer is also responsible for specifying demand responsive controls that meet the code requirements. The design team documents intent to comply with demand responsive control requirements in the NRCC-LTI-02 document and other lighting design documents.
- **Permit Application Phase:** Plans examiner will review design documents and confirm that the design complies with the demand responsive control requirements.
- **Construction Phase**: The lighting system, which can curtail load, and the demand responsive controls are installed and commissioned during the construction phase. The controls must be programmed/configured so the system can automatically implement the control strategy that is tested during the acceptance test. A certified Acceptance Test Technician (ATT) will conduct functional performance testing on the control system to complete required acceptance tests and

the commissioning process. The ATT completes the NRCA-LTI-04-A: Demand Responsive Lighting Control Acceptance Test Document to document a passing score on the acceptance test.

- **Inspection Phase:** The building inspector confirms acceptance tests were completed by reviewing the NRCA documents during inspection.

2.5.4 Compliance and Enforcement Process for Demand Responsive Controls for Electronic Messaging Centers

Electronic Message Centers (EMC) having a new connected lighting power load greater than 15 kW must comply with mandatory requirements for demand responsive controls. The key steps to the compliance process for nonresidential buildings are summarized below:

- **Design Phase**: During the design phase, the lighting designer is responsible for ensuring that the lighting control system is capable of curtailing power usage by 30 percent or more. The designer is also responsible for specifying demand responsive controls that meet the code requirements. The design team documents intent to comply with demand responsive control requirements in the NRCC-LTS-01-E: Sign Lighting document.
- **Permit Application Phase:** Plans examiner will review design documents and confirm that the design complies with the demand responsive control requirements.
- **Construction Phase**: The sign lighting and control system are installed and commissioned during the construction phase. The construction team is responsible for installing the system per the design specifications.
- **Inspection Phase:** Building inspector confirms the appropriate equipment and controls have been installed.

If this code change proposal is adopted, the Statewide CASE Team recommends that information presented in this section, Section 3 and Appendix B be used to develop a plan that identifies a process to develop compliance documentation and how to minimize barriers to compliance.

3. Market Analysis

The Statewide CASE Team performed a market analysis with the goals of identifying current technology availability, current product availability, and market trends. The Statewide CASE Team considered how the proposed standard may impact the market in general and individual market actors. The Statewide CASE Team gathered information about the incremental cost of complying with the proposed measure. Estimates of market size and measure applicability were identified through research and outreach with stakeholders including utility program staff, Energy Commission staff, and a wide range of industry players who were invited to participate in utility-sponsored stakeholder meetings held on October 11, 2016 and March 28, 2017.

3.1 Market Structure

The California DR marketplace consists of three types of participants – market administrators, third-party providers, and utility customers. The wholesale market administrator is the CAISO, while IOUs and a number of municipal utilities administer retail markets. Each administrator maintains a variety of DR programs that can vary by utility territory or customer size, type, or end-use.

California IOUs also offer DR programs in which customers can participate using third-party aggregators. The California Public Utility Commission Electric Rule 24 extended this option to CAISO programs, allowing customers to enroll with third-party Demand Response Providers (DRPs) for bidding directly into the wholesale electricity market. Third-party providers include companies such as

EnerNOC, Cpower, OhmConnect, Stem, AutoGrid, Chai, Electric Motor Werks, Weather Bug, IPKeys, Siemens, and THG. DR Aggregators and DRPs are responsible for delivering an agreed-upon kW load shed to utilities when dispatched and in return have the flexibility to design their own DR programs for customers. Third-party providers often offer services to customers beyond financial compensation for participation in DR programs.

Customers of every type and market sector participate in DR programs in California, including residential, multifamily, commercial, industrial, and agricultural customers of every size. Despite the availability of DR programs, understanding and communicating the benefits of DR participation can be difficult, and enrollment for utilities and third-party providers can be a challenge. Traditional DR can compromise occupant comfort or standard business operations. Mandatory building codes that require demand responsive controls can increase the uptake of DR technology adoption and lower costs, thereby encouraging more cost-effective and greater levels of automated grid transactions in buildings. Additionally, mandatory standards can provide clear guidance to builders, engineers, contractors, and others as they design and build systems subject to DR requirements.

Beyond market participants, a wide variety of manufacturers, contractors, and organizations play an integral role in the DR landscape. The variety of commercially-available DR-capable products continues to grow, and includes everything from integrated building management systems to controller gateways to connected devices including thermostats and appliances.

3.2 Technical Feasibility, Market Availability, and Current Practices

3.2.1 Customer Participation in Demand Response

DR can be initiated at customer sites in one of several ways: manually, semi-automated, and fully-automated (see Figure 2). Manual DR requires the greatest amount of customer effort and involvement. A utility representative places a phone call, email, text or paging message to the customer contact at the facility. The customer manually turns off individual pieces of energy consuming equipment per a load shed action plan throughout the facility or property. Specifically, this could involve turning of individual light switches, changing setpoints of individual thermostats, and turning off other non-critical equipment such as outdoor signage, vending machines, escalators, or pumps. One issue with this type of DR is that the customer receiving the event message, often the building engineer or operator, does not respond, or responds inconsistently to the demand reduction request for one reason or another.

In semi-automated DR, HVAC, lighting and other equipment targeted for load reduction are connected to an EMCS. The utility customer’s specific load reduction strategies, such as light level reduction or temperature setpoint reset, are pre-programmed into the EMCS. The customer contact receives a phone call, email, text or paging message for a DR event. The contact carries out the load shed throughout the facility by initiating the DR command from the central EMCS. Semi-automated DR is a significant reduction in effort and time by the facility operator because the load shed actions are pre-programmed and can be initiated through a single command from the central EMCS. However, it still requires that the operator is available to receive the DR event communication from the utility and initiate the reduction strategies.

In automated DR (ADR), communications equipment in the form of gateways (also known as virtual end nodes [VENs]) are installed in facilities to receive notification of DR events. The VEN(s)[2] then communicate to a control system[3] that in turn automatically initiates the pre-programmed DR load shed strategies. Customer intervention is not required; however, email, phone or text communication is often sent in parallel to the event notification to the VEN. This is typically so that the operator has the option to override the event, if other priorities require that equipment targeted for shut down continue to operate. Note that ADR differs from direct load control programs, where the technologies allow customer equipment such as air conditioners to be directly shutoff, remotely. In ADR, the signal is a communication or notification that a DR event is either: 1) a request to modify electricity consumption or 2) notification of a change in electricity price. Effectively, it communicates that a DR event is occurring or about to occur. Customers retain full control to decide how facility controls will change equipment operation to modify their electricity consumption.

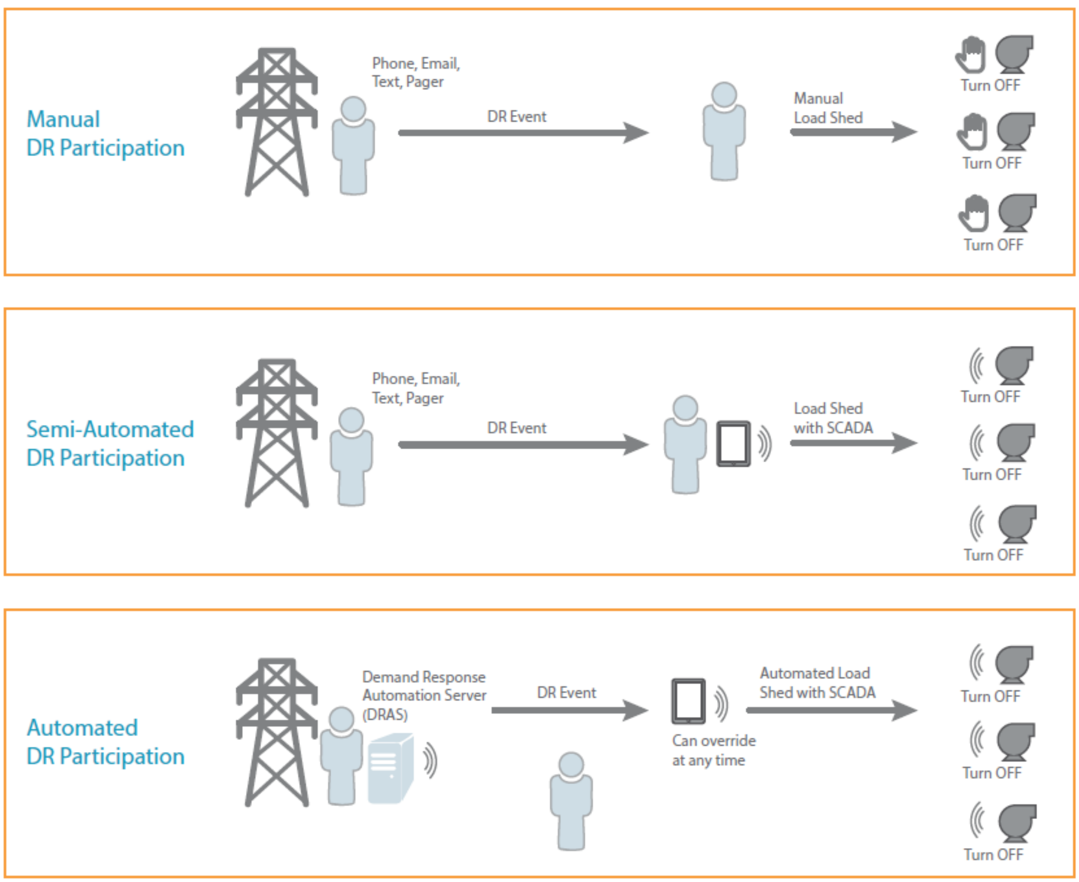

Figure 2: Illustration of manual, semi-auto, and auto-demand response

The current Title 24, Part 6 language requires lighting and HVAC controls in new construction and alterations to be ADR-*capable*. That is, the standards require that energy controls be *capable* of receiving a communications signal for ADR and have the capability to automatically reduce lighting

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[2] There can be more than one VEN per building. There can also be more than one VEN for the lighting and/or HVAC system controls. For example, each thermostat can have its own VEN.

[3] The control system connected to the VEN can be a stand-alone lighting or HVAC control system or an EMCS.

power or adjust temperature setback if an ADR signal is received. However, it does not require that the DR controls to be *enabled*, meaning the communication pathway between the signaler and the control does not need to be intact, nor does the code require that customers *enroll* in DR programs in order to participate in DR events. A building that is compliant with Title 24, Part 6 has the energy controls that are necessary to participate in DR events, but to carry out ADR, customers must *enroll* in a DR program and *enable* the equipment's capabilities, through programming and end-to-end signal testing with the utility during commissioning. Customers who choose to enroll in a DR program can choose between different levels of DR load reduction among different programs.

3.2.2 Current Control Strategies for Demand Response: Lighting

There are three main DR strategies for lighting in non-residential facilities: 1) dimming; 2) non-essential lighting shutoff; and 3) partial shutoff. All three are dependent on the lighting technology and facility layout. Lighting fixtures with dimmable ballasts can sometimes be found in office spaces, for instance, and allow for load shed while maintaining sufficient lighting in all occupied areas. Retail facilities may have non-essential accent or decorative lighting that can be turned off during an event. Warehouses and box stores tend to have high-bay lighting fixtures on different circuits – shutting off one of a facility's multiple lighting circuits such that high-bay fixtures are turned off in a "checkerboard pattern" may allow for significant load reduction while maintaining acceptable lighting levels in the facility. This would not be an effective tactic in facilities where each fixture is closer to building occupants and the shutoff of any one fixture could prevent a building occupant from utilizing the space.

A number of automated DR device manufacturers have developed products designed to either integrate with existing lighting control systems or establish new lighting control capabilities. These include Acuity, Daintree, Enlighted, and Exergy.

3.2.3 Current Control Strategies for Demand Response: HVAC

HVAC equipment in commercial facilities largely fall into categories: packaged rooftop units (RTUs) and engineered systems or central chiller plants. Available control options differ for each equipment type. This means that available control strategies for DR also differ by equipment type. This section discusses each category in greater detail.

3.2.3.1 Packaged Rooftop Units

RTUs are the most common type of HVAC equipment in the market. Equipment sizes range from five tons to over 100 tons of cooling capacity. They are "packaged" units, because all the main air conditioning components are enclosed in a single casing or unit. They are installed equally in new construction and retrofit projects. Typical controls for RTU equipment consist of thermostats only. Most RTUs do not have advanced controls.

Figure 3: Illustration of a packaged rooftop air conditioning unit

With basic thermostat controls, common DR strategies include temperature reset and pre-cooling. When the temperature is set above the cooling setpoint for DR, the RTU effectively turns off. Pre-cooling is a dynamic form of load shifting. The space is first cooled below the typical cooling setpoint a few hours before the DR period, and then the RTU's cooling setpoint is set to a higher temperature, thus limiting its operations during the DR period. Sophisticated DR strategies require more sophisticated controls, potentially with more advanced RTU equipment. More powerful or intelligent control systems can be installed on new construction, or retrofitted on existing construction to allow additional types of DR strategies. These include automated shut-off of units, cycling or intermittent shutoff, or turning down variable speed compressors or fans in the RTU. In lieu of variable speed, larger high efficiency RTUs often have multi-stage compressors, and one of the stages can be turned off during a DR event.

3.2.3.2 Chillers and Engineered Systems

Chillers are engineered systems that require engineered plans to deliver cooling to a space. Chillers are either air-cooled or water-cooled, which means they use water-driven cooling towers to reject heat. Air-cooled chillers are used to meet cooling loads from 80 tons to several hundred tons. Water-cooled chillers are used to meet cooling loads from 150 tons to 500 tons. Larger sizes in the thousands of tons are possible, by installing multiple chillers in central plants serving multiple buildings on a campus.

There are four common subcategories of chillers: scroll, centrifugal, screw driven, and absorption chillers. Chillers have many options that need to be specified to meet specific needs for a site. Chillers designed at a certain tonnage can have different sized condensers, evaporators and even compressors. They also can have different motor efficiencies and a different number of passes through the condenser and evaporator. Auxiliary equipment and systems, in the form of air handlers, water towers, pumps, and controls also must be included and designed.

Given this complexity, chillers require sophisticated controls. The relative sophistication of chiller systems also offer a larger field of strategy options for DR. In addition to the strategies used by RTUs, chillers can reset chilled water temperatures, or cycle fans. In variable air volume air handling systems, fan pressure or speed can be limited. Because components of a chiller system interact in a complex way, extra care must be taken to ensure that one control action does not result in a compensating control action elsewhere in the system. For example, raising chilled water temperature can cause the fans to run faster to try to maintain cooling. Increased fan power would negate the effect of chilled water temperature reset for DR. For chiller systems, it is critical that qualified control experts with knowledge and experience program controls carefully for DR, to mitigate unintended interactive effects between chiller components.

A survey from a 2006 Title 24, Part 6 CASE Report on the DDC to the zone level indicated that roughly 90 to 95 percent of the new construction market by building utilizes systems with DDC to zone level (Hydeman 2006). A study by the Energy Information Administration (EIA), suggests that 50 to 70 percent of buildings greater than 100,000 square feet, contain an EMCS (which is a good indicator for DDC to the zone level, see Figure 4).

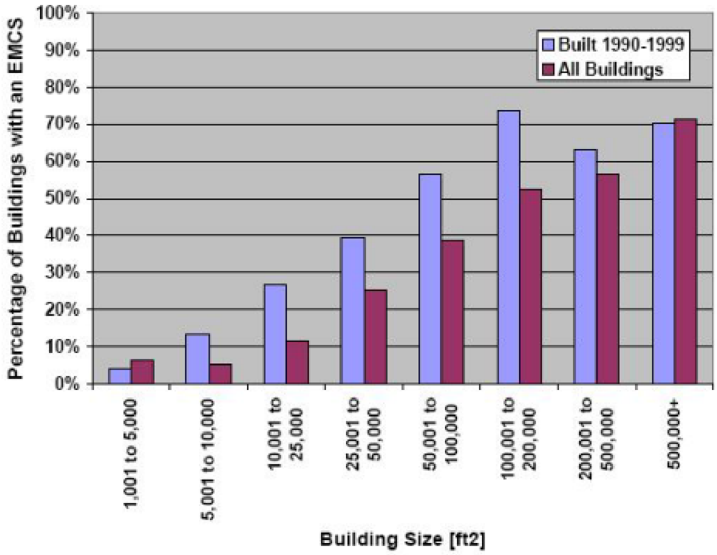

Figure 4: Percent of buildings with an EMCS by square footage

Source: (Hydeman 2006)

3.2.3.3 Mixed HVAC Systems

Many buildings, particularly those with larger square footage, are divided into different use types. For example, one building may have a retail floor or section, banking section, and office section. Each may have a separate leasing contract with a single building owner. This can lead to facilities with mixed HVAC systems, including a combination of RTUs and chillers. DR strategies in these situations are still tied to the particular HVAC equipment present and depend on the available controls associated with the HVAC equipment.

3.2.4 Communication Protocols

For DR controls to function properly, information must be exchanged between the entity that initiates the DR signal and the building control system. To facilitate successful communication the signaler and the building control use the same information exchange models (also called communications protocols) to send and receive information. The information exchange model can be thought of as a language; the signaler and the building control system need to speak the same language for the control strategy to be implemented effectively. The communication protocols specify packets of information to be sent, such as event status, event starts, event end, override, supersession, and event cancel. Different protocols vary in the richness of functions they can support. Advanced functions include two-way communications between sender and recipient, remote device telemetry data (temperature setpoint or HVAC runtime) and remote programming capabilities. In California, ADR communications between a facility and the IOUs and SMUD use OpenADR, an internet-based protocol. Proprietary communication protocols also exist on the market. These protocols are developed by controls manufacturers such as Automatic Logic Corporation, Johnson Controls, and Honeywell. Proprietary protocols can offer even richer sets of functions to serve additional and specific needs of their customers.

OpenADR was developed by Lawrence Berkeley National Laboratory (LBNL) initially in 2002, with funding from the Energy Commission Public Interest Energy Research Program. LBNL describes OpenADR as “a communications data model designed to facilitate sending and receiving DR signals from a utility or independent system operator to electric customers. The OpenADR specification is a highly flexible infrastructure design to facilitate common information exchange between a utility or Independent System Operator (ISO) and their end-use participants. The concept of an open specification is intended to allow anyone to implement the signaling systems, providing the automation server or the automation clients," (OpenADR Alliance 2011b). Improvements were made continuously to the protocol over time, and in 2010 the OpenADR Alliance was formed by industry stakeholders "to support the development, testing, and deployment of commercial OpenADR and facilitates its acceleration and widespread adoption," (OpenADR Alliance n.d.).

OpenADR is adopted by all three California IOUs and SMUD for ADR. The IOU customers must adopt technology solutions that use OpenADR to be eligible for enabling technology incentives. Many municipal utilities in California do not yet have DR programs. With their smaller territories, most municipal utilities have used DR for reliability purposes using traditional methods, such as calling their largest customers and requesting that they voluntarily reduce load.

See Appendix B for further discussion on communications protocols in use today and for proposed communications requirements.

Oftentimes, control systems within a facility are composed of multiple devices that must communicate information for the control system to work effectively. Typically, separate protocols are used for controls to communicate within a facility. Communications within a facility typically use a wireless local area network with protocols such as ZigBee, Wi-Fi, or BACnet. Communications between devices in a facility can also be wired (i.e., hard-wiring or through Ethernet).

The communications protocols referenced in this report and in the proposed standards are listed in Table 6 along with the industry consensus standard upon which the communication protocol is based.

Table 6: Communication Protocols and Associated Standards

Communication Protocol	Standard Upon Which Communication Protocol is Based
OpenADR	OpenADR 2.0 Profile Specification A Profile: Revision 1.0 (OpenADR Alliance 2011a) OpenADR 2.0 Profile Specification B Profile: Revision 1.1 (OpenADR Alliance 2015)
BACnet	ISO 16484-5:2017 (ASHRAE): Building automation and control systems (BACS) -- Part 5: Data communication protocol (International Organization for Standardization 2017)
Ethernet	IEEE 801.3-2015: IEEE Standard for Ethernet (IEEE Standards Association 2015)
WiFi	IEEE 802.11: IEEE Standard for Information technology— Telecommunications and information exchange between systems Local and metropolitan area networks—Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications (IEEE Standards Association 2016)
ZigBee	IEEE 802.15-4: IEEE Standard for Low-Rate Wireless Networks (IEEE Standards Association 2015)

3.2.4.1 Communication Signal Pathways

The ADR environment in California, in which hardware or software devices are installed in customer facilities and dispatched for participation in DR events by utilities or third-party providers, is currently a complex mix of technologies, communications methods, and protocols. The OpenADR Alliance, the primary open-standard protocol used in the California market, utilizes an OASIS Energy Interoperation taxonomy that defines two types of communications entities – virtual top nodes (VTNs) and virtual end nodes (VENs). VTNs are information exchange servers typically operated by utilities or third-party providers and can dispatch events. VENs are the recipients of DR payloads and are typically the gateway or end-use devices installed at customer facilities throughout a dispatcher's territory. The definition can be somewhat fluid, as a third-party DR aggregator may have a server operating as both a VTN and VEN – receiving event payloads from a utility and dispatching event payloads to customers. Figure 5 from the OpenADR Alliance shows one way utilities and DR aggregators use VTNs and VENs to communicate DR events to customers, regardless of whether they use the open-source OpenADR protocol or a proprietary communications language. There are many other possible configurations of communication between the entity that initiates the DR signal and the end load. Transmission of DR payload information occurs over the internet or via cellular communication – the latter is often used by customers with end-use devices such as agricultural pumps that are unlikely to have internet connection.

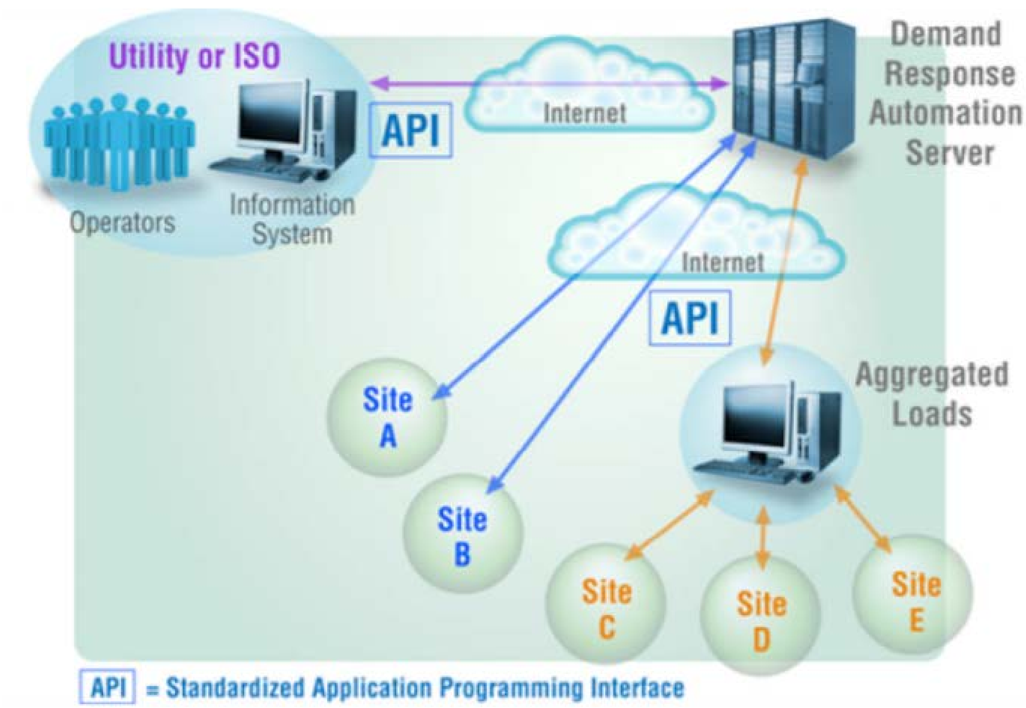

Figure 5: Schematic of DR event signaling pathways from utility or ISO to site (blue and orange)

Source: (OpenADR Alliance 2011b)

The communications infrastructure for a customer varies depending on the communications pathway used. While utilities have historically dispatched DR events system-wide, over the last few years DR in California has moved towards a more targeted approach in which particular regions, distribution nodes, or even individual resources could be called in an event. Older VEN technology required customers to install one VEN device per resource, but the development of the OpenADR 2.0 profile allows a single VEN gateway to parse a complex event payload and trigger load shed at the appropriate resources dispatched by the utility or third-party provider. This allows a customer with multiple facilities, such as a retail chain, to more easily participate in ADR across its building portfolio.

If VTNs and VENs are able to communicate using either OpenADR or a proprietary protocol, the information exchange between the VEN and the controllers used to activate load shed at a customer's facility vary even further. VENs can be hardware gateways connected directly to a building control system via dry contact relays or another building protocol such as Modbus or BACnet. They can also connect with facility controllers using DDC, Wi-Fi, or ZigBee radios. VENs can also be a piece of software running on a computer or server. VENs can even be entirely cloud-based, connecting a utility or third-party VTN server with a customer's existing cloud-based controls platform. Establishing VTN-to-VEN connectivity is a technology challenge for many customers, but the variety of technical options means a solution can be found for most customers.

The network of VTNs, VENs, and connected devices can be complex for a large utility and the effectiveness of DR programs is predicated upon successful transmission of event information to customers. To ensure the entire network is connected and configured for events, utilities typically require multiple levels of signal testing. First, customers installing ADR equipment – particularly equipment incentivized by a utility rebate – are often required to conduct a load shed test of their equipment that tests the VTN-to-VEN link to ensure that their facility would receive a signal payload during a DR season event and shed load accordingly. In addition to individual customer testing, utilities also typically undergo a slate of end-to-end signal tests at least once a year. Event scenarios are developed that mimic the expected use cases of the upcoming season and test out any changes made to the VTN or payload since the previous season, and tests are scheduled to guarantee that when the DR season begins real events will be dispatched, transmitted, and responded to correctly. Each utility has its own requirements and designs its testing regimen accordingly.

3.3 Market Trends in Demand Response

As DR technology evolves, more and more cloud-based solutions are becoming commercially available. Cloud-based products have several advantages, such as offering facility managers remote insight and control into facility operations and leveraging advanced functionality across multi-site portfolios. The data collection and analysis enabled by the cloud allow manufacturers and service providers to develop innovative offerings such as ongoing maintenance, fault detection, and the ability to identify energy savings opportunities – this helps improve the value proposition of DR technologies. Cloud-based controls also help provide underserved small and medium customers more affordable DR control systems.

3.3.1 Demand Responsive Thermostatic Controls

Keeping device intelligence and enhanced functionalities in the cloud allows the cost to be shared by all users. Thermostats with cloud-based intelligence, as with other cloud-based devices, commonly require users to pay a monthly or annual subscription to access the additional and enhanced features of the cloud. The cost covers primarily data storage, so that customers can view historical operations (e.g., settings) and other metrics (e.g., run time). A limited number of manufacturers offer cloud access free of charge, but only maintain data storage for hours to several days.

The current Title 24, Part 6 JA5 requirements are written as if every thermostat individually must meet every requirement. If every thermostat complies with the JA5 requirements individually, every thermostat must be able to receive a Demand Response Signal, and every thermostat must have the logic embedded to automatically respond to the signal by adjusting the temperature setpoints within the HVAC zone that the thermostat controls. In practice, it is more common for Demand Response Signals to be sent from the utility's server to the thermostatic control system's cloud server. The cloud server then either disseminates the signal to each connected thermostat or initiates the control strategy for the thermostatic control system. Although there is a footnote in JA5 (footnote 1) that speaks to how "networked systems of devices" can comply with the JA5 requirements if the networked system of devices meet requirements in JA5 when considered as a whole, the language in the footnote is vague and it is unclear how this footnote is supposed to apply to systems that use a gateway or systems that are cloud-based. At the time JA5 was developed, the cloud-based systems that are common today were not yet available.

While keeping the price point low by using cloud-based services offers enhanced functionalities for users, there are some drawbacks for the utilities. The signal from the utility server to the manufacturer's cloud-based VEN server uses OpenADR, and the signal from the cloud-based VEN to the thermostats uses proprietary communications protocols. Individual thermostats cannot process OpenADR signals from the utility server, so there is now way to the utility to communicate directly with connected thermostats. One link in the communication path uses proprietary protocols. If a customer ends their cloud contract or if the manufacturer goes out of business, the utility is left with stranded assets. Despite some of the draw-backs of thermostatic control systems that use cloud-based VENs, at the time of writing, the cloud-based configuration seems to be gaining market share. A couple manufacturers such as Ecobee and Venstar offer the option of direct communication from the utility server to the thermostat using OpenADR, but the product loses the enhanced capabilities offered through the cloud. Considering current market trends, the Statewide CASE Team proposes that demand responsive thermostatic controls be allowed to use cloud-based VENs.

Thermostat systems must have an OpenADR 2.0-certified VEN to participate in utility DR programs. The current JA5 requirements require JA5-compliant thermostats to be *compliant* with OpenADR 2.0, but they do not need to be OpenADR *certified*. Currently, Ecobee is the only manufacturer on the Energy Commission's list of certified JA5-compliant thermostats that is also OpenADR certified and therefore eligible for California smart thermostat incentives, however it is not supported for commercial programs. The other thermostats on the list of JA5-compliant products are not OpenADR certified. This means that customers moving in new buildings who later decide they want to participate in a utility DR program may have to replace their potentially brand new thermostat with an eligible DR program thermostat. One of the key reasons for pursuing this CASE effort is to bridge the gap between Title 24, Part 6 code compliance and DR programs and address discrepancies like this one. The Statewide CASE Team recommends resolving this issue by updating JA5 to require that demand responsive thermostatic controls have a VEN that is OpenADR 2.0 certified and allow that the VEN can be located in the cloud. The revision will allow more DR thermostats to be compliant with Title 24, Part 6 requirement while meeting utility program eligibility requirements.

3.3.2 Interoperability Between Demand Responsive Controls for Lighting and HVAC Systems

Currently, buildings over 10,000 square feet must have automatic demand responsive controls for both lighting and HVAC systems. It is common construction practice that the lighting system and the HVAC system are two separate systems, usually provided by different manufacturers. Lighting controls are typically supplied by the same manufacturer that provides the lighting equipment. Similarly, RTUs and controls for RTUs are typically provided by the same manufacturer. In large facilities, however, the chiller manufacturer and the EMCS manufacturer are separate entities. Furthermore, these control systems operate independently and commonly do not need to communicate with each other.

A facility that wishes to dim lights and reset temperatures issues separate and parallel communications to each system. This is sufficient from a code compliance standpoint, and is the least-cost compliance solution for the facility owner. Integration of DR controls for lighting and HVAC requires additional programming, configuration, and commissioning – which adds costs that can be significant depending on the type of controls installed and the size of the facility.

With integration, the objective is to send a single DR signal to the facility that would then be relayed to the lighting and HVAC systems. For smaller facilities, additional hardware in the form of an external communications gateway would be necessary to integrate the systems. For large facilities, EMCS can be upgraded to include additional control points for the lighting system, plus the installation of a communications gateway and additional programming. Some stakeholders have provided feedback that controls manufacturers/service providers prefer to have control over every link of the communication and control pathway so they can troubleshoot and resolve issues relatively quickly and thereby maintain a positive user experience. Unless the same entity provides both the lighting and HVAC controls, which is not common especially in buildings with more complex lighting and HVAC controls, integrating the controls can result in one or both controls providers losing control of steps along the communication and control pathway. When controls are integrated, multiple entities must work collaboratively to resolve issues, which can be both timely and expensive. For this reason, there are concerns that although one would think integrating controls would improve the user experience and reduce cost, it could have the opposite effect. If the same entity provides both the lighting and HVAC controls, integrating the systems can be beneficial to the building occupant.

3.3.3 Moving to Greater Demand Flexibility

One major change in California's DR landscape over the next several years will likely be a move away from traditional system-wide peak load shed as the primary form of DR. Historically, peak load shed has been a cost-effective way of deferring capacity investments, but due to the rise of renewables (primarily solar) California's challenges are less in guaranteeing sufficient generation capacity than in managing new load shapes and grid balancing. The "duck curve" and its increasingly steep ramping period in the late afternoon is a new challenge for the California grid and a new opportunity for DR. Wholesale and retail programs that incentivize customers to shift load on an hour-to-hour or day-to-day basis, influence load shaping (such as time-of-use programs and Critical Peak Pricing), and activate fast-responding variable resources have the potential to drastically change the way DR is dispatched and valued by both utilities and customers. More frequent events with shorter durations and lower shed levels have changed the idea of DR from one of distinct emergency event intended to prevent blackouts to that of an ongoing process for maintaining grid health and promoting renewable generation. This may help mitigate historical customer comfort issues as events become less noticeable to facility occupants, but could produce a new set of challenges.

3.3.4 Voluntary Programs

In California, utilities offer a portfolio of electric DR programs for its customers. These programs provide financial incentives and other benefits to participating customers for reducing their energy usage during times of peak demand. DR programs in California began in the 1990s for emergency-triggered events, but they proliferated since 2003 when the Energy Commission placed DR second on the list after energy efficiency at the top of California's loading order as a preferred resource to avoid nonrenewable energy generation. In 2003 the California Public Utilities Commission set the goal of meeting five percent of the system's annual peak energy demand through DR programs by 2007. However, there are significant knowledge gaps between customers and the utilities' DR programs that has prevented greater uptake of DR practices. Understanding and communicating the benefits of DR participation can be difficult and enrollment for utilities and third-party providers can be a challenge. Traditional DR strategies can compromise occupant comfort or standard business operations.

3.4 Market Impacts and Economic Assessments

3.4.1 Impact on Builders

The proposed code change is not modifying any of the code requirements, so there are no anticipated macro-level market impacts, including impacts on builders.

3.4.2 Impact on Building Designers and Energy Consultants

Adjusting design practices to comply with changing building codes practices is within the normal practices of building designers. Building codes (including the California Building code and model national building codes published by the International Code Council, the International Association of Plumbing and Mechanical Officials and ASHRAE) are typically updated on a three-year revision cycles. As discussed in Section 3.4.1 the building industry, including building designers and energy consultants, should (and do) plan for training and education that may be required to adjusting design practices to accommodate compliance with new building codes. As a whole, the measures the Statewide CASE Team is proposing for the 2019 code cycle aim to provide designers and energy consultants with opportunities to comply with code requirements in multiple ways, thereby providing flexibility in how requirements can be met.

This proposed code change is primarily a cleanup measure. It does not recommend new requirements, so the impacts on building designers and energy consultants will be minimal. Designers and the controls contractors who specify the DR controls systems will need to learn how to identify OpenADR certified VENs, which is a small change that is not expected to impact workflow. See Appendix B for a further discussion on how the proposed revisions might impact various market actors including designers.

3.4.3 Impact on Occupational Safety and Health

The proposed code change does not alter any existing federal, state, or local regulations pertaining to safety and health, including rules enforced by the California Division of Occupational Safety and Health. All existing health and safety rules will remain in place. Complying with the proposed code change is not anticipated to have adverse impacts on the safety or health of occupants or those involved with the construction, commissioning, and maintenance of the building.

3.4.4 Impact on Building Owners and Occupants (Including Homeowners and Potential First-Time Homeowners)

The proposed code change will clarify the code requirements with the intent of increasing the understanding of DR requirements that will lead to an uptake of DR program participation by building owners. Greater participation in DR programs will benefit occupants by reducing energy bills.

3.4.5 Impact on Building Component Retailers (Including Manufacturers and Distributors)

The proposed code change is not introducing new requirements; the intent is to clarify existing requirements. Control manufacturers and service provers will need to make certain they certify VENs to OpenADR, if they have not been doing so already. Manufacturers of demand responsive thermostatic controls will also need to make certain to certify products to the Energy Commission, if they have not been doing so already.

3.4.6 Impact on Building Inspectors

The proposed code change is not modifying any of the code requirements, so there are no anticipated impacts on building inspectors significantly.

3.4.7 Impact on Statewide Employment

The proposed code change is not modifying any of the code requirements, so there are no anticipated impacts on statewide employment.

3.5 Economic Impacts

The proposed code change is not modifying any of the code requirements, so there are no anticipated economic impacts including impacts on:

- Creation or elimination of jobs
- Creation or elimination of businesses in California
- Competitive advantages or disadvantages for businesses in California
- Increase or decrease of investments in the state of California
- Effects on the state General Fund, state special funds, or local government funds
- Cost of enforcement to the state or local governments
- Specific persons

4. ENERGY SAVINGS

The code change proposal will not modify the stringency of the existing building standards related to DR or add new DR requirements. Thus, Sections 4, 5, and 6, which typically present analysis on the lifecycle cost-effectiveness and the energy impacts of the proposed code change, will not be completed for this DR Cleanup CASE Report. Although this measure does not result in electricity or gas savings, the measure will promote:

- Better comprehension of DR requirements by implementers
- Enhanced compliance and enforcement for DR in buildings
- Building readiness for enrollment in DR programs and events

All these outcomes will result in higher participation in DR programs and increased grid reliability.

5. LIFECYCLE COST AND COST-EFFECTIVENESS

The code change proposal will not modify the stringency of the existing building standards related to DR or add new DR requirements. Thus, Sections 4, 5, and 6, which typically present analysis on the lifecycle cost-effectiveness and the energy impacts of the proposed code change, will not be completed for this DR Cleanup CASE Report. Although this measure does not result in electricity or gas savings, the measure will promote:

- Better comprehension of DR requirements by implementers
- Enhanced compliance and enforcement for DR in buildings
- Building readiness for enrollment in DR programs and events

All these outcomes will result in higher participation in DR programs and increased grid reliability.

6. FIRST YEAR STATEWIDE IMPACTS

The code change proposal will not modify the stringency of the existing building standards related to DR or add new DR requirements. Thus, Sections 4, 5, and 6, which typically present analysis on the lifecycle cost-effectiveness and the energy impacts of the proposed code change, will not be completed for this DR Cleanup CASE Report. Although this measure does not result in electricity or gas savings, the measure will promote:

- Better comprehension of DR requirements by implementers
- Enhanced compliance and enforcement for DR in buildings
- Building readiness for enrollment in DR programs and events

All these outcomes will result in higher participation in DR programs and increased grid reliability.

7. PROPOSED REVISIONS TO CODE LANGUAGE

The proposed changes to the Standards, Reference Appendices, and the ACM Reference Manuals are provided below. Changes to the 2016 documents are marked with <u>underlining</u> (new language) and ~~strikethroughs~~ (deletions). Text that is highlighted in gray has been moved from another section of the 2016 Standards to the new proposed location. The gray text will appear in the proposed location for the 2019 Standards (in Section 110.X or 110.Y). If the gray text does not have underlining or strikeouts, no changes to the 2016 language have been proposed apart from moving the language to the new section. If revisions are recommended in addition to moving the language, the proposed revisions to the 2016 language are marked with strikethroughs and underlining. Language that has strikethroughs and is highlighted in ~~turquoise~~ has been moved from the existing section to either section 110.X or 110.Y. The turquoise strikeouts will appear where the language resides in the 2016 Standards.

7.1 Standards

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

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

1. **Compliance information.**

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

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

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

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

SECTION 100.1 – DEFINITIONS AND RULES OF CONSTRUCTION

AUTOMATIC CONTROL SYSTEM is a device or system capable of automatically adjusting loads without manual intervention.

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

a. changes in the price of electricity; or

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

   i. in response to wholesale market prices, or

   ii. when system reliability is jeopardized.

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

DEMAND RESPONSE SIGNAL is a signal sent by the local utility, Independent System Operator (ISO), or designated curtailment service provider or aggregator, to a customer, indicating a price or a request to modify electricity consumption, for a limited time period.

DEMAND RESPONSIVE CONTROL is an automatic control system a kind of control that is capable of receiving and automatically responding to a Ddemand Rresponse Ssignal and automatically initiating a control strategy.

ENERGY MANAGEMENT CONTROL SYSTEM (EMCS) is a computerized automatic control system designed to that regulates the energy consumption of a building by controlling the operation of energy consuming systems such as the heating, ventilation and air conditioning (HVAC), lighting, and water heating systems, and is capable of monitoring environmental and system loads, and adjusting HVAC operations in order to optimize energy usage and respond to demand response signals.

ENERGY MANAGEMENT CONTROL SYSTEM (EMCS) is a computerized control system designed to

LIGHTING definitions: *[several definitions omitted]*

DESIGN FULL OUTPUT is the power level of the controlled luminaires after all associated controls have been installed, commissioned and calibrated.

OPENADR 2.0a is the OpenADR Alliance document titled, "OpenADR 2.0 Profile Specification A Profile," 2011.

OPENADR 2.0b is the OpenADR Alliance document titled, "OpenADR 2.0 Profile Specification B Profile," 2015.

VIRTUAL END NODE (VEN) is an interface with a demand responsive control system that accepts signals transmitted through OpenADR.

SIGN definitions include the following:

ELECTRONIC MESSAGE CENTER (EMC) is a pixilated image producing electronically controlled sign formed by any light source. Bare lamps used to create linear lighting animation sequences through the use of chaser circuits, also known as "chaser lights" are not considered an EMC.

THERMOSTAT is an automatic control device or system used to maintain temperature at a fixed or adjustable setpoint.

THERMOSTATIC CONTROL is an automatic device or system used to maintain temperature at a fixed or adjustable setpoint.

SECTION 110.2 – MANDATORY REQUIREMENTS FOR SPACE- CONDITIONING EQUIPMENT

(b) **Controls for Heat Pumps with Supplementary Electric Resistance Heaters.** Heat pumps with supplementary electric resistance heaters shall have controls:

1. That prevent supplementary heater operation when the heating load can be met by the heat pump alone; and
2. In which the cut-on temperature for compression heating is higher than the cut-on temperature for supplementary heating, and the cut-off temperature for compression heating is higher than the cut-off temperature for supplementary heating.

EXCEPTION 1 to Section 110.2(b): The controls may allow supplementary heater operation during:

A. Defrost; and

B. Transient periods such as start-ups and following room thermostat setpoint advance, if the controls provide preferential rate control, intelligent recovery, staging, ramping or another control mechanism designed to preclude the unnecessary operation of supplementary heating.

EXCEPTION 2 to Section 110.2(b): Room air-conditioner heat pumps.

(c) **Thermostatic controls.**

1. All uUnitary heating or cooling systems not controlled by a central energy management control system (EMCS) shall have thermostatic controls with a setback thermostat. **Setback Capabilities.** All thermostats shall have a clock mechanism that allows the building occupant to Pprogram the

temperature setpoints for at least four periods within 24 hours.

2. ~~Thermostats for h~~Heat pump systems shall have thermostatic controls that meet the requirements of Section 110.2(b).

EXCEPTION to Section 110.2(c): Gravity gas wall heaters, gravity floor heaters, gravity room heaters, noncentral electric heaters, fireplaces or decorative gas appliances, wood stoves, room air conditioners, and room air-conditioner heat pumps.

SECTION 110.10 – MANDATORY REQUIREMENTS FOR SOLAR READY BUILDINGS

(a) Solar Zone

1. **Minimum Area.** The solar zone shall have a minimum total area as described below. The solar zone shall comply with access, pathway, smoke ventilation, and spacing requirements as specified in Title 24, Part 9 or other Parts of Title 24 or in any requirements adopted by a local jurisdiction. The solar zone total area shall be comprised of areas that have no dimension less than five feet and are no less than 80 square feet each for buildings with roof areas less than or equal to 10,000 square feet or no less than 160 square feet each for buildings with roof areas greater than 10,000 square feet.

   A. **Single Family Residences.** The solar zone shall be located on the roof or overhang of the building and have a total area no less than 250 square feet.

   A.

   EXCEPTION 1 to Section 110.10(b)1A: Single family residences with a permanently installed solar electric system having a nameplate DC power rating, measured under Standard Test Conditions, of no less than 1000 watts.

   EXCEPTION 2 to Section 110.10(b)1A: Single family residences with a permanently installed domestic solar water-heating system meeting the installation criteria specified in the Reference Residential Appendix RA4 and with a minimum solar savings fraction of 0.50.

   EXCEPTION 3 to Section 110.10(b)1A: Single family residences with three habitable stories or more and with a total floor area less than or equal to 2000 square feet and having a solar zone total area no less than 150 square feet.

   EXCEPTION 4 to Section 110.10(b)1A: Single family residences located in Climate Zones 8-14 and the Wildland-Urban Interface Fire Area as defined in Title 24, Part 2 and having a whole house fan and having a solar zone total area no less than 150 square feet.

   EXCEPTION 5 to Section 110.10(b)1A: Buildings with a designated solar zone area that is no less than 50 percent of the potential solar zone area. The potential solar zone area is the total area of any low-sloped roofs where the annual solar access is 70 percent or greater and any steep-sloped roofs oriented between 110 degrees and 270 degrees of true north where the annual solar access is 70 percent or greater. Solar access is the ratio of solar insolation including shade to the solar insolation without shade. Shading from obstructions located on the roof or any other part of the building shall not be included in the determination of annual solar access.

   EXCEPTION 6 to Section 110.10(b)1A: Single family residences that meet the following conditions: ~~having a solar zone total area no less than 150 square feet and where~~

   A. All thermostatic controls ~~that~~ comply with Reference Joint Appendix JA5; and

   B. The building complies with one of the following: ~~are capable of receiving and responding to Demand Response Signals prior to granting of an occupancy permit by the enforcing agency.~~

      ~~**EXCEPTION 7 to Section 110.10(b)1A:** Single family residences meeting the following conditions:~~
      ~~All thermostats comply with Reference Joint Appendix JA5 and are capable of receiving and responding to Demand Response Signals prior to granting of an occupancy permit by the enforcing agency. C the building comply with one of the following measures:~~

      i. Have a solar zone with total area no less than 150 square feet; or

ii. Install a dishwasher that meets or exceeds the ENERGY STAR Program requirements with either a refrigerator that meets or exceeds the ENERGY STAR Program requirements or a whole house fan driven by an electronically commutated motor; or

iii. Install an Energy Management Control System ~~home automation system~~ capable of, at a minimum, controlling the appliances and lighting of the dwelling and responding to demand response signals; or

iv. Install alternative plumbing piping to permit the discharge from the clothes washer and all showers and bathtubs to be used for an irrigation system in compliance with the *California Plumbing Code* and any applicable local ordinances; or

v. Install a rainwater catchment system designed to comply with the *California Plumbing Code* and any applicable local ordinances, and that uses rainwater flowing from at least 65 percent of the available roof area.

B. **Low-rise and High-rise Multi-family Buildings, Hotel/Motel Occupancies, and Nonresidential Buildings.** The solar zone shall be located on the roof or overhang of the building or on the roof or overhang of another structure located within 250 feet of the building or on covered parking installed with the building project and have a total area no less than 15 percent of the total roof area of the building excluding any skylight area.

EXCEPTION 1 to Section 110.10(b)1B: Buildings with a permanently installed solar electric system having a nameplate DC power rating, measured under Standard Test Conditions, of no less than one watt per square foot of roof area.

EXCEPTION 2 to Section 110.10(b)1B: Buildings with a permanently installed domestic solar water- heating system complying with Section 150.1(c)8Ciii.

EXCEPTION 3 to Section 110.10(b)1B: Buildings with a designated solar zone area that is no less than 50 percent of the potential solar zone area. The potential solar zone area is the total area of any low-sloped roofs where the annual solar access is 70 percent or greater and any steep-sloped roofs oriented between 110 degrees and 270 degrees of true north where the annual solar access is 70 percent or greater. Solar access is the ratio of solar insolation including shade to the solar insolation without shade. Shading from obstructions located on the roof or any other part of the building shall not be included in the determination of annual solar access.

EXCEPTION 4 to Section 110.10(b)1B: Low-rise and high-rise multifamily buildings meeting the following conditions:

A. All thermostatic controls in each dwelling unit comply with Reference Joint Appendix JA5 ~~and are capable of receiving and responding to Demand Response Signals prior to granting of an occupancy permit by the enforcing agency~~.

B. ~~In e~~Each dwelling unit, comply with one of the following measures:

i. Install a dishwasher that meets or exceeds the ENERGY STAR Program requirements with either a refrigerator that meets or exceeds the ENERGY STAR Program requirements or a whole house fan driven by an electronically commutated motor; or

ii. Install an Energy Management Control System ~~home automation system~~ capable of, at a minimum, controlling the appliances and lighting of the dwelling and responding to demand response signals; or

iii. Install alternative plumbing piping to permit the discharge from the clothes washer and all showers and bathtubs to be used for an irrigation system in compliance with the *California Plumbing Code* and any applicable local ordinances; or

iv. Install a rainwater catchment system designed to comply with the *California Plumbing Code* and any applicable local ordinances, and that uses rainwater flowing from at least 65 percent of the available roof area.

EXCEPTION 5 to Section 110.10(b)1B: Buildings where the roof is designed and approved to be used for vehicular traffic or parking or for a heliport.

SECTION 110.X – MANDATORY REQUIRED AUTOMATIC DEMAND RESPONSIVE CONTROL

(a) **Covered Occupancies.** The requirements in section 110.X apply to nonresidential, high-rise residential, and hotel/motel buildings as well as covered processes that are within the scope of Section 100.0(a).

(b) **Manual Override Control.** All Demand Responsive Control Systems shall be capable of being disabled and controlled manually by authorized facility operators.

1. ~~The controls shall have the following features:~~

   A. ~~Disabled. Disabled by authorized facility operators; and~~

   B. ~~Manual control. Manual control by authorized facility operators to allow adjustment of heating and cooling set points globally from a single point in the EMCS; and~~

   C. ~~Automatic Demand Shed Control. Upon receipt of a demand response signal, the space-conditioning systems shall conduct a centralized demand shed, as specified in Sections 120.2(h)1 and 120.2(h)2, for non-critical zones during the demand response period.~~

(c) **External Communication.**

   A. All Demand Responsive Control Systems shall have one or more Virtual End Node (VEN) that is certified to OpenADR 2.0a or OpenADR 2.0b.

   B. Each VEN shall have the capability to communicate with the demand responsive control system for which it is intended to communicate.

   ~~Demand responsive controls and equipment shall be capable of receiving and automatically responding to at least one standards-based messaging protocol by enabling demand response after receiving a demand response signal.~~

(d) **Internal Communication.** All demand responsive control systems shall be capable of using one of the following for communications that occur within the building: Wi-Fi, ZigBee, BACnet, Ethernet, or hard-wiring.

(e) **Automatic Demand Responsive Control Strategies.** For the applications identified in Table 110.X, the Demand Responsive Control Systems shall be capable of automatically implementing the control strategy defined in Table 110.X-A upon receiving a Demand Reponses Signal.

(f) **Acceptance Testing for Demand Responsive Controls.** Acceptance test requirements for Demand Responsive Controls are defined in Table 110.X-A.

TABLE 110.X-A AUTOMATIC *DEMAND RESPONSIVE CONTROL STRATEGY REQUIRMENTS FOR NONRESIDENTIAL, HIGH-RISE RESIDENTIAL, and HOTEL/MOTEL BUILDINGS*

Application	**Required Demand Responsive Controls**	**Required Automatic Response to Demand Response Signal**	**Other Demand Responsive Control Requirements**	**Acceptance Test Requirement**
All HVAC System with Direct Digital Control (DDC) to the Zone level[1]	Must have Automatic Demand Responsive Controls that are compliant with Sections 110.X(a) through 110.X(d). Thermostatic controls for all single zone air conditioners and heat pumps, shall comply with the requirements of Section 110.2(c) and Reference Joint Appendix JA5 or, if equipped with DDC to the Zone level, with the Automatic Demand Shed Controls of Section 120.2(h).	• Adjust the operating cooling temperature set points up by 4ºF or more in all Non-Critical Zones and maintain adjusted set points for the Demand Response Period. • Adjust the operating heating temperature set points down by 4ºF or more in all Non-Critical Zones and maintain adjusted set points for the Demand Response Period. • Upon conclusion of the Demand Response Period, reset the temperature set points in all Non-Critical Zones to the set points in place before the Demand Response Signal was received. 1. The controls shall have a capability to remotely setup the operating cooling temperature set points by 4 degrees or more in all non-critical zones on signal from a centralized contact or software point within an Energy Management Control System (EMCS). 2. The controls shall have a capability to remotely setdown the operating heating temperature set points by 4 degrees or more in all non-critical zones on signal from a centralized contact or software point within an EMCS. 3. The controls shall have capabilities to remotely reset the temperatures in all non-critical zones to original operating levels on	Provide an adjustable rate of change for the temperature. 4. The controls shall be programmed to provide an adjustable rate of change for the temperature setup and reset.	NA7.5.10: Automatic Demand Shed Control Acceptance

		signal from a centralized contact or software point within an EMCS.		
Single-zone air conditioners and heat pump system (without DDC to the Zone Level)[1,2]	Must have thermostatic controls that are compliant with Joint Appendix 5. Thermostatic controls for all single zone air conditioners and heat pumps, shall comply with the requirements of Section 110.2(c) and Reference Joint Appendix JA5 or, if equipped with DDC to the Zone level, with the Automatic Demand Shed Controls of Section 120.2(h).	Defined in Joint Appendix 5.	Defined in Joint Appendix 5	Not applicable
Lighting in buildings that are larger than 10,000 square feet[3,4] Buildings larger than 10,000 square feet, excluding spaces with a lighting power density of 0.5 watts per square foot or less,	Must have automatic demand responsive controls that are compliant with Sections 110.X(a) through 110.X(d)	Reduce lighting power by a minimum of 15 percent below the design full output level for the duration of the Demand Response Period. [3,4] shall be capable of automatically reducing lighting power in response to a Demand Response Signal; so that the total lighting power of non-excluded spaces can be lowered by a minimum of 15 percent below the total installed lighting power when a Demand Response Signal is received. Lighting shall be reduced in a manner consistent with uniform level of illumination requirements in TABLE 130.1-A.	None	NA7.6.3 Demand Responsive Controls Acceptance
Electronic Message Center (EMC)s having a new connected lighting power load greater than 15 kW[5]	Must have automatic demand responsive controls that are compliant with Sections 110.X(a) through 110.X(d)	Reduce lighting power by a minimum of 30 percent for the duration of the Demand Response Period. have a control installed that is capable of reducing the lighting power by a minimum of 30 percent when receiving a demand response signal.	None	Not applicable

1. ~~**EXCEPTION 1 to Section 120.2(b)4:**~~ Systems serving exempt process loads that must have constant temperatures to prevent degradation of materials, a process, plants, or animals are exempt from the requirements in Section 110.X.
2. ~~**EXCEPTION 2 to Section 120.2(b)4:**~~ Package terminal air conditioners, package terminal heat pumps, room air conditioners, and room air-conditioner heat pumps are excepted from the automatic demand responsive control requirements.
3. Spaces with a lighting power density of 0.5 watts per square foot or less: 1) are not required to be capable of automatically reducing lighting power when a Demand Response Signal is received; and 2) shall not be included in calculations of the design full output level or the reduced lighting power level.
4. Lighting in which lighting power or illuminance is not permitted to be reduced in accordance with a health or life safety statute, ordinance, or regulation:1) is not required to be capable of automatically reducing lighting power when a Demand Response Signal is received; and 2) shall not be included in calculations of the design full output level or the reduced lighting power level.
5. Lighting for EMCs in which lighting power or illuminance is not permitted to be reduced by 30 percent in accordance with a health or life safety statute, ordinance, or regulation is exempt from the requirements in Section 110.X.

SECTION 110.Y – MANDATORY REQUIREMENTS FOR ENERGY MANGEMENT CONTROL SYSTEMS (EMCS)

(a) **Use of EMCS to Meet Demand Responsive Control Requirements.** If an EMCS is used to meet Demand Responsive Control Requirements, each VEN must be capable of communicating with the EMCS.

(b) **Use of EMCS to Meet HVAC Control Requirements.** An ~~Energy Management Control System (~~EMCS~~)~~ may be installed to comply with the requirements of one or more thermostatic controls if it complies with all applicable requirements for each thermostatic control.

(c) Use of EMCS to Meet Lighting Controls Requirements.

1. For nonresidential, high-rise residential and hotel/motel buildings, ~~A~~an EMCS may be used to comply with the requirements of one or more lighting controls if it meets the following minimum requirements:
   - A. Provides all applicable functionality for each specific lighting control or system for which it is installed in accordance with Section 110.9; and
   - B. Complies with all applicable Lighting Control Installation Requirements in accordance with Section 130.4 for each specific lighting control or system for which it is installed; and
   - C. Complies with all applicable application requirements for each specific lighting control or system for which it is installed, in accordance with Part 6.
2. For low-rise residential buildings:
   - A. An EMCS may be used to comply with dimmer requirements in Section 150.0(k) if at a minimum, it provides the functionality of a dimmer in accordance with Section 110.9, meets the installation certificate requirements in Section 130.4, the EMCS requirements in Section 130.5(f), and complies with all other applicable requirements in Section 150.0(k)2.
   - B. An EMCS may be used to comply with vacancy sensor requirements in Section 150.0(k) if at a minimum, it provides the functionality of a vacancy sensor in accordance with Section 110.9, meets the installation certificate requirements in Section 130.4, the EMCS requirements in Section 130.5(f), and complies with all other applicable requirements in Section 150.0(k)2.

SECTION 120.2 – MANDATORY REQUIRED CONTROLS FOR SPACE-CONDITIONING SYSTEMS

(a) **Thermostatic Controls for Each Zone.** The supply of heating and cooling energy to each space-conditioning zone or dwelling unit shall be controlled by ~~individual~~ thermostatic controls that respond to temperature within the zone and that meet the applicable requirements of Section 120.2(b). ~~An Energy Management Control System (EMCS) may be installed to comply with the requirements of one or more thermostatic controls if it complies with all applicable requirements for each thermostatic control.~~

EXCEPTION to Section 120.2(a): An independent perimeter heating or cooling system may serve more than one zone without individual thermostatic controls if:

1. All zones are also served by an interior cooling system;
2. The perimeter system is designed solely to offset envelope heat losses or gains;
3. The perimeter system has at least one thermostatic control for each building orientation of 50 feet or more; and
4. The perimeter system is controlled by at least one thermostat located in one of the zones served by the system.

(b) **Criteria for Zonal Thermostatic Controls.** The individual thermostatic controls required by Section 120.2(a) shall meet the following requirements as applicable:

1. Where used to control comfort heating, the thermostatic controls shall be capable of being set, locally or remotely, down to 55°F or lower.
2. Where used to control comfort cooling, the thermostatic controls shall be capable of being set, locally or remotely, up to 85°F or higher.
3. Where used to control both comfort heating and comfort cooling, the thermostatic controls shall meet Items 1 and 2 and shall be capable of providing a temperature range or dead band of at least 5°F within which the

supply of heating and cooling energy to the zone is shut off or reduced to a minimum.

EXCEPTION to Section 120.2(b)3: Systems with thermostats that require manual changeover between heating and cooling modes.

4. Thermostatic controls for all single zone air conditioners and heat pumps, shall comply with the requirements of Section 110.2(c) and Reference Joint Appendix JA5 or, if equipped with DDC to the Zone level, with the Automatic Demand Shed Controls of Section 120.2(h).

EXCEPTION 1 to Section 120.2(b)4: Systems serving exempt process loads that must have constant temperatures to prevent degradation of materials, a process, plants or animals.

EXCEPTION 2 to Section 120.2(b)4:, Package terminal air conditioners, package terminal heat pumps, room air conditioners, and room air-conditioner heat pumps.

(c) Hotel/Motel Guest Room and High-rise Residential Dwelling Unit Thermostatic Controls

1. Hotel/motel guest room thermostatic controls shall:

   A. Have numeric temperature setpoints in °F and °C; and

   B. Have setpoint stops, which are accessible only to authorized personnel, such that guest room occupants cannot adjust the setpoint more than ±5°F (±3°C); and

   C. Meet the requirements of Section 150.0(i).

   EXCEPTION to Section 120.2(c)1: Thermostatic controls that are integrated into the room heating and cooling equipment.

2. High-rise residential dwelling unit thermostatic controls shall meet the requirements of Section 150.0(i).

(d) **Heat Pump Controls.** All heat pumps with supplementary electric resistance heaters shall be installed with have controls that comply with Section 110.2(b).

(h) **Automatic Demand Shed Responsive Controls.** HVAC systems with DDC to the Zone level shall meet demand responsive control requirements in Section 110.X. be programmed to allow centralized demand shed for non-critical zones as follows:

1. The controls shall have a capability to remotely setup the operating cooling temperature set points by 4 degrees or more in all non-critical zones on signal from a centralized contact or software point within an Energy Management Control System (EMCS).

2. The controls shall have a capability to remotely setdown the operating heating temperature set points by 4 degrees or more in all non-critical zones on signal from a centralized contact or software point within an EMCS.

3. The controls shall have capabilities to remotely reset the temperatures in all non-critical zones to original operating levels on signal from a centralized contact or software point within an EMCS.

4. The controls shall be programmed to provide an adjustable rate of change for the temperature setup and reset.

5. The controls shall have the following features:

   A. Disabled. Disabled by authorized facility operators; and

   B. Manual control. Manual control by authorized facility operators to allow adjustment of heating and cooling set points globally from a single point in the EMCS; and

   C. Automatic Demand Shed Control. Upon receipt of a demand response signal, the space-conditioning systems shall conduct a centralized demand shed, as specified in Sections 120.2(h)1 and 120.2(h)2, for non-critical zones during the demand response period.

SECTION 130.0 – LIGHTING SYSTEMS AND EQUIPMENT, AND ELECTRICAL POWER DISTRIBUTION SYSTEMS —GENERAL

(e) **Energy Management Control System (EMCS).**

1. An EMCS may be installed to comply with the requirements of one or more lighting controls if it meets the following minimum requirements:

   A. Provides all applicable functionality for each specific lighting control or system for which it is installed in accordance with Section 110.9; and

   B. Complies with all applicable Lighting Control Installation Requirements in accordance with Section

~~2. 130.4 for each specific lighting control or system for which it is installed; and~~

~~A. Complies with all applicable application requirements for each specific lighting control or system for which it is installed, in accordance with Part 6.~~

SECTION 130.1 – MANDATORY INDOOR LIGHTING CONTROLS

(e) **Demand Responsive Controls.** Buildings larger than 10,000 square feet shall meet the meet demand responsive control requirements in Section 110.X

~~1. Buildings larger than 10,000 square feet, excluding spaces with a lighting power density of 0.5 watts per square foot or less, shall be capable of automatically reducing lighting power in response to a Demand Response Signal; so that the total lighting power of non-excluded spaces can be lowered by a minimum of 15 percent below the total installed lighting power when a Demand Response Signal is received. Lighting shall be reduced in a manner consistent with uniform level of illumination requirements in TABLE 130.1-A.~~

EXCEPTION to Section 130.1(e): Lighting in which lighting power or illuminance is not permitted to be reduced in accordance with ~~by~~ a health or life safety statute, ordinance, or regulation ~~to be reduced~~ ~~shall not be counted toward the total lighting power~~.

~~2. Demand responsive controls and equipment shall be capable of receiving and automatically responding to at least one standards-based messaging protocol by enabling demand response after receiving a demand response signal.~~

TABLE 130.1-A MULTI-*LEVEL LIGHTING CONTROLS AND UNIFORMITY REQUIREMENTS*

Luminaire Type	Minimum Required Control Steps (percent of full rated power[1])	Uniform level of illuminance shall be
Line-voltage sockets except GU-24	Continuous dimming 10-100 percent	
Low-voltage incandescent systems		
LED luminaires and LED source systems		
GU-24 rated for LED		
GU-24 sockets rated for fluorescent > 20 watts	Continuous dimming 20-100 percent	
Pin-based compact fluorescent > 20 watts[2]		
GU-24 sockets rated for fluorescent ≤ 20 watts	Minimum one step between 30-70 percent	Stepped dimming; or Continuous dimming; or Switching alternate lamps in a luminaire
Pin-based compact fluorescent ≤ 20 watts[2]		
Linear fluorescent and U-bent fluorescent ≤ 13 watts		
Linear fluorescent and U-bent fluorescent > 13 watts	Minimum one step in each range: 20-40 % / 50-70 % / 75-85 % / 100 %	Stepped dimming; or Continuous dimming; or Switching alternate lamps in each luminaire, having a minimum of 4 lamps per luminaire illuminating the same area and in the same manner
Track Lighting	Minimum one step between 30 – 70 percent	Step dimming; or Continuous dimming; or Separately switching circuits in multi-circuit track with a minimum of two circuits.
HID > 20 watts	Minimum one step between 50 - 70 percent	Stepped dimming; or Continuous dimming; or Switching alternate lamps in each luminaire, having a minimum of 2 lamps per luminaire, illuminating the same area and in the same manner.
Induction > 25 watts		
Other light sources		

1. Full rated input power of ballast and lamp, corresponding to maximum ballast factor
2. Includes only pin based lamps: twin tube, multiple twin tube, and spiral lamps

SECTION 130.3 – MANDATORY SIGN LIGHTING CONTROLS

(a) **Controls for Sign Lighting.**

3. **Demand Responsive ~~Electronic Message Center~~ Controls.** An Electronic Message Center (EMC) having a new connected lighting power load greater than 15 kW shall meet Demand Responsive Control Requirements in Section 110.X. ~~have a control installed that is capable of reducing the lighting power by a minimum of 30 percent when receiving a demand response signal.~~

EXCEPTION to Section 130.3(a)3: Lighting for EMCs ~~that~~ in which lighting power or illuminance is not permitted to be reduced by 30 percent in accordance with a by a health or life safety statute, ordinance, or regulation ~~to be reduced by 30 percent~~.

SECTION 130.5 – MANDATORY ELECTRICAL POWER DISTRIBUTION SYSTEMS

(e) **Demand responsive controls and equipment.** When demand responsive controls are installed, they must meet demand responsive control requirements in Section 110.X. ~~Demand responsive controls and equipment, where installed, shall be capable of receiving and automatically responding to at least one standards-based messaging protocol which enables demand response after receiving a demand response signal.~~

SECTION 141.0 – ADDITIONS, ALTERATIONS, AND REPAIRS TO EXISTING NONRESIDENTIAL, HIGH-RISE RESIDENTIAL, AND HOTEL/MOTEL BUILDINGS, TO EXISTING OUTDOOR LIGHTING, AND TO INTERNALLY AND EXTERNALLY ILLUMINATED SIGNS

(b) **Alterations.**

2. **Prescriptive approach.**

E. **Altered Space-Conditioning Systems.** When a space-conditioning system is altered by the installation or replacement of space-conditioning system equipment (including replacement of the air handler, outdoor condensing unit of a split system air conditioner or heat pump, or cooling or heating coil:

i. ~~For a~~All altered units where the existing thermostatic controls do~~es~~ not comply with Reference Joint Appendix JA5, the existing thermostatic controls shall be replaced with ~~a~~ thermostatic controls that comply with Reference Joint Appendix JA5.

ii. All newly installed space-conditioning systems requiring ~~a~~ thermostatic controls shall ~~be equipped with a thermostat that~~ have thermostatic controls that comply ~~ies~~ with Reference Joint Appendix JA5; and

iii. The duct system that is connected to the new or replaced space-conditioning system equipment shall be sealed, if the duct system meets the criteria of Sections 140.4(l)1, 2 and 3, as confirmed through field verification and diagnostic testing, in accordance with the applicable procedures for duct sealing of altered existing duct systems as specified in Reference Nonresidential Appendix NA2, and conforming to the applicable leakage compliance criteria in Section 141.0(b)2D.

EXCEPTION 1 to Section 141.0(b)2Eii: Duct Sealing. Buildings altered so that the duct system no longer meets the criteria of Sections 144 (l)1, 2, and 3 are exempt from the requirements of Subsection 141.0(b)2Eii.

EXCEPTION 2 to Section 141.0(b)2Eii: Duct Sealing. Duct systems that are documented to have been previously sealed as confirmed through field verification and diagnostic testing in accordance with procedures in the Reference Nonresidential Appendix NA2 are exempt from the requirements of Subsection 141.0(b)2Eii.

EXCEPTION 3 to Section 141.0(b)2Eii: Duct Sealing. Existing duct systems constructed, insulated or sealed with asbestos are exempt from the requirements of Subsection 141.0(b)2Eii.

SECTION 150.0 – MANDATORY FEATURES AND DEVICES

(i) **Thermostatic Controls**. All unitary heating or cooling systems, including heat pumps, not controlled by a central energy management control system (EMCS) shall have ~~a setback thermostat~~ thermostatic controls that meet the requirements~~, as specified~~ in Section 110.2(c).

(j) *[omitted]*

(k) **Residential Lighting.**

1. **Luminaire Requirements.** *[omitted]*

2. **Interior Lighting Switching Devices and Controls.**

A. All forward phase cut dimmers used with LED light sources shall comply with NEMA SSL 7A.

B. Exhaust fans shall be switched separately from lighting systems.

EXCEPTION to Section 150.0(k)2B: Lighting integral to an exhaust fan may be on the same switch as the fan provided the lighting can be switched OFF in accordance with the applicable provisions in

Section 150.0(k)2 while allowing the fan to continue to operate for an extended period of time.

C. Luminaires shall be switched with readily accessible controls that permit the luminaires to be manually switched ON and OFF.

D. Lighting controls and equipment shall be installed in accordance with the manufacturer's instructions.

E. No controls shall bypass a dimmer or vacancy sensor function where that dimmer or vacancy sensor has been installed to comply with Section 150.0(k).

F. Lighting controls shall comply with the applicable requirements of Section 110.9.

G. An Energy Management Control System (EMCS) may be used to comply with dimmer requirements in Section 150.0(k) if at a minimum it provides the functionality of a dimmer in accordance with Section 110.9, meets the installation certificate requirements in Section 130.4, the EMCS requirements in Section 130.5(f), and complies with all other applicable requirements in Section 150.0(k)2.

H. An Energy Management Control System (EMCS) may be used to comply with vacancy sensor requirements in Section 150.0(k) if at a minimum it provides the functionality of a vacancy sensor in accordance with Section 110.9, meets the installation certificate requirements in Section 130.4, the EMCS requirements in Section 130.5(f), and complies with all other applicable requirements in Section 150.0(k)2.

SECTION 150.2 – ENERGY EFFICIENCY STANDARDS FOR ADDITIONS AND ALTERATIONS TO EXISTING LOW-RISE RESIDENTIAL BUILDINGS

(b) **Alterations.**

1. **Prescriptive approach.**

F. **Altered Space-Conditioning System - Mechanical Cooling:** When a space-conditioning system is an air conditioner or heat pump that is altered by the installation or replacement of refrigerant-containing system components such as the compressor, condensing coil, evaporator coil, refrigerant metering device or refrigerant piping, the altered system shall comply with the following requirements:

i. All thermostats associated with the system shall be replaced with setback thermostatsic controls that meeting the requirements of Section 110.2(c).

7.2 Reference Appendices

JA5: Technical Specifications for Occupant Controlled Smart Thermostats

The Statewide CASE Team is recommending a rewrite of Joint Appendix 5 (JA5). Instead of providing marked up language for JA5, the new proposed version is provided in Appendix E.

NA7.5.10 Automatic Demand Shed Control Acceptance

NA7.5.10.1 Construction Inspection

Prior to Acceptance Functional Testing, verify and document the following:

(a) That the demand responsive control is capable of initiating a control strategy when a Demand Response Signal is received. EMCS interface enables activation of the central demand shed controls.

NA7.5.10.2 Functional Testing

Step 1: Engage the global demand shed system. Verify and document the following:

(a) That the cooling setpoint in Nnon-Ccritical Zones spaces increases by four degrees as required by Section 110.X. the proper amount.

(b) That the cooling setpoint in Ccritical Zones spaces do not change.

Step 2: Disengage the global demand shed system. Verify and document the following:

(c) That the cooling setpoint in N~~n~~on-C~~c~~ritical Zones ~~spaces~~ return to the set points in place before the Demand Response Signal was received. ~~their original values.~~

(d) That the cooling setpoint in C~~c~~ritical Zones ~~spaces~~ do not change.

NA7.6.3 Demand Responsive Controls Acceptance Tests

NA7.6.3.1 Construction Inspection

Prior to Functional T~~t~~esting, verify and document the following:

(a) That the D~~d~~emand R~~r~~esponse C~~c~~ontrol is capable of initiating a control strategy when a Demand Response Signal is received. ~~receiving a~~ ~~D~~~~demand~~ ~~R~~~~response~~ ~~S~~~~signal directly or indirectly through another device and that it complies with the requirements in Section 130.1(e)~~

~~(b) If the demand response signal is received from another device (such as an EMCS), that system must itself be capable of receiving a demand response signal from a utility meter or other external source.~~

NA7.6.3.2 Functional testing

For buildings with up to seven (7) enclosed spaces requiring automatic demand responsive control for lighting ~~controls~~, all spaces shall be tested. For buildings with more than seven (7) enclosed spaces requiring automatic demand responsive control for lighting ~~control~~s, sampling may be done on additional spaces with similar lighting systems; sampling shall include a minimum of 1 enclosed space for each group of up to 7 additional enclosed spaces. If the first enclosed space with ~~a~~ automatic demand responsive controls for lighting ~~control~~ in the sample group passes the acceptance test, the remaining building spaces in the sample group also pass. If the first enclosed space with ~~a~~ automatic demand responsive controls for lighting ~~contro~~l in the sample group fails the acceptance test the rest of the enclosed spaces in that group must be tested. If any tested automatic demand responsive control for lighting ~~control system~~ fails it shall be repaired, replaced or adjusted until it passes the test.

Test the reduction in lighting power due to the automatic demand responsive control for lighting ~~control~~ using one of the following two methods.

Method 1: Illuminance Measurement. Measure the reduction in illuminance in enclosed spaces required to meet Section ~~130.1(b)~~ 110.X(b), as follows:

(a) In each space, select one location for illuminance measurement. The chosen location must not be in a skylit or primary sidelit area. When placed at the location, the illuminance meter must not have a direct view of a window or skylight. If this is not possible, perform the test at a time and location at which daylight illuminance provides less than half of the design illuminance. Mark each location to ensure that the illuminance meter can be accurately located.

(b) Design ~~F~~full output test

1. Using the manual switches/dimmers in each space, set the lighting system to design full output condition. Note that the lighting in areas with photocontrols or occupancy/vacancy sensors may be at less than full output, or may be off.
2. Take one illuminance measurement at each location, using an illuminance meter.
3. Simulate a demand response condition using the demand responsive control.
4. Take one illuminance measurement at each location with the electric lighting system in the demand response condition.
5. Calculate the area-weighted average reduction in illuminance in the demand response condition, compared with the Design Full Output condition. The area-weighted reduction must be at least 15% but must not reduce the combined illuminance from electric light and daylight to less than 50% of the D~~d~~esign Full Output condition ~~illuminance~~ in any individual space.

(c) Minimum output test

1. Using the manual switches/dimmers in each space, set the lighting system to minimum output (but not off). Note that the lighting in areas with photocontrols or occupancy/vacancy sensors may be at more than minimum output, or may be off.
2. Take one illuminance measurement at each location, using an illuminance meter.
3. Simulate a demand response condition using the demand responsive control.
4. Take one illuminance measurement at each location with the electric lighting system in the demand response condition
5. In each space, the illuminance in the demand response condition must not be less than the illuminance in the minimum output condition or 50% of the Design Full Output condition ~~illuminance~~, whichever is less. ~~d~~

   EXCEPTION: In daylit spaces, the illuminance in the demand response condition may reduce below the minimum output condition, but in the demand response condition the combined illuminance from daylight and electric light must be at least 50% of the D~~d~~esign Full Output condition ~~illuminance~~.

Method 2: Current measurement. Measure the reduction in electrical current in spaces required to meet Section ~~130.1(b)~~ 110.X(b), as follows:

(a) At the lighting circuit panel, select at least one lighting circuit that serves spaces required to meet Section 130.1(e).

(b) Design ~~F~~full O~~o~~utput test

1. Using the manual switches/dimmers in each space, set the lighting system to Design F~~f~~ull O~~o~~utput condition. Note that the lighting in areas with photocontrols or occupancy/vacancy sensors may be at less than full output, or may be off.
2. Take one electric current measurement for each selected circuit.
3. Simulate a demand response condition using the demand responsive control.
4. Take one illuminance measurement at each location with the electric lighting system in the demand response condition.
5. Add together all the circuit currents, and calculate the reduction in current in the demand response condition, compared with the Design F~~f~~ull O~~o~~utput condition. The combined reduction must be at least 15% but must not reduce the output of any individual circuit by more than 50%.

(c) Minimum output test

1. Using the manual switches/dimmers in each space, set the lighting system to minimum output (but not off). Note that the lighting in areas with photocontrols or occupancy/vacancy sensors may be at more than minimum output, or may be off.
2. Take one electric current measurement for each selected circuit.
3. Simulate a demand response condition using the demand responsive control.
4. Take one electric current measurement for each selected circuit with the electric lighting system in the demand response condition.
5. In each space, the electric current in the demand response condition must not be less than 50% or the electric current in the minimum output condition, whichever is less.

   EXCEPTION: Circuits that supply power to the daylit portion of enclosed spaces as long as lighting in non-daylit portions of the enclosed space.

7.3 ACM Reference Manual

There are no proposed changes to the ACM Reference Manual.

7.4 Compliance Manuals

The following chapters of the Residential and Nonresidential Compliance Manuals will be revised:

- Residential Compliance Manual
  - Chapter 7 Solar Ready Buildings
- Nonresidential Compliance Manual:
  - Chapter 4 Mechanical Systems
  - Chapter 5 Nonresidential Indoor Lighting
  - Chapter 7 Sign Lighting
  - Chapter 8 Electrical Power Distribution
  - Chapter 9 Solar Ready

7.5 Compliance Documents

The documents listed below will be revised to update terminology and section numbering. No new documents will be created. The Statewide CASE Team recommends that the Energy Commission search all compliance documents for the term “setback thermostat” and replace all instances with “thermostatic control compliant with Section 110.2(c)”.

- Occupant Controlled Smart Thermostat Declaration
- NRCC-CXR-02-E: Commissioning - Construction Documents-General – Update section numbers on the document so the correspond to the new location of Demand Responsive Control Requirements for lighting and HVAC.
- NRCC-PRF-01-E: Nonresidential Performance Compliance
- NRCC-LTS-01-E: Sign Lighting
- NRCI-LTI-02-E: Energy Management Control System or Lighting Control System
- NRCI-LTO-02-E: Energy Management Control System or Lighting Control System
- NRCA-LTI-04-A: Demand Responsive Lighting Control Acceptance Document
- NRCA-MCH-11-A: Automatic Demand Shed Control Acceptance

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Appendix A: REVISED VERSION OF JOINT APPENDIX 5

The Statewide CASE Team is recommending a rewrite of Joint Appendix 5 (JA5). The revisions to the structure and wording are extensive without modifying the intent of the requirements. Instead of providing marked up language with in-line stuck and underlined text, the proposed version is provided in its entirety with all text underlined followed by the 2016 version with all text struck.

Joint Appendix JA5 – Proposed Version

Appendix JA5 - Technical Specifications for Demand Responsive Thermostatic Controls

Table of Contents

[Table of contents will be inserted after proposed code language is finalize]

JA5.1 Purpose and Scope

Joint Appendix (JA) 5 provides the technical requirements for Demand Responsive Thermostatic Controls.

The requirements in this appendix are intended to be compatible with National Electrical Manufacturers Association (NEMA) Standard DC 3-2013 Residential Controls – Electrical Wall-Mounted Thermostats and NEMA DC 3 Annex A-2013 Energy-Efficiency Requirements for Programmable Thermostats.[4]

Note: When selecting thermostatic controls that comply with JA5, it is recommended that the project team work with the local utility to select a control system that meets the utility's eligibility criteria for enrollment and participation in demand response programs.

JA5.2 Manufacturer Self-Certification of Demand Responsive Thermostatic Controls

Demand responsive thermostatic controls are compliant with Title 24, Part 6 only if they have been certified to the Energy Commission. To certify demand responsive thermostatic controls to the Energy Commission, manufacturers must execute a declaration that the control complies with the applicable requirements in Title 24, Part 6. The manufacturer declaration is executed under penalty of perjury attesting that all information provided is true, complete, accurate, and in compliance with the applicable provisions of this appendix (JA5) and other applicable requirements in Title 24, Part 6. The declaration document is provided by the Energy Commission.[5]

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[4] NEMA DC 3-2013 and NEMA DC 3 Annex A-2013 are available here: http://www.nema.org/news/Pages/NEMA-Publishes-Thermostat-Standards-NEMA-DC-3-2013-and-NEMA-DC-3-Annex-A-2013.aspx

[5] The Demand Responsive Thermostatic Control Declaration form is available on the California Energy Commission's website: http://www.energy.ca.gov/title24/equipment_cert/ocst/index.html

JA5.3 Compliance With Independent Device(s) or Networked Systems of Devices

Demand responsive thermostatic controls can be independent devices or control systems comprised of multiple devices.[6] An independent device is compliant if it meets all requirements in Sections JA5.4 through JA5.6. For a control system composed of multiple devices to be compliant, the networked system of devices must meet the requirements in Section JA5.4 through JA5.6 when all devices in the system are considered as a whole.

JA5.4 Communications Requirements

JA5.4.1 Internal Communications Requirements

Demand responsive thermostatic controls shall be capable of using one of the following for communications that occur within the building: Wi-Fi, ZigBee, BACnet, Ethernet, or hard-wiring.

Demand responsive thermostatic controls can have the capability of using other wireless or wired (proprietary or non-proprietary) communications protocols for internal communications in addition to one or more of the protocols listed above.

JA5.4.2 External Communication Requirements

All demand responsive thermostatic controls shall have one or more Virtual End Node (VEN) that is certified to OpenADR 2.0a or OpenADR 2.0b. The thermostatic control system can have one VEN for the entire building. Each VEN shall be capable of communicating with the thermostatic control system.

Demand responsive thermostatic controls can have the capability of using additional (proprietary or non-proprietary) communications protocols for external communications in addition to an OpenADR certified VEN.

JA5.4.3 Communication Security

Security of information transfer is of utmost importance. All parties participating in communications shall consider recent security protocols and protect against cyberattacks.

JA5.4.4 Communication Module

The communication module is the physical component that allows the demand responsive thermostatic control to meet the communications requirements specified in JA5.5.1 through JA5.5.3. The communication module must be either integrated with the thermostatic control (that is, onboard or not removable), or removable with a connection[7] to the thermostatic control by means of an expansion port.

JA5.4.4.1 Onboard Communication Module

Demand responsive thermostatic controls with onboard communication modules shall have the capability to enable or disable communication using an interface that is readily accessible to the

[6] A networked system of devices, for example, could include a stand-alone OpenADR 2.0a certified Virtual End Note, temperature sensors located throughout the building, and temperature setpoint controls for each Zone located within the zone or in a central location.

[7] The removable communication module does not need to be installed at the time of certification. It can be selected and installed at the time of enrollment in a utility demand response program.

occupant or by an authorized facility manager.

When onboard communications are disabled, the demand responsive thermostatic controls shall continue to meet the appropriate requirements in Sections 110.2(b), 110.2(c), 120.1(a) and 120.1(b).

JA5.4.4.2 Removable Communication Module with Expansion Port

Demand responsive thermostatic controls with removable communication modules shall have an expansion port that is readily accessible to the occupant or authorized facility manager for the removal and/or installation of the communication module.

The removable communication module may provide a means of memory storage, logging, and firmware upgrades.

When the expansion port is unpopulated (that is, the communications module is removed), the demand responsive thermostatic controls shall continue to meet the appropriate requirements in Sections 110.2(b), 110.2(c), 120.1(a) and 120.1(b).

JA5.5 Functional Requirements

JA5.5.1 Compliance With Section 110.2 and Section 120.2

All demand responsive thermostatic controls shall meet the requirements of Section 110.2(c).

Demand responsive thermostatic controls used to control heat pumps with supplemental electric resistance heaters shall meet the requirements of Section 110.2(b).

Demand responsive thermostatic controls used in nonresidential, high-rise residential, and hotel/motel buildings shall comply with the applicable requirements of Sections 120.2(a) through 120.2(k).

JA 5.5.2 Normal Operation

When the demand responsive thermostatic controls are not implementing a control strategy during a Demand Response Period, it is performing under normal operation. During normal operation, the Demand responsive thermostatic controls shall continue to meet the appropriate requirements in Sections 110.2(b), 110.2(c), 120.1(a) and 120.1(b) and control temperature following a temperature setpoint schedule. Under normal operation, the Demand responsive thermostatic controls shall have a clock mechanism that allows the building occupant to program the temperature setpoints for at least four periods within 24 hours.

JA5.5.3 Demand Responsive Control Strategy

Demand responsive thermostatic controls must be capable of automatically implementing a control strategy after receiving a Demand Response Signal.[8] Demand responsive thermostatic controls shall:

1. Be programmed with the following default control strategies:
    a. For Demand Response Signals that requests a modification to electricity consumption for a limited time period:
        i. Adjust temperature setpoints up 4°F for cooling

[8] A Demand Response Signal can communicate pricing or a request to modify electricity consumption for a limited time period.

ii. Adjust temperature setpoint down 4°F for heating

iii. Temperature setpoints shall not be set above 90°F or below 50°F.[9]

b. For Demand Response Signals that are an indication of price:

i. Adjust temperature setpoint in cooling mode to 82°F and hold setpoint for the duration of the Demand Response Period.

ii. Adjust temperature setpoint in heating mode to 60°F and hold setpoint for the duration of the Demand Response Period.

c. For all Demand Response Signals, ignore programmed temperature setpoint adjustments if the control strategy setpoints are lower (in cooling mode) or higher (in heating mode) than the temperature setpoint in effect before the Demand Response Period begins.

2. Be capable of allowing occupants, the occupants' representative (e.g., service provider), or an authorized facility operator to modify the default control strategy by:

a. Establishing occupant-defined temperature setpoint adjustments

b. Establishing occupant-defined start times for the control strategy

c. Establishing occupant-defined maximum and minimum temperature setpoints.

Note: The demand responsive thermostatic controls can provide additional occupant adjustments to the default control strategies.

3. Be capable of automatically implementing unique control strategies for the following types of Demand Response Signals:[10]

a. An indication of price; and

b. A request to modify electricity use for a limited period of time.

4. Be capable of automatically implementing a control strategy in response to a Demand Response Signal that is an indication of price only when the occupant-defined price threshold is exceeded.

5. Be capable of initiating a control strategy (thereby commencing the Demand Response Period) immediately after receiving a Demand Response Signal or at a specific start time as indicated in the Demand Reponses Signal.

6. Be capable of continuing the control strategy for the duration of the Demand Response Period.

7. Allow occupants to override or modify a control strategy at any time, including in the middle of a Demand Response Period.

8. Automatically adjust the temperature setpoints in one of the following ways upon conclusion of the Demand Response Period or if occupant, occupants' representative, or authorized facility operator overrides the control strategy:

a. Restore temperature setpoints that were in existence just prior to the start of the Demand Response Period; or

b. Adjust temperature setpoints to the setpoints that are programmed to restore at the conclusion of the Demand Response Period.

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[9] Establishing maximum and minimum temperature setpoints protects the building from extreme temperatures that might otherwise be imposed if the occupant already had a very high or low temperature setpoint in effect before the Demand Response Period commenced.

[10] The occupant would have the option of using similar or identical control strategies for signals that indicate price or signals that request a modification in electricity use.

JA5.5.4 Other Functional Requirements

JA5.5.4.1 User Display and Interface

The demand responsive thermostatic controls shall have the capability to display information to the user. The following information shall be readily available whenever the display is active:

1. communications system connection status;
2. an indication that a Demand Response Period or pricing event is in progress;
3. other maintenance-related information;
4. the currently sensed temperature; and
5. the current temperature setpoint(s).

JA5.5.4.1 Restore Default Settings

The demand responsive thermostatic controls shall include the capability to allow the occupant to restore the factory-installed default settings.

JA5.5.4.3 Default Restart Settings

In the event of a disruption of power to the device that results in power off or restart, upon device restart, the demand responsive thermostatic controls shall automatically restore the most recently programmed settings, including reconnection to a network, if the device was previously enabled and network connectivity is available.

JA5.5.4.4 Automatic Rejoin

Demand responsive thermostatic controls are expected to connect and remain connected. When communication is lost, the demand responsive thermostatic controls shall trigger an automatic rejoin function to restore communication.

JA 5.5.4.5 Clock Operation

1. Clock accuracy must have a precision of one minute.
2. Clock may be set manually by the occupant or authorized facility operator, or when communications are enabled, it may be set or synchronized by the occupant's selected service provider.

JA5.6 HVAC System Interface

HVAC wiring terminal designations shall be clearly labeled. Demand responsive thermostatic controls shall use labels that comply with Table 5-1 in NEMA DC 3-2013.

Joint Appendix JA5 – 2016 Version

Appendix JA5 - Technical Specifications For Occupant Controlled Smart Thermostats

Table of Contents

(a) JA5.1 Introduction

The Occupant Controlled Smart Thermostat (OCST) [1] shall be self-certified by the manufacturer to the Energy Commission to meet the requirements described in this section. This document provides a high level technical specification for an OCST. All OCSTs shall comply with the specifications set forth in this document or a specification approved by the Executive Director. This specification focuses on three interfaces that the Energy Commission has determined shall be supported by all OCSTs:

(a) Communications Interface
(b) User Display and Interface
(c) HVAC System Interface

Sections within this document address each interface in terms of its hardware and software characteristics. This specification is intended to compatible with National Electrical Manufacturers Association (NEMA) Standards Publication DC 3-2013 – "Residential Controls – Electrical Wall-Mounted Thermostats" [2] unless otherwise specified.

The Communications Interface is comprised of the (1) physical communication interface and the (2) logical communication interface.

(a) The physical communication interface describes the physical connection that enables receipt of demand response signals or price signals.
(b) The logical communication interface describes the information model and its messaging protocol used for representation and interpretation of signals received by the OCST.

See Section 5.3.1 for a more detailed explanation of these communication interfaces.

JA5.2 Required Functional Resources

JA5.2.1 Setback Capabilities

All OCSTs shall meet the requirements of Section 110.2(c). Thermostats for heat pumps shall also meet the requirements of Section 110.2(b).

JA5.2.2 Communication Capabilities

OCSTs shall include communication capabilities compliant with Section 5.3.1 and be enabled through either

(a) At least one expansion port with a removable module to enable communication; or
(b) Onboard communication device(s).

See Sections 5.3.2 and 5.3.3 for a more detailed description of expansion port and onboard communication device.

[1] A networked system of devices which is capable of receiving and responding to demand response signals and provides equivalent functionality to an OCST as specified in Reference Joint Appendix JA5, including being capable of automatically initiating demand responsive control when a signal is received as specified in JA 5.3.1, shall be considered to be an OCST. This includes, but is not limited to, systems that use a wired or wireless gateway or access point to comply with JA5.3.

[2] NEMA DC 3-2013 – http://www.nema.org/news/Pages/NEMA-Publishes-Thermostat-Standards-NEMA-DC-3-2013-and-NEMA-DC-3-Annex-A-2013.aspx.

~~JA5.2.3 OCST Messages and Attributes~~

~~The OCST communications capabilities shall enable Demand Responsive Control through receipt of Demand Response Signals or price signals. After OCST communication is enabled and the occupant has enrolled in a Demand Response program or subscribed to receive demand response or pricing related messages or information updates, the OCST shall be capable of both receiving and responding to Demand Response Signals. The OCST with communications enabled recognizes two basic system event modes: price response and Demand Response Periods. Both basic system event modes can be overridden by the occupant.~~

~~JA5.2.3.1 Demand Responsive Control~~

~~The OCST shall be capable of demand responsive control for the demand response period upon receipt of a demand response signal, which is a signal sent by the local utility, California Independent System Operator (California ISO), or designated curtailment service provider or aggregator, to a customer, indicating a price or a request to modify electricity consumption, for a limited time period. A price signal is a type of demand response signal.~~

~~Price signals allow the utility or another entity selected by the occupant to send a signal or message to the occupant's OCST to provide pricing information to the occupant and initiate Demand Responsive Control for the Demand Response Period utilizing a Demand Response Signal.~~

~~Price signal attributes and requirements shall be specified within the messaging protocol utilized by the utility or other entity selected by the occupant.~~

~~JA5.2.3.2 Demand Response Periods~~

~~This event class allows the utility or another entity selected by the occupant to initiate Demand Responsive Control for the Demand Response Period utilizing a Demand Response Signal.~~

~~Demand Response Signal attributes and requirements shall be specified within the messaging protocol utilized by the utility or other entity selected by the occupant.~~

~~If a price signal or Demand Response Signal is received and validated, but conflicts with a prior message, the newer message shall supersede the previous message and any continuing action for the prior message is automatically terminated by the OCST (unless the subsequent message attempts to initiate an action that has been disapproved by the occupant).~~

~~JA5.2.4 Event Response~~

~~Event response, unless overridden by the occupant or modified by an energy management control system or service, may be triggered by price signals or Demand Response Signals. The OCST shall provide one set of event responses for price signals and one set of event responses for Demand Response Signals. The responses may be common for both types of events.~~

~~OCSTs shall be capable of receiving and automatically responding to the Demand Response Signals as follows:~~

- ~~(a) A Demand Response Signal shall trigger the OCST to adjust the thermostat setpoint by either the default number of degrees or the number of degrees established by the occupant.~~
- ~~(b) When a price signal indicates a price in excess of a price threshold established by the occupant, the OCST shall adjust the thermostat setpoint by either the default number of degrees or the number of degrees established by the occupant.~~
- ~~(c) In response to price signals or Demand Response signals, the OCST shall default to an event response that initiates setpoint offsets of +4°F for cooling and -4°F for heating relative to the current setpoint.~~
- ~~(d) The OCST shall have the capability to allow occupants or their representative to modify the default event response with occupant defined event responses for cooling and heating relative to the current setpoint in response to price signals or Demand Response Signals.~~

(e) Override Function: Occupants shall be able to change the event responses and thermostat settings or setpoints at anytime, including during price events or Demand Response Periods.
(f) The Demand Response Signal shall start the Demand Response Period either immediately or at a specific start time as specified in the event signal and continue for the Demand Response Period specified in the Demand Response Signal or until the occupant overrides the event setpoint.
(g) The thermostat's price response shall start either immediately or at a specific start time as specified in the pricing signal and continue for the duration specified in the pricing signal or until the occupant overrides the event setpoint.
(h) The OCST shall have the capability to allow occupants to define setpoints for cooling and heating in response to price signals or Demand Response signals as an alternative to the default event response.
(i) At the end of a price event or Demand Response Period, the thermostat setpoint shall be set to the setpoint that is programmed for the point in time that the event ends or to the manually established setpoint that existed just prior to the Demand Response Period.

JA5.2.5 Other Required Capabilities

(a) Default Restart Settings: In the event of a disruption of power to the device that results in power off or restart, upon device restart, the device shall automatically restore the most recently programmed settings, including reconnection to a network, if the device was previously enabled and network connectivity is available.
(b) Automatic Rejoin: OCSTs are expected to connect, and remain connected in its communication path and control end point. The OCST shall incorporate an automatic rejoin function. When physical and/or logical communication is lost, the OCST shall trigger its automatic rejoin function to restore the physical and/or logical communication.

JA5.3 Functional Descriptions

JA5.3.1 Communications Interface

The communications interface has two aspects – the physical interface and the logical interface.

The physical communications interface describes the physical connection through which event signals are received, and shall meet the following requirements:

1. The OCST shall be capable of receiving signals that have been transmitted using a non-proprietary communications protocol. This shall include, at a minimum, one of the following:
    a. connecting to a Wi-Fi network compliant with Institute of Electrical and Electronics Engineers (IEEE) Standard 802.11,
    b. connecting to a Zigbee network compliant with IEEE Standard 802.15.4, or
    c. for nonresidential, high-rise residential, and hotel-motel buildings, connecting to an Ethernet network compliant with IEEE Standard 802.3.

    Manufacturers may choose to include additional wireless or wired physical communication interfaces.
2. The physical communication interface shall be capable of bi-directional exchange of information over its communication path.

The logical communication interface within the OCST hardware, which describes the messaging protocol and information model used in representation and interpretation of demand response signals, shall comply at a minimum, with any individual or combination of the following open-based standards: OpenADR 2.0[3] or

[3] http://www.openadr.org

Smart Energy Profile (SEP) 1.1 [4] which are listed the Smart Grid Interoperability Panel (SGIP) Catalog of Standards (CoS) [5]. Manufacturers may choose to provide additional logical communication protocols. Builders, HVAC installer, architects, and all other Title 24 professionals should check with the local utility where the property is located) on guidance when choosing the DR signal standard for the OCST.

Using receipt of a demand response signal via the physical communication interface, and interpretation of the signal via the logical communication interface, the OCST shall be capable of automatically initiating demand responsive control.

JA5.3.2 Expansion/Communication Port

The expansion port allows for the installation of a removable module to enable physical and logical communication as described in Section 5.3.1.

When the Expansion port is unpopulated, the thermostat shall function as a programmable setback thermostat and shall meet the requirements of Sections 110.2(b) and (c).

The removable module may also provide a means of memory storage, logging, and firmware upgrade. The requirements associated with the expansion port are:

(a) The expansion port shall be readily accessible to the occupant for installing and removing the communication module.

(b) Installation of the module shall upgrade the programmable setback thermostat to an OCST.

(c) After communications are enabled and the occupant has enrolled in a Demand Response program or subscribed to receive demand response related messages or information updates, the OCST shall be capable of both receiving and responding to Demand Response Signals.

The expansion port has no mandated configuration or design specification.

JA5.3.3 Onboard Communications Devices

When onboard communication devices are present, the thermostat or HVAC control system shall be equipped with the capability to enable or disable the onboard communication device(s). The switch or interface to enable or disable onboard communications shall be readily accessible to the occupant.

When onboard communications are disabled, the thermostat shall function as a programmable setback thermostat and shall meet the requirements of Section 110.2(c). Thermostats for heat pumps shall also meet the requirements of Section 110.2(b).

JA5.3.4 User Display and Interface

The OCST shall have the capability to display information to the user. The following information shall be readily available whenever the OCST display is active:

(b) communications system connection status,
(c) an indication that a Demand Response Period or pricing event is in progress,
(d) other maintenance-related information,
(e) the currently sensed temperature,
(f) the current setpoint.

[4] http://zigbee.org/Standards/ZigBeeSmartEnergy/Overview.aspx

[5] http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/SGIPCoSStandardsInformationLibrary

[6] The removable module, for enabling communications can be selected and installed at the time of enrollment in a Demand Response program or subscription to receive demand response related messages or information updates.

JA5.3.5 Required Functional Behavior

(a) Clock Operation. The clock mechanism enables the OCST to execute temperature setpoints scheduled by the occupant. It also supports other timing functions such as start-time, end-time and duration for coordination of Demand Response Periods and price signal response.

The OCST shall provide a pair of programmable thermostat setpoint time and temperature parameters for at least four operating periods that collectively govern thermostat operation during the 24-hour day.

Accuracy to a precision of one minute is acceptable for this operating environment and the applications being considered.

The clock in an OCST may be set by the occupant, using the OCST's human-machine interface. Alternatively, an OCST with communications enabled may be set or synchronized by the occupant's selected service provider.

(b) Normal Operation. Normal operation of an OCST is defined to be the OCST's[7] prevailing mode of operation as determined by the occupant's prior settings and use of features provided by the OCST manufacturer's design. Aspects of normal operation of an OCST may be modified or interrupted in response to occupant subscribed price signals or when Demand Response Periods are in progress, but only to the extent specified by occupants or their representatives.

Unless an occupant has elected to connect the OCST to an energy management control system or service that provides for alternate strategies, the OCST shall provide a mode of operation whereby it controls temperature by following the scheduled temperature setpoints.

Occupants shall always have the ability to change OCST settings or use other features of an OCST during an event. Those changes may alter what is considered to be the prevailing mode of operation when a Demand Response Period is terminated and the OCST returns to normal operation.

(c) Demand Responsive Control. Upon receiving a price signal or a Demand Response Signal, OCSTs shall be capable of automatic event response by adjusting the currently applicable temperature setpoint by the number of degrees indicated in the temperature offset (heating or cooling, as appropriate).

Override: OCSTs shall allow an occupant or their representative to alter or eliminate the default response to price signals or Demand Response Signals, and to override any individual price response or Demand Responsive Control and allow the occupant to choose any temperature setpoint at any time including during a price event or a Demand Response Period.

When the price signal changes to a non-response level or the Demand Response Period is concluded, OCSTs shall return to normal operation. The thermostat setpoint shall be set to the setpoint that is programmed for the point in time that the event ends or to the manually established setpoint that existed just prior to the Demand Response Period.

The OCST shall also be equipped with the capability to allow occupants to define setpoints for cooling and heating in response to price signals or Demand Response Signals as an alternative to the default event response. The default setpoint definitions unless redefined by the occupant shall be as follows:

1. The default price response or Demand Response Period setpoint in the cooling mode for OCSTs shall be 82°F. The OCST shall allow the occupant to change the default event setpoint to any other value.

[7] The specific design of such features (e.g. ,HOLD, OVERRIDE) is defined by individual manufacturers and not by this document.

2. The default price response or Demand Response Period setpoint in the heating mode for OCSTs shall be 60°F. The OCST shall allow the occupant to change the default event setpoint to any other value.
3. The OCST shall ignore price response or Demand Response Period setpoints that are lower (in cooling mode) or higher (in heating mode) than the programmed or occupant selected prevailing setpoint temperature upon initiation of the price event or Demand Response Period.
4. By default, thermostats shall not be remotely set above 90°F or below 50°F. Occupants shall have the ability to redefine these limits. This measure protects occupant premises from extreme temperatures that might otherwise be imposed by event responses, should the occupant already have a very high or low temperature setpoint in effect.

The occupant may still override or change the setpoint during all price events and Demand Response Periods. Price signal response and Demand Responsive Control only modify the operating range of the thermostat. They do not otherwise affect the operation and use of features provided by the manufacturer's design.

JA5.3.6 Restoring Factory Installed Default Settings

The OCST shall include the capability to allow the occupant to restore the factory installed default settings.

JA5.3.7 Security

Demand Response Signal security attributes and requirements shall be specified within both the communications standard and the messaging protocol utilized by the utility or other entity selected by the
occupant. The OCST communications system shall consider relevant security issues and potential cyber- attacks [8].

JA5.5 Terminology

Current Setpoint	The setpoint that existed just prior to the price event or Demand Response Period.
Demand Response	See Joint Appendix JA1- Glossary.
Demand Response Period	See Joint Appendix JA1- Glossary.
Demand Response Signal	See Joint Appendix JA1- Glossary.
Demand Responsive Control	See Joint Appendix JA1 – Glossary.
Energy Management Control System	See Joint Appendix JA1 – Glossary.
Override	Refers to an occupant adjusting thermostat settings to either not respond to a Demand Response Signal or adjusting the setpoint compared to the OCST's programmed response to a price signal or Demand Response Signal.
Price Event	Refers to a change in pricing sent to the OCST from the

[8] A thorough discussion of security issues may be found at: http://collaborate.nist.gov/twiki- sggrid/bin/view/SmartGrid/CyberSecurityCTG

utility or the occupant's selected demand response provider.

JA5.4 The HVAC System Interface

HVAC wiring terminal designations shall be clearly labeled. OCSTs shall use labels that comply with Table 5-1 in NEMA DC 3-2008. It is noted that OCSTs using wired or wireless digital data interfaces do not directly follow NEMA DC 3-2008.

Appendix B: Discussion of Impacts of Compliance Process on Market Actors

This appendix discusses how the recommended changes could impact various market actors. The Statewide CASE Team asked stakeholders for feedback on how the measure will impact various market actors during public stakeholder meetings that were held on October 11, 2016, and March 28, 2017. The key results from feedback received during stakeholder meetings and other target outreach efforts are detailed below.

Table 7 identifies the market actors who will play a role in complying with the proposed change, the tasks for which they will be responsible, their objectives in completing the tasks, how the proposed code change could impact their existing work flow, and ways negative impacts could be mitigated.

Since this proposal clarifies the code language, the Statewide CASE Team expected greater compliance to the DR requirements. This proposal will help designers understand the capabilities the controls system will need to have for HVAC, indoor lighting, sign lighting, and electrical power distribution. Leaving project triggers and exceptions within the existing sections of the Standards will help designers understand when the requirements in the new section apply to projects. HVAC and lighting controls manufacturers and service providers may incur some costs to certify their VENs to OpenADR if they were not previously certifying the equipment. The Statewide CASE Team is further investigating this issue.

In 2016 and 2017, Pacific Gas and Electric Company (PG&E) led an initiative, *The Automated Demand Response in Title 24, Part 6: Stakeholder Outreach Assessment,* that aimed to gain a better understanding of the level of awareness of the DR requirements in Title 24, Part 6 and to identify stakeholder preferences for outreach communications and trainings (Bruceri, Alxugaray and Pearson 2017). The utility team will take the lessons learned from this initiative into consideration when developing plans to communicate the revisions to the DR requirements to market actors.

The following actors would be involved in implementing this measure.

Table 7: Roles of Market Actors in The Proposed Compliance Process

Market Actor	Task(s) In Compliance Process	Objective(s) in Completing Compliance Tasks	How Proposed Code Change Could Impact Work Flow	Opportunities to Minimize Negative Impacts of Compliance Requirement and to Increase Participation in DR Programs
Facility Owner/Occupant	• Initiates project • Coordinates with designers and contractors to approve design and construction • Ongoing maintenance of controls system once project is complete • Enables DR controls and signs up to participate in DR programs	• Occupy constructed facility within scheduled timeframe and budget parameters • Experience energy benefits as modeled • Experience a comfortable, functionally optimized building	Owner/Occupant will be more educated about building's DR capabilities	• Educate Owner/Occupant so they understand the building's DR capabilities and are aware of how to enable controls and enroll in DR programs so they can realize the energy and energy cost benefits of DR controls capabilities • Create a resource that would educate the Owner/Occupant of Title 24-compliant DR controls, benefits of participating in DR programs, and how to enroll
HVAC, Electrical and Lighting Designers	• Design systems to meet Title 24, Part 6 requirements • Specify DR controls in construction documents • Complete compliance documents	• System meets owner needs • Do this quickly and within budget and schedule • Do this cost-effectively • System is Title 24, Part 6 compliant • Provide controls that Owners/Occupants may actually enable to enroll in DR programs and realize energy and cost benefits	• Clarifying DR control requirements and implementation strategies and will reduce confusion, make it easier to confirm designs meet code requirements, and expedite the design process • Eased navigation of relevant DR code sections will save time	• Update Compliance Manual to explain code requirements more clearly • Train designers to know where to find compliant controls systems (CEC's list of certified DR Thermostats, database of OpenADR certified VENs) • Develop Frequently Asked Questions document to explain requirements in appendices (Compliance Manual could direct to it) • Conduct outreach to confirm designers understand DR controls requirements and how buildings with DR controls capabilities can benefit Owners/Occupant, utilities, grid managers, and the state (Blueprint, Code Update Trainings). Improved understanding could lead to improved participation in DR programs • Add resources related to DR requirements to Energy Code Ace

Market Actor	Task(s) In Compliance Process	Objective(s) in Completing Compliance Tasks	How Proposed Code Change Could Impact Work Flow	Opportunities to Minimize Negative Impacts of Compliance Requirement and to Increase Participation in DR Programs
Builder/Contractor	• Build system exactly as designed to meet code • Purchase system from retailers/distributors • Install DR controls to specifications • Provide building control capabilities to owner/occupant • Coordinate with other market actors including Acceptance Testers and Commissioning Authority	• Do this quickly and within budget and schedule • Do this with minimal paperwork • System is Title 24, Part 6 compliant	• Increase likelihood of plans and specifications correctly reflecting DR requirements for contractors to follow • Improved documentation of building controls capabilities to provide Owners/Occupants	• Define roles and responsibilities of who will educate Owner/Occupant on DR capabilities of their building. This may be required by more than one subcontractor • Train builders and contractors to look for DR control requirements (especially when used to trade off against other residential measures) and provide guidance on how to select and install compliant controls. • Add resources related to DR requirements to Energy Code Ace
Acceptance Testers & Commissioning Authority	• Third –party verifier of proper installation and functionality • Ensure Compliance, Operating, Maintenance and Ventilation Information is delivered to Building Owner	Compliance demonstrated on first visit and with minimal coordination beforehand	Clarification of language in standards and the tests themselves (in appendix) are intended to make acceptance testing go more smoothly	• Develop materials that can help Owners/Occupants understand the documentation that is provided explaining the building DR control capabilities (Include description of DR and how Owners/Occupants can benefit from participating in DR programs) • Add resources related to DR requirements to Energy Code Ace • Update training materials for ATTCPs, so they received the necessary training to complete the DR acceptance tests correctly.
Plans Examiner	Confirm Title 24, Part 6, compliance in construction documents	Only one review required; no clarifications necessary	No changes in the workflow	• Train plans examiners to look check that certified DR Thermostats and certified VENs are specified when applicable (especially when taking the DR Thermostat trade-off to the solar-ready requirements) • Train plans examiners to know where to find compliant controls systems (CEC's list of certified DR

Market Actor	Task(s) In Compliance Process	Objective(s) in Completing Compliance Tasks	How Proposed Code Change Could Impact Work Flow	Opportunities to Minimize Negative Impacts of Compliance Requirement and to Increase Participation in DR Programs
				Thermostats, database of OpenADR certified VENs) • Add resources related to DR requirements to Energy Code Ace
Building Inspector	Confirm proper installation and Title 24, Part 6 documentation	• Only one site visit required per inspection item	No changes in the workflow	Add resources related to DR requirements to Energy Code Ace
HVAC and Lighting Controls Manufacturers and Service Providers	• Provide compliant equipment to marketplace • Self-certify products	• Provide equipment that is compatible with DR incentive programs • Sell equipment with minimal product returns or exchanges • Sell equipment that Owners/Occupants can enable and us to enroll in DR programs • Sign Owners/Occupants up for control services	• Control Manufacturers and Service Provers will need to certify VENs to OpenADR and for DR Thermostats they will certify products to the Energy Commission Work with contractors to ensure systems are installed correctly	• Recommend harmonize DR program eligibility requirements and equipment • Communicate how products are code compliant, and are compatible with DR programs to Owner/Occupant • Create opportunities for contractors and manufacturers / service providers to reflect and improve upon on installation process
California Energy Commission	• Code Development (including reach codes that will need load shifting to get to ZNE in the most cost-effective manner) • Review and approve product self-certifications • Maintains database thermostatic controls that comply with JA5	• Review and approve certification applications on first review • Provide accurate database to public • Gain better understanding of how Title 24-compliant buildings are participating in DR programs to inform future code changes	Clarified requirements could simplify process to review and approve manufacturer self-declaration documents for DR Thermostats.	Provide Frequently Asked Questions document for JA5 compliance (similar to JA8 FAQ)

Market Actor	Task(s) In Compliance Process	Objective(s) in Completing Compliance Tasks	How Proposed Code Change Could Impact Work Flow	Opportunities to Minimize Negative Impacts of Compliance Requirement and to Increase Participation in DR Programs
Post-Compliance: Provided with the Goal of Increasing Participation in DR Programs				
Utility Demand Response Programs	• Recruit participants (currently existing buildings only) • Coordinate controls software programming to receive requests • Send load reduction requests to participants • Evaluate reduction periods to determine actual savings • Administrate DR Incentive Programs	• Demonstrated demand reduction to meet goals • Increase participation in DR Programs	Better understanding of the code requirements by both Owner/Occupant and utility program managers could help increase participation in the DR programs	• Provide training and/or resources to help identify what DR controls capabilities buildings that Title 24-compliant buildings have and the types of alterations projects trigger compliance with DR requirements • Recommend adding a New Construction DR Program
Demand Response Aggregators	• Identify small facility candidates for aggregated groups • Recruit participants (currently existing buildings only) • Coordinate controls software programming to receive requests • Send load reduction requests to participants • Evaluate reduction periods to determine actual savings	• Demonstrated energy savings to meet savings goals • Increase program participation	Better understanding of the code requirements by both Owner/Occupant and Aggregators PMs could help increase participation in the DR Programs	• Provide training and/or resources to help identify what DR controls capabilities buildings that Title 24-compliant have and the types of alterations projects trigger compliance with DR requirements • Recommend DR Aggregators work with new construction to enroll new buildings in DR programs
California Independent System Operator (CAISO)	• Owner of electrical grid • Determines when load reduction request is appropriate; coordinates with Utilities to send request • Independent DR program implementer	• Maintain optimal grid function	NA	• Conduct outreach to ensure CAISO is aware of the DR controls capabilities that Title 24-compliatn buildings have.

Appendix C: FURTHER DISCUSSION OF PROPOSED COMMUNICATIONS REQUIREMENTS

Introduction

This appendix provides further discussion of the recommended clarifications for the communications requirements. The discussion is divided into two components:

1. External communications: requirements for communications protocols used to exchange information between the demand responsive control system in the building and entities external to the building that initiates or convey the DR signal, and
2. Internal communications: requirements for communication among the components of the demand responsive control system excluding external communications.

The communication requirements presented here apply to all demand responsive controls that are used to comply with Title 24, Part 6 in both residential and nonresidential buildings.

External Communication Requirements

Problem Statement – External Communications Requirements

Existing requirements for external communications requirements are vague and inconsistent across all demand responsive control requirements in the standards. This is causing confusion and suspected compliance and enforcement issues. See Table 8 for a summary of the existing external communication requirements for each type of required demand responsive control.

Table 8: Existing External Communications Requirements for Demand Responsive Controls

Existing DR Control Requirement	Existing External Communication Requirement	Existing Relevant Code Section(s)
Nonresidential HVAC (DDC to the Zone Level)	None	120.2(b), 120.2(h)
Nonresidential HVAC (DDC not to the Zone level)	"shall comply at a minimum, with any individual or combination of the following open-based standards: OpenADR 2.0 or Smart Energy Profile (SEP) 1.1 which are listed the Smart Grid"	JA5
Nonresidential Indoor Lighting	"capable of receiving and automatically responding to at least one standards-based messaging protocol"	130.1(e)
Nonresidential Electronic Messaging Centers	None	130.3(c)
Nonresidential Electrical Power Distribution Systems	"capable of receiving and automatically responding to at least one standards-based messaging protocol"	130.5(e)
Residential HVAC Control	"shall comply at a minimum, with any individual or combination of the following open-based standards: OpenADR 2.0 or Smart Energy Profile (SEP) 1.1 which are listed the Smart Grid"	JA5

Proposed Clarification of External Communications Requirements

The Statewide CASE Team recommends that all demand responsive control systems have a Virtual End Node (VEN) that is certified for OpenADR 2.0a or OpenADR 2.0b. As discussed below, for the 2019 code cycle, it is recommended that the building code allow for ample flexibility on how the certified VEN(s) is configured within the control system. The limitations being the VEN must be capable of communicating with the relevant building control system(s), and, if there is an EMCS, all VENs must be capable of communicating with the EMCS.

Table 9 presents the proposed external communications requirements for the 2019 Title 24, Part 6 standards.

Table 9: Proposed External Communications Requirements

<table>
<tr><th>Existing DR Control Requirement</th><th>Proposed External Communication Requirement</th><th>Proposed Relevant Code Section(s)</th></tr>
<tr><td>Nonresidential
HVAC (DDC to the Zone Level)</td><td rowspan="6">1. DR control system must:
a. Have a Virtual End Node that is certified to OpenADR 2.0a or OpenADR 2.0b; and
b. Be capable of communicating with the relevant DR controls.
2. If an EMCS is installed, all VENs in the building must be capable of communicating with the EMCS.</td><td>110.x</td></tr>
<tr><td>Nonresidential
HVAC (DDC not to the Zone level)</td><td>JA5</td></tr>
<tr><td>Nonresidential
Indoor Lighting</td><td>110.x</td></tr>
<tr><td>Nonresidential
Electronic Messaging Centers</td><td>110.x</td></tr>
<tr><td>Nonresidential
Electrical Power Distribution Systems</td><td>110.x</td></tr>
<tr><td>Residential
HVAC Control</td><td>JA5</td></tr>
</table>

Discussion of Proposed External Communications Requirements

The OpenADR specifications define a way in which entities who send and receive DR signals can communicate with each other in an open, standardized, and secure manner using a common information exchange model over any existing Internet Protocol-based communications network. The OpenADR Alliance developed the protocols after extensive research, development, and industry participation.

The OpenADR Alliance has finalized two specifications, “A Profile” and “B Profile,” that describe the OpenADR 2.0 communications framework and the requirements that devices and users must adhere to if they wish to communicate with other entities who are using the OpenADR 2.0 communications framework. The OpenADR 2.0 communications framework was intentionally designed to accommodate a range users and devices: from residential entities using simple end-use devices like thermostats to participate in DR markets to more sophisticated end users such as DR aggregators who are collecting and processing information from multiple users each of which is deploying a variety of controls and building control strategies.

The first OpenADR 2.0 specification, “OpenADR 2.0 Profile Specification A Profile” or OpenADR 2.0a, was released in 2011 and describes the overall OpenADR 2.0 framework and the features that would be required for a simple user (OpenADR Alliance 2011a).

The second OpenADR specification, “OpenADR 2.0 Profile Specification B Profile” or OpenADR 2.0b, was released in 2015 and describes the overall OpenADR 2.0 framework and the features that would be required for a more sophisticated user (OpenADR Alliance 2015).

The OpenADR Alliance offers opportunities for manufacturers to "certify" products to one of two OpenADR 2.0 profiles: OpenADR 2.0a or OpenADR 2.0b.[11] To certify products, a manufacturer must be a Contributing Members of the OpenADR Alliance. Products must be tested at a certified test laboratory. The test lab conducts test to confirm that the product meets all requirements.

Requiring the use of an OpenADR 2.0 (a or b) certified VEN provides assurance that all Title 24-compliant buildings that have DR controls are capable of communicating through an OpenADR 2.0 network, which provides reliability, security, and interoperability. It also ensures that the that the control system will continue to be capable of communicating with DR signalers for years to come, even if the initial occupant does not enable the controls and does not participate in any DR programs.

The CASE Team is recommending that all DR controls installed for Title 24, Part 6 have a VEN that is certified to OpenADR 2.0a or OpenADR 2.0b for the following reasons:

- **Title 24, Part 6 should require controls that can be used to participate in DR programs:** The purpose of the DR control requirements in Title 24, Part 6 standards is to ensure that newly constructed buildings have controls in place so they are *capable* of participating in ADR) programs[12] or DR thermostat programs should the building occupant choose to *enable* the control system and *enroll* in a program. Aligning Title 24, Part 6 with existing program eligibility requirements will help ensure that buildings that are compliant with the building code can participate in DR programs.

  As of April 2017, all three electricity IOUs and SMUD have an eligibility requirements for ADR and DR thermostat programs requiring that DR control systems use OpenADR certified VENs. The three IOUs and SMUD represented over 70 percent of California's electricity consumption in 2015.[13]

  Local DR programs may have more stringent eligibility requirements than the minimum requirements that are proposed for Title 24, Part 6 and therefore apply to the entire state. The Statewide CASE Team recommends pursuing opportunities through the code requirements in Title 24, Part 6 and through guidance provided in the compliance manuals encourage or designers to specify DR control systems that meet local DR program eligibility requirements.

- **Standardizing around OpenADR certification will provide consistency as new DR programs emerge:** It has taken many years for the IOU DR programs in California to standardize to one communication protocol. Now that all IOUs are requiring the use of OpenADR 2.0 certified products, manufacturers of controls equipment can develop products that meet the program requirements throughout California. It is anticipated that in the future DR programs will be offered by a wider variety of market actors including by Community Choice Aggregation entities and DR aggregators bidding directly into wholesale markets. Including a requirement in Title 24, Part 6 that DR controls use OpenADR 2.0 certified products will encourage emerging DR programs to further standardize the communications networks in California. This standardization will help manufacturers anticipate eligibility requirements into the future, which is helpful for long-term planning.

- **Stakeholders provided feedback to require OpenADR:** During the public stakeholder meeting held on March 28, 2017, the CASE Team asked stakeholders their preference for using

[11] The OpenADR Alliance does not offer certification to earlier versions of the OpenADR specification (that is, OpenADR 1.0).

[12] http://pge-adr.com/act/eligibility/

[13] http://www.ecdms.energy.ca.gov/elecbyutil.aspx

OpenADR as the external communication protocol. A wide variety of stakeholders suggested that requiring compliance with OpenADR 2.0 was appropriate.

- **OpenADR 2.0 address interoperability, reliability and security:** OpenADR 2.0a and OpenADR 2.0b include requirements that address the interoperability, reliability and security.
- **Most DR controls are already certified to OpenADR 2.0a or OpenADR 2.0b:** As of April 2017, there are dozens of companies who have collectively certified 226 products to one of the two OpenADR 2.0 specifications.[14] This is a majority of manufacturers who are active in the California DR markets. That is, most market actors who are participating in California's DR markets already have certified products or are pursuing OpenADR 2.0 certification already.

Anticipated Comments and Request for Feedback

- **Anticipated Comment:** Certifying products can be expensive. Manufacturers must be a Contributor member of the OpenADR Alliance, which costs between $1,500 and $7,500 per year depending on the manufacturers' revenue. Testing must be conducted at an OpenADR Alliance test lab, which costs between $4,500 and $10,000 depending on the supported features of the product being tested.[15]
    - **Response:** Certification can be expensive, but manufacturers already must certify products if they wish to be eligible for IOU and SMUD ADR programs. Title 24 is not adding a cost. Rather, it is requiring a certification that most manufacturers are already pursuing.
- **Anticipated Comment:** There are not many OpenADR 2.0 certified thermostats on the Energy Commission's certified Occupant Controlled Smart Thermostat list.[16] All but one of the 70 listed thermostats use OpenADR 2.0 *compliant*, but few thermostats are actually OpenADR 2.0 *certified*.
    - **Response:** The thermostat itself does not need to be certified for the thermostatic control system to have a certified VEN. The VEN can be located off-site, including in the cloud. Thermostat programs offered by the three IOUs and SMUD allow a variety of VEN configurations for thermostat programs. Thermostat manufacturers can offer the following options: each thermostat has its own integrated VEN, there is one on-site VEN (usually in a gateway) that receives DR signal for the entire building, or there is one off-site VEN (usually in the cloud) for the entire building. Third parties (not the manufacturer) can also offer thermostat programs. The third-parties usually offer a VEN solution where the VEN is off-site (usually in the cloud). The OpenADR Alliance does currently certify cloud-based VENs and as of May 2017, there are many cloud-based certified products.

      Although there are not many OpenADR 2.0 certified thermostats, there are a number of VENs that can serve thermostatic control systems. These VENs can be located on-site or off-site.
- **Anticipated Comment:** What is the difference between a certified VEN and a certified system?

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[14] http://products.openadr.org/?posts_per_page=-1

[15] The OpenADR certification requirements and fees are available here: http://www.openadr.org/build-a-product.

[16] http://www.energy.ca.gov/title24/equipment_cert/ocst/

    - **Response:** Title 24, Part 6 would not require that each unique system configuration be certified. Rather, it would require that systems be designed using an OpenADR 2.0 certified VEN as a component of the control system. It will be the responsibility of the building designer, the controls contractors, and the mechanical subcontractors to ensure that the OpenADR 2.0 certified VEN is integrated into the design of the larger lighting or HVAC system in such a way that the system will function properly and to confirm that the VENs are installed correctly Allowable system configurations are discussed in more detail below.

- **Anticipated Comment:** How do I know if a product is OpenADR certified?
    - **Response**: The OpenADR Alliance maintains a database of certified products. Manufacturers will also know if a product has been certified (http://products.openadr.org/). The designer (and the plans examiner) can confirm the VEN is certified by checking the OpenADR database.
- **Anticipated Comment:** Should Title 24, Part 6 allow certification to OpenADR 2.0a, OpenADR 2.0b, or a version of OpenADR that is released at a future date?
    - **Response:** It is not prudent to develop a building code requirement that would allow products to be certified to a yet-to-be developed or approved specification. It is impossible to predict what a future version of the OpenADR specification might include. For the 2019 standards, which will be in effect from January 2020 through December 2022, the Statewide CASE Team recommends that products be certified to OpenADR 2.0a or OpenADR 2.0b. These are the two specifications that are available and in use today. If the OpenADR Alliance develops and approves a new specification, they could write it in such a way that certifying to the new specification would also result in compliance with either OpenADR 2.0a or OpenADR 2.0b. Since Title 24, Part 6 is revised on a three-year cycle, if a new OpenADR specification is approved, the Title 24, Part 6 requirements could be updated for the 2022 Standards to accommodate the new OpenADR specification.
- **Anticipate Comment:** Some manufacturers do not have OpenADR certified products,
    - **Response:** The market is standardizing around OpenADR certification. Manufacturers who do not wish to certify products cannot participate in IOU DR programs. The Statewide CASE Team will conduct outreach to key manufacturers who do not already have certified products to discuss impacts of proposed Title 24 requirement.
- **Anticipated Comment:** The VEN that is specified at the time of new construction may not meet the needs of the customer when they want to participate in DR. Voluntary utility programs provide technology incentives to assist customers in converting from no participation in DR programs to manual or semi-automated DR participation, to full ADR participation. Doing so usually requires a fair amount of education and assessment of each facilities' operating conditions and the occupants' relative comfort with various DR control strategies, which may include only HVAC, only lighting, both HVAC and lighting, or HVAC and lighting plus additional load reductions. Today, these conversations are necessary to determine the best DR load shed plan. The selected VEN will depend on the required functions.
- **Anticipate Comment:** OpenADR is the currently accepted communications protocol by all the IOUs in California plus SMUD for retail DR programs. However, CAISO is starting to turn to DR more and more as a capacity resource in the wholesale markets. The CAISO uses different protocols for communicating and requesting capacity from resources. Distribution engineers inside the IOUs are also looking at DR to reduce local capacity constraints or defer distribution upgrades, firm distributed renewables. These groups may use proprietary communications to

call for load modification by customers. The communication protocols used by CAISO and utility distribution teams have different payloads (data and information) or other requirements that is not available in the OpenADR protocol. Also in this scenario, an OpenADR VEN that is specified at the time of new construction would need to be replaced, and the initial investment by the customer thus wasted.

The Statewide CASE Team is tracking this issue. If appropriate, the communication protocol requirements can be revisited during the 2022 code cycle if the market evolves and the wholesale markets converge on a new or different protocol.

Internal Communication Requirements

Problem Statement – Internal Communication Requirements

Existing Title 24, Part 6 requirements for internal communications are vague and inconsistent across all DR controls requirements. The vague and inconsistent requirements is causing confusion and suspected compliance and enforcement issues.

See Table 10 for a summary of the existing internal communication requirements for each type of required DR control.

Table 10: Existing Communications Requirements for DR Controls

Existing DR Control Requirement	Existing Physical Communication Protocol	Relevant Code Sections
Nonresidential DR HVAC Control (DDC to the Zone Level)	Implies DR signals must be routed through EMCS[a]	120.2(b), 120.2(h), NA7.5.10
Nonresidential DR HVAC Control (DDC not to the Zone level)	• Must have Wi-fi or Zigbee, or Ethernet • Communication allowed to the device level (thermostat) or through a "networked system of devices"	JA5
Nonresidential DR Indoor Lighting Controls	Open-ended[b]	130.1(e), NA7.6.3
Nonresidential DR Sign Lighting Controls	None	130.3(c)
Nonresidential Electrical Power Distribution Systems	None	130.5(e)
Residential DR HVAC Control	• Must have either Wi-Fi or Zigbee • Communication allowed to the device level (thermostat) or through a "networked system of devices"	JA5

a. The acceptance test language states, "NA7.5.10.1 Construction Inspection. Prior to Acceptance Testing, verify and document the following: (a) That the EMCS interface enables activation of the central demand shed controls." This implies that buildings that have DR controls also have an EMCS and the DR controls are integral to the EMCS.

b. The acceptance test language states, "NA7.6.3.1 Construction Inspection. Prior to Functional testing, verify and document the following: (a) That the demand responsive control is capable of receiving a demand response signal directly or indirectly through another device and that it complies with the requirements in Section 130.1(e). (b) If the demand response signal is received from another device (such as an EMCS), that system must itself be capable of receiving a demand response signal from a utility meter or other external source."

Proposed Clarification of Physical Communications Requirements

The Statewide CASE Team recommends that Title 24, Part 6 require that all DR control systems have the capability of using one of the following protocols for communications within the building: Wi-Fi, ZigBee, BACnet, Ethernet, or hard-wiring. Control systems can have the capability to use other protocols, but at a minimum they must also have the capability of using one of five protocols.

The Statewide CASE Team recommends that Title 24, Part 6 avoid overly prescriptive or restrictive language in how VENs can be configured within the building control systems. The code requirements would allow most configurations, as long as the meet the following requirements:

- Each VEN must be capable of communicating with the control system it will be linked to if DR controls are enabled; and
- If the building has an EMCS, every VEN must have the capability of communicating with the EMCS

The proposed code language is short and simple. The Compliance Manual can provide additional clarification about allowable configurations. Some anticipated clarifications for allowable VEN configurations include:

- More than one VEN is allowed in each building.
  - Each building system (lighting, HVAC, other) can have a unique VEN
  - In some cases, there can be more than one VEN for DR lighting or HVAC controls (e.g., each thermostat may act as a unique VEN)
- VENs do not need to be physically located in the building (i.e., VENs in the cloud are allowed)
- VENs can be integrated as a component of the control or as a stand-alone device
- If the building has an EMCS, the EMCS does not have to have an VEN that is integral to the EMCS.

Discussion of Proposed Internal Communications Requirements

The Statewide CASE Team recommends that Title 24, Part 6 provide flexibility in how VENs are configured within building control systems. There is not currently sufficient standardization within the market to limit the available configuration options. Since DR markets are still evolving, it is critical that code requirements do not inhibit innovation. The market is still exploring, iterating, and innovating to find the best way to use the OpenADR framework to communicate openly, reliably, and securely. The proposed Title 24, Part 6 requirements would allow ample flexibility in how control systems could be configured. If the market settles upon a standard configuration in the future, it might be appropriate to consider limiting the allowable configurations though the building code.

Some common configurations are described below. Figure 6 depicts a configuration where OpenADR 2.0 links are used for communication from the entity that initiates the DR signal to a VEN that is located on-site VEN. The right side of Figure 7 depicts a configuration where the DR signal uses OpenADR 2.0 links between the entity that initiates the DR signal and an off-site VEN/VTN (in this case, depicted as a DR aggregator) and the link between the VEN/VTN (aggregator) using a communication protocol that is not OpenADR 2.0. In this configuration, it is common for the link between the off-site VEN/VTN and the load on the site to use a proprietary communication protocol. The Statewide CASE Team prefers the configuration that uses OpenADR 2.0 links all the way to the site because using OpenADR 2.0 all the way to the site can help address concerns about stranded assets. However, configurations that use a proprietary communications protocols between an off-site VEN/VTN and the site are very common. Market actors who provide products and services to facilitate DR communications and participation in DR programs have an interest in ensuring security and reliability. At the time of writing, the market is exploring ways in which configurations that use off-site VEN/VTNs can safeguard against stranded assets if a market actor that controls the proprietary portion of the communication link goes out of business or can no longer provides the DR communication services that it offers today. Given the market is evolving, and it is difficult to predict the direction industry might take around the use of off-site VEN, the Statewide CASE Team recommends that Title 24, Part 6 allow configurations where

VENs are located off-site, at least for the 2019 code cycle. Throughout the 2019 code cycle, industry can continue to explore how to provide security, reliability, and safeguard against stranded assets when using off-site VENs. The CASE Team recommends revisiting the Title 24, Part 6 requirement regarding the physical location of VENs during the 2022 code cycle.

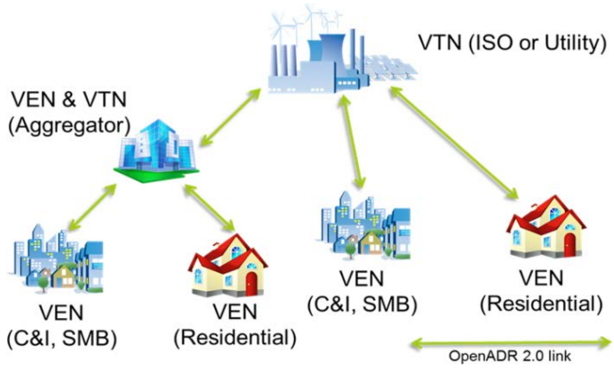

Figure 6: Configuration of communication using OpenADR 2.0 links from signaler to on-Site VEN

Source: (OpenADR Alliance 2017)

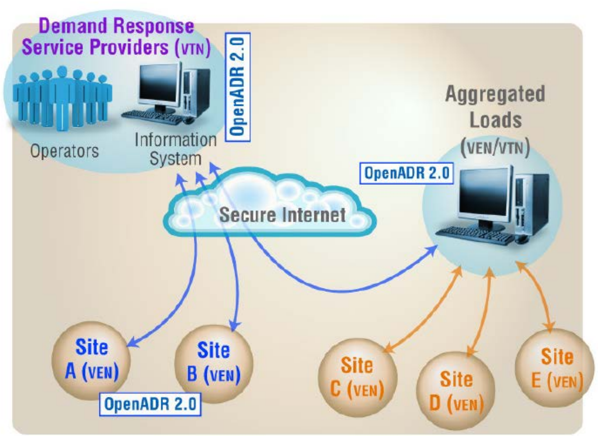

Figure 7: Configuration of communication using OpenADR 2.0 links from signaler to off-site VEN to site

Source: (OpenADR Alliance 2011b)

Figure 6 and Figure 7 depict configurations where these is only one VEN per building site. It is possible to have more than one VEN per building with a separate VEN for each building system that has DR controls. For example, one VEN for DR lighting, a second VEN for DR HVAC, and additional VENs of other DR building systems.

Table 11 presents examples of common DR communication configurations that are in use today and would be allowed during the 2019 code cycle if the Statewide CASE Team's proposal is adopted. The examples are illustrative and are not intended to encompass all possible configurations. The proposed code language will be structured to allow a variety of configurations.

Table 11: Examples of Allowable VEN and Control Configurations for Enrolled DR Programs (Retrofits and New Construction)

Example Configuration	Are All DR Controls Integrated	VEN Configuration	Building Controls	EMCS Present?	Notes
1	N/A only one DR control system	• Building only has either DR Lighting OR DR HVAC (not both) • One VEN	Only one DR control system (communication amongst controls not applicable)	No	Most common design
2	No. Control strategies for each DR system function independently; no interactive communication or cross-system decisions on control strategies.	• Separate VENs for each DR system • Every VEN is on-site: o One on-site VEN for DR lighting o Second on-site VEN for DR HVAC o Additional on-site VENs for other DR systems	Separate control (brain) for each DR system: • DR lighting control system • DR HVAC controls system • Additional DR control system for other building systems	No	Not common
3		• Separate VENs for each DR system • Every VEN is off-site (in cloud): o One off-site (in cloud) VEN for DR lighting o Second off-site (in cloud) VEN for DR HVAC o Additional off-site (in cloud) VENs for other DR systems	Separate control for each DR system: • DR lighting control system • DR HVAC controls system • Additional DR control system for other building systems	No	Likely most common for new construction
Combination of 2 and 3		• Separate VENs for each DR system • One or more VEN on-site; one or more VEN off-site • Example: o VEN for DR HVAC controls is off-site (cloud) o VEN and lighting control is on-site VEN	Separate control for each DR system: • DR lighting control system • DR HVAC controls system • Additional DR control system for other building systems	No	Not common for new construction
4		• One or more VENs on-site o One on-site VEN for DR lighting o Second on-site VEN for DR HVAC o Additional VENs for other DR systems • EMCS but does not have an integral VEN	• On-site EMCS controls multiple systems in the building • EMCS controls both DR lighting and DR HVAC	Yes – on site	Rare, but allowed
5	Yes. Central processing of DR signals	• One VEN that receives DR signals for all building systems • VEN is integral to EMCS (or a separate VEN networked to EMCS)	• On-Site EMCS controls multiple systems in the building • EMCS controls both DR lighting and DR HVAC	Yes: on-site VEN	Rare, but allowed

The VEN can be configured with the building control system in multiple ways. In some cases, the VEN is integral to the control. That is, the VEN is a component of the control system and is contained within the same physical unit as the controls. Examples of manufacturers that offer integrated controls include: Daintree or Enlighted (lighting controls with integrated VENs) and Automated Logic Corporation or Honeywell (EMCS manufacturers that have integral VENs). It is also common for the VEN to be physically separated from the control system. That is, the VEN is a stand-alone unit that is networked with the control system so communication between the VEN and the control happens seamlessly. Examples of control strategies that use stand-alone VENs include: Universal Devices Inc., Gridling by IC Systems, and Jace by Honeywell. The 2019 Title 24, Part 6 standards would allow the VEN to be integral to the control or a stand-alone device.

Allowable configurations of VENs in utility ADR and DR thermostat programs.

For the most part, the IOU ADR programs prefer VENs to be located within the building site. Off-site VEN solutions, including cloud-based VENs raise more concerns about stranded assets because the communication link between the off-site VEN and the controls located within the building occur over a proprietary communication link (see depiction on the right side of Figure 7). PG&E and SCE allow off-site VENs to be used for ADR programs if the building's average peak summer demand is less than 500 kW. This threshold is in place to prevent larger loads from becoming stranded assets.

Another option that is used by several large companies that have multiple buildings participating in DR programs is to have both the VEN and the EMCS located off-site. The off-site VEN and EMCS is often located at the company headquarters (sometimes located in a different state), and controls the DR control strategy for an entire portfolio of buildings.

The IOU DR thermostat programs allow VENs to be on-site or off-site, with most off-site VENs being located in the cloud.

Local DR programs may have more stringent eligibility requirements than the minimum requirements that are in Title 24, Part 6 that are applicable to the entire state. The Statewide CASE Team recommends pursuing opportunities through the code requirements in Title 24, Part 6 and through guidance provided in the compliance manuals encourage designers to specify DR control systems that meet local DR program eligibility requirements.

Anticipated Comments and Request for Feedback

- **Anticipated Comment:** Do VENs have to be physically located in the building?
    - **Response:** No. Although utilities and others prefer the VENs to be physically located in the building to avoid stranded assets, the market is currently exploring with off-site VENs (i.e., VENs in the cloud). PG&E currently allows VENs to be in the cloud if the average peak summer demand is under 500kW. With the market evolving, it is probable that DR program eligibility requirements regarding VENs in the cloud will evolve when the 2019 standards are in effect (January 1, 2020 – December 31, 2021). Although the Statewide CASE Team would like to see safeguards against stranded assets, the market is still exploring and innovating using VENs in the cloud. The code should not inhibit innovation. It is recommended that VENs in the cloud are allowed in Title 24, Part 6 for the 2019 code cycle, but the requirements should be revisited for the 2022 code cycle. As discussed, the Statewide CASE Team is recommending several code requirements to encourage designers to specify control systems (including VEN configurations) that qualify for DR programs. This step will help ensure that the VEN configurations specified for Title 24 compliance will also meet local DR program eligibility requirements, which may change over the course of the 2019 Standards.

- **Anticipated Comment:** Doesn't it make more sense for all DR signals coming into the building to be routed through a central location within the EMCS and for the EMCS to determine the appropriate response for each unique DR signal?
    - **Response:** Establishing a structure whereby the building's control system implements customized DR strategy based on a single DR signal is a rational hope for the direction for DR controls to take in the future. This is not, however, a common or most cost-effective configuration for DR controls that are used today. It might become more common in the future. It is more common for lighting and HVAC systems to have separate control systems with no central EMCS. In small-to-medium sized buildings that only have lighting or HVAC controls (not both), it is common for the DR controls to operate independently of other building controls. The lighting system and the HVAC system can have different control strategies programmed that can be initiated automatically when a DR signal is received, and each system can deploy with different control strategies implemented based on the type of signal (e.g., price signal v. peak demand signal).

      Although it is not common today, it is possible for all DR signals intended for lighting, HVAC, and other systems to be routed through one VEN. This can be accomplished by having a VEN integral to the EMCS (the VEN could also be a stand-alone device that is networked to the EMCS). The EMCS interprets the DR signal from the VEN and initiates the appropriate control strategy for all building systems.

      It is also possible for all DR signals to be routed through a single VEN located off-site or in the cloud. The lighting or HVAC controls or EMCS then determines the appropriate response for each DR system within the building. A modification of this configuration has both the VEN and the EMCS located off-site with the EMCS controlling more than one building. For example, a company that has more than one building participating in a DR program can have one VEN and one EMCS that controls dozens of buildings.

      The most common (and least expensive) configuration is for the lighting and HVAC systems to respond separately. This configuration does allow for customized responses based on the DR signal. Although there are benefits to have all DR signals going to a building to be routed through one VEN, this is not a common configuration today. For the sake of allowing and encouraging innovation, the CASE Team recommends not including a requirement that all signals be routed through one VEN. Throughout the 2019 code cycle, DR programs can encourage industry to pursue whole-building DR control strategies by offering higher incentives for this type of configuration. The requirement to route DR signals through a single VEN can be reconsidered for the 2022 code cycle after the market has an opportunity to evolve more and for DR programs have an opportunity to encourage configurations that provide reliability, security, and persistent savings while minimizing risk of stranded assets.
- **Anticipated Comment:** The communication between the DR signaler and the building occurs mostly outside of the building itself. Communication protocols are also more pertinent to DR programs than building codes. Why are there building codes that dictate the required communication protocols?
    - **Response:** As discussed, the DR control system often includes some components inside the building and some components are sometimes located outside of the physical boundaries of the building site (e.g., cloud-based VENs). The building code traditionally only covers equipment and components that are physically located within

the building. The fact that VENs can be located off-site challenges the existing boundaries of what should be included in the building code. Allowing the VEN to be located off-site is an attempt to provide sufficient flexibility for the industry to meet the requirements while also allowing the markets to innovate and mature.

Coordination with DR Programs

A key goal of the DR Cleanup CASE effort is to clarify the code requirements in a way that results in increased enrollment in DR programs given the variation in how DR controls systems are configured. The CASE Team is recommending that the 2019 standards allow a wide variety of configurations. Although the code would allow many configurations, it is critical that the building designer specify a system that meets eligibility requirements for DR programs, which may be more stringent than what is allowable in the code. In addition to clarifying the communications requirements, the CASE Team recommends the following requirements be added to Title 24, Part 6 to encourage designers to specify controls strategies that qualify for DR programs offered in the area.

- Designers of DR controls, other than thermostats compliant with JA5, would be encouraged to check with the local utility and specify controls that meet local ADR program eligibility requirements.
- Manufacturers of JA5 compliant DR thermostats would be required to answer a question in their certification disclosure document indicating whether it meets local ADR program eligibility requirements including those offered by Community Choice Aggregation entities, DR aggregators and CAISO.

Appendix D: DETAILED DR-RELATED REQUIREMENTS IN TITLE 24, PART 6

The following tables outline the DR requirements in Title 24, Part 6 for indoor lighting, HVAC, and sign lighting.

Table 12: Indoor Lighting DR-Related Requirements

Criteria	ADR Requirements	Code Reference
• Buildings larger than 10,000 square feet • Spaces where the lighting power density is greater than 0.5 watts/square foot • Other exceptions apply - see §130.1(e) for details	Lighting system must be capable of reducing power by a minimum of 15 percent below the total installed lighting power in response to a DR signal using at least one standards-based messaging protocol.	§130.1(e); §130.5(e); §100.1: Definition of Demand Response Signal; §100.1: Definition of Demand Responsive Control;
	Lighting shall be reduced in a manner consistent with uniform level of illumination requirements as listed in Title 24, Part 6 Table 130.1-A Multi-Level Controls and Uniformity Requirements.	§130.1: Table 130.1-A
	An EMCS is optional – it may be substituted for a lighting control system if it complies with all relevant lighting control system requirements.	§130.5(f)(1)

Table 13: HVAC DR-Related Requirements

Criteria	ADR Requirements	Code Reference
• HVAC system with DDC to the zone level • Non-critical Zones (Zones in which reset of zone temperature setpoint during a demand response event will not disrupt a process served by the zone – see §100.1, Definition of Critical Zone and Definition of Non-Critical Zone	Controls must be capable of responding automatically to a DR signal using at least one standards-based messaging protocol.	§120.2(b); §120.2(h)(5)(C); §130.5(e); §100.1: Definition of Demand Response Signal; §100.1: Definition of Demand Responsive Control;
	Controls must be capable of remotely increasing the operating *cooling* temperature setpoints by 4°F or more in all non-critical zones upon receiving a signal from a centralized contact or software point within the EMCS.	§120.2(b); §120.2(h)(1)
	Controls must capable of remotely decreasing the operating *heating* temperature setpoints by 4°F or more in all non-critical zones upon receiving a signal from a centralized contact or software point within the EMCS.	§120.2(b); §120.2(h)(2)
	Controls must capable of remotely resetting the temperatures in all non-critical zones to original operating levels upon receiving a signal from a centralized contact or a software point within the EMCS.	§120.2(b); §120.2(h)(3)
	Controls must be capable of being programmed to provide an adjustable rate of change for the temperature adjustments.	§120.2(b); §120.2(h)(4)
	Controls must have a "disable" feature that allows authorized facility operators to disable the controls.	§120.2(b); A §120.2(h)(5)(A)
	Building must have an EMCS or dry contacts to allow manual, global adjustment of heating and cooling setpoints from a single point by authorized facility operators.	§120.2(h)(5)(B) A; Non-Residential Compliance Manual 4.5.1(o) and 13.7.22

Criteria	ADR Requirements	Code Reference
• HVAC system has thermostatic controls for all unitary single zone air conditioners, heat pumps, and furnaces • System not serving process load that must have constant temperatures to prevent degradation of materials, a process, plants or animals. • Other exceptions apply – see §120.2(b)(4)	All thermostats must have a clock mechanism that allows the building occupant to program the temperature setpoints for at least four periods within 24 hours.	§120.2(b); §110.2(c); §130.5(f)(2)
	Thermostats must comply with specifications for Occupant Controlled Smart Thermostats (OCST) specified in Reference Joint Appendix JA5, including having the capability of responding automatically to an ADR signal using a standards-based messaging protocol.	§120.2(b); Reference Joint Appendix JA5; §110.2(c)
	An EMCS is optional – it may be substituted for thermostatic controls if it meets all thermostat requirements below.	§130.5(f)(2); §120.2(b); Reference Joint Appendix JA5

Table 14: Electronic Messaging Center ADR-Related Requirements

Criteria	Auto DR Requirements	Code Reference
New connected lighting power load greater than 15 kW. Exceptions apply.	Controls must can reduce the lighting power by a minimum of 30 percent upon receipt of an ADR signal.	§130.3(a)(3); §100.1: Definition of Demand Response Signal; §100.1: Definition of Demand Responsive Control

Appendix E: Potential Load Management Measures for Future Code Cycles

It is anticipated that as we move towards ZNE goals, it will be critical to establish code requirements that encourage load management strategies that allow buildings to achieve ZNE in ways that allow the grid to evolve to accommodate more distributed renewable energy and meet RPS goals. This code change proposal is intended to clean up existing DR requirements and establish a foundation on which measures that encourage smart ZNE through building control strategies can be more easily integrated into the code in future code cycles. Figure 5 lists potential Title 24, Part 6 code change proposals for consideration in future code cycles that could help encourage "smart" load management strategies. This list is included to help provide some context of possible direction the code could take in future code cycles, which the Statewide CASE Team considered when attempting to create a framework during this cleanup cycle that could accommodate future code revisions. These potential code change proposals include all ideas that the Statewide CASE Team has heard with no screening for priority or probability of adoption. They are listed in no order of importance or probability of inclusion in future code cycles.

Table 15: Potential Load Management Title 24, Part 6 Code Change Proposals for Future Code Cycles

Building Type	Measure Name	Description
Residential	Mandatory Requirement for Smart Thermostats	Require DR T-stats in residential buildings. OCSTs are currently a trade-off for solar ready requirements. Make them mandatory for all new residential buildings. Would want to explore how savings from smart thermostats are achieved. Do occupants manage their smart t-stats on their own in a way that achieves savings, or do occupants need to work with a service provider to achieve reasonable savings? Include service provider fees in cost-effectiveness analysis. If occupants aren't using service provider, then may want to look at default settings for smart t-stats to ensure they are shipped with appropriate settings to assure occupant comfort while also achieving energy conservation on a regular basis and/or load shifting on key days or on regular basis depending on appropriate strategy for each CZ.
Residential	DR Electric Water Heaters Prescriptive Option	Add a prescriptive alternative prescriptive option that includes the use of electric water heater (heat pump water heater) with DR capabilities. Heat pump water heater with DR.
Residential and Nonresidential	DR Control Prescriptive / Performance Budget	Establish prescriptive requirements for DR control options. This would require some defined control options through the prescriptive path that could not be traded against efficiency measures or other measures whose savings are more assured (e.g., solar PV, battery storage). These prescriptive controls options would be options whose savings are certain based on a market assessment (that would need to be conducted) that demonstrates that a reasonable percentage of occupants of buildings with the given control capability use the control feature to achieve energy (and energy cost) benefits. This measure would also establish compliance options in the performance approach that could only be used to trade off against the prescriptive control requirements. For example, the prescriptive requirement might be install DR lighting controls that automatically dim lighting x percent for the duration of the DR event. The performance approach might include modeling rules for a number of DR control options. The builder would install a control that is programmed to automatically initiate one or more DR control option available in the performance approach that would allow them to achieve equivalent energy benefit to the prescriptive lighting dimming requirement. For this approach to be successful, there would need to be a number of DR control options added to CBECC along with some sort of control commissioning requirement to demonstrate the control programmed appropriate to implement the selected control strategies. This could be a 2-3 code cycle effort. Might start by adding some alternatives to the existing mandatory 4ºF temperature setback and 15 percent dimming requirement along with a control commissioning requirement if the alternate path is chosen. Then move the limited mandatory alternatives into CBECC and start developing more DR control options for CBECC. This effort will require data to be collected from a variety of buildings across climate zones to identify how load profiles change as a result of different DR strategies.
Nonresidential	Additional Nonresidential DR Control Options	Consider adding alternative DR Control requirements/options for Nonresidential buildings apart from 4ºF temperature set points. Include looking at compressor cycling. Currently, systems must be capable of automatically initiating only one response for the duration of the DR event (required HVAC Response: 4ºF temperature setback; required lighting response: 15 percent dimming). The system can be capable of initiating different responses and if occupants participate in DR events they can tailor their response as appropriate, but Title 24, Part 6 requires and test for the one response. Revisit the response requirements so they more closely resemble responses that are actually

Building Type	Measure Name	Description
		being deployed and/or responses that are needed. For example, explore options for compressor cycling, or compressor + fan cycling. Develop strategies that won't preclude participation in fast DR.
Residential	Additional Residential DR Control Options	Consider adding alternative DR control requirements apart from 4-degree temp setbacks including options for residential adaptive pre-cooling.
Residential and Nonresidential	Require Thermostats to Obtain Pricing Controls	Require thermostats to obtain pricing controls from the utility.
Residential and Nonresidential	DR Controls Labeling	Adopt a labeling requirement for thermostats and other control systems that have demand responsive capabilities. This would make it easier for field inspectors to verify compliance with building code requirements.
Nonresidential	Nonresidential DR Control Hierarchy	Currently lighting systems and HVAC systems are controlled separately. The two systems do not communicate with one another to determine the appropriate response to each DR event. Is there value in having all responses within the building coordinated, or at least communicated in one central location? Explore if code should continue to treat all DR control requirements for independently by building systems. If decided that having a centralized control and/or a system that reports all scheduled response and/or current status of responses in one location for the building owner/manager/occupant, then explore code opportunities to promote centralized control and/or reporting. There may be opportunities to harmonize with industry virtual end node (VEN) requirements/practices. There may also be opportunities to expand and/or revised building energy system metering and monitoring requirements (Section 130.5) to accommodate requirements for centralized control and/or reporting of all DR controls within the building. This may be a candidate for a compliance credit (if a DR prescriptive / performance path is established first).
Nonresidential	DR Control Commissioning Acceptance Testing	Consider revisions to Nonresidential DR HVAC Control acceptance testing to match required tests to more closely match occupant's DR strategy and to make it easier for acceptance test technicians to complete. It can cost tens of thousands of dollars to upgrade EMCS systems in relatively new buildings so they are capable of initiating a response that is appropriate for the building and its occupants. This includes confirming that the control action does not inadvertently impact building systems that it should not impact. Should DR commissioning occur for Title 24, Part 6 compliance - perhaps offer a compliance credit through the performance approach (if a DR performance path is established) that provides higher DR credit if commissioning occurs before Title 24, Part 6 compliance verification? Should DR control commissioning occur after the occupancy certificate has been issued? Each customer's DR response should be customized. It may be more appropriate to fully commission of the control system after the Title 24, Part 6 compliance process is completed. If this is the case, how can the Title 24, Part 6 compliance process help simplify /streamline the DR control commissioning process?
Residential and / Nonresidential	Energy Reporting User Interfaces to Help Inform Occupants' Behavior	Consider requirements for residential Home Area Networks or other energy reporting technologies that provide users with feedback on energy use for various energy systems within the building. This could be zone-level reporting or reporting on specific energy systems (e.g., lighting, HVAC, plug loads in specific circuits).
Nonresidential	Submetering of curtailable loads	Establish submetering requirements for curtailable loads.
Residential	Plug Load Controls	Consider requirements for residential plug load controls.

Building Type	Measure Name	Description
Residential and /Nonresidential	Smart ZNE Management Strategy Trade-offs	Trade-off options for integrated demand side management strategy measures.
Nonresidential	Plug Load Controls	Consider expanding plug load controls to other space and/or building types including schools.
Nonresidential	DR Controls for Additional Loads (1 of 2)	Establish DR control requirements for 220v circuits.
Nonresidential	DR controls for Additional Loads (2 of 2)	Establish DR control requirements for forklift chargers in warehouses.
Nonresidential	Minimum Response Times for DR controls	Establish minimum response time for DR controls.
Nonresidential	Eliminate Max Power Reduction Test from DR Lighting Control Acceptance Test	Eliminate requirements in lighting acceptance test that lighting power cannot be reduced more than 50 percent.
Nonresidential	Revise DR Lighting Test Control Strategy	Revise existing requirement that lighting power be reduced by at least 15 percent. Alternatively, require a certain percentage of lighting power to be reduced, but do not specify a minimum required reducing in lighting power.
Nonresidential	Revise Building Size Threshold Requirement for DR Lighting Controls	Revise the existing requirement that DR lighting controls are required in buildings over 10,000 square feet. Some stakeholders recommended that the building size should be smaller; some recommended the building size should be larger. Others have recommended that the threshold should be based on “project” size, not building size.
Residential and Nonresidential	Compliance credit for appliances with DR capabilities	Establish compliance credit if appliances with DR controls are installed at time of permitting.
Residential and Nonresidential	Electric Vehicle Managed Charging	Establish requirements for electric vehicle charging that would harmonize with smart ZNE goals. Would not require chargers be installed, but would establish criteria for chargers if builder opts to install the charger.
Residential and Nonresidential	Battery Storage Ready Requirements	Consider requirements that would make it easier for building occupants to install battery storage systems at a future date. Similar concept to high-performance water heater ready and solar-ready requirements.
Residential and Nonresidential	Solar, Battery, and EV Infrastructure Communications Requirements	Consider if the building code should include requirements for the communications protocols for solar PV systems, battery storage, and electric vehicle charging infrastructure.

Building Type	Measure Name	Description
Residential and Nonresidential	Thermal Energy Storage Systems	Compliance options for thermal storage systems (including adding eligibility criteria, performance requirements, and potentially acceptance test).
Residential and Nonresidential	Battery Storage Systems	Compliance options for thermal storage systems (including adding eligibility criteria, performance requirements, and potentially acceptance test).
Residential and Nonresidential	Peak Load HVAC Performance	Evaluate peak load HVAC performance and consider revisions to compliance software to improve accuracy model hourly performance and therefore apply more accurate compliance credit based HVAC systems' impact on peak demand. If appropriate, consider prescriptive requirements for peak performance.
Residential and Nonresidential	Emergency generation, battery storage, renewables and DR integration	Consider compliance options that appropriately encourage the use of renewables and battery storage to optimize the integration of buildings with the grid. Also, consider if/how back-up generation should be integrated with battery storage systems.
Residential and Nonresidential	DC systems with DR controls	Consider compliance options for DC systems with DR controls. For example, a solar PV system directly powering a DC lighting system.
Residential and Nonresidential	Acceptance Test for VTN – VEN Link	Establish portable virtual top node (VTN) and modify DR acceptance tests to require that the link between the (VTN) and the VEN be tested as part of the acceptance test.
Nonresidential	DR Requirements for Outdoor Lighting	Establish requirements for DR controls for outdoor lighting.
Nonresidential	Revise Lighting Power Density Exception for DR Lighting Controls	Revise the existing 0.5 Watt/ft^2 Exemption for DR lighting controls.
Nonresidential	Revise Lighting Acceptance Test	Revise lighting acceptance test so all spaces are tested as opposed to the current procedure that allows only seven spaces to be tested.