# Proposal Summary

CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

**2022 California Energy Code (Title 24, Part 6)**

## Nonresidential Data Center Efficiency

Updated: Sunday, October 13, 2019

Prepared by: Hillary Weitze, Red Car Analytics

## Introduction

The document summarizes proposed revisions to the California Energy Code (Title 24, Part 6) that will be discussed during a utility-sponsored stakeholder meeting on October 15, 2019. The Statewide Utility Codes and Standards Enhancement (CASE) Team is seeking input and feedback. To provide your comments, email info@title24stakeholders.com by October 29, 2019.

## Measure Description

The data center efficiency CASE Report will improve energy performance of data center mechanical and electrical systems by including the following submeasures:

- **Uninterruptible Power Supply (UPS) Efficiency**
  This submeasure proposes adding minimum UPS prescriptive efficiency requirements for Ac-output UPS units used in computer rooms to match EnergyStar minimum efficiency requirements. The minimum average UPS efficiency takes into account UPS efficiency at 100%, 75%, 50%, and 25% load factor.
- **Computer Room Heat Recovery**
  Computer rooms with airflow containment that are controlled to ASHRAE's allowable upper limit for server inlet temperature (80.6°F)[1] can see high return air temperatures, in many cases in excess of 95°F to 100°F. This high air temperature can be used for direct heating in forced air systems, ventilation preheating, or process load heating. This submeasure proposes a prescriptive requirement to recover computer room return air heat for heating other building heating loads. Analysis will determine the building system constraints and computer room cooling loads for which this measure is cost effective.
- **Monitoring**
  This submeasure proposes a prescriptive requirement for computer rooms of a minimum size to have metering installed to calculate Power Usage Effectiveness (PUE) and server utilization rates and provide this data to the building operator in an accessible manner. This measure will be evaluated to determine metering, network, and data dashboard display requirements.
- **Increased Temperatures**

[1] ASHRAE. *Thermal Guidelines for Data Processing Environments, Fourth Edition*, 2015.

- Title 24-2019 prescriptively requires computer rooms to economize 100% of the cooling load with an air economizer at outside air temperatures of 55°F drybulb/50°F wetbulb and below, or to economize 100% of the cooling load with a water economizer at outside air temperatures of 40°F drybulb/35°F wetbulb and below. This submeasure proposes increasing the minimum drybulb temperature for 100% economizing and simplifying the economizer requirement to a single outside air temperature condition of 65°F drybulb/50°F wetbulb for any economizer type.
- Title 24-2019 prescriptively requires airflow containment for air-cooled computer racks for rooms exceeding 175 kW/room. Airflow containment is widely implemented in data centers, and there are many containment products on the market that make containment viable and cost-effective even for small computer rooms. This submeasure proposes reducing the IT load threshold where containment is required to 35 kW/room.
- This submeasure proposes raising the supply air temperature (SAT)/ return air temperature (RAT) from 60°F/80°F to 70°F/90°F in the baseline compliance modeling software model to better match industry standard practice. Many data centers are designing for a server inlet temperature of nearly 80°F per ASHRAE *Thermal Guidelines for Data Processing Environments*, *Fourth Edition*, 2015.

- **Generator Crankcase Heating**
  This submeasure prescriptively requires generators serving computer rooms to be located in an indirectly conditioned space. Generators must have dampers on both intake and exhaust. The goal of this measure is to reduce generator crankcase heating energy through reduced heat loss to the outdoors and more efficient heating sources. There are many options for reducing crankcase heater energy including transferring data center relief air into the generator room before exhausting it to the outdoors or using heat pumps for heating. The ACM will include a baseline heater heating load (Btu/hr) and heater efficiency based on this prescriptive requirement and multiple design options ranging from heating via computer room heat recovery to a worst-case heater efficiency for generators located outdoors without an enclosure using electric resistance heating. Heater runtime will vary depending on the generator location (outdoors vs. enclosed) and climate.
- **Liquid Cooling Credit in Compliance Software**
  This submeasure proposes adding a compliance credit in the compliance modeling software for data centers that use liquid cooling at the server chip level. Using liquid cooling instead of the air-cooled server cooling reduces energy use by eliminating server fan energy and computer room air handler fan energy.
- **Mandatory Measures**
  The following Prescriptive Requirements in Title 24-2019 will become Mandatory Requirements:
  - 140.9(a)2: Reheat
  - 140.9(a)3: Humidification
  - 140.9(a)5: Fan Control.

## Draft Code Language

The proposed changes to the Standards and Reference Appendices are provided below. Changes to the 2019 documents are marked with red underlining (new language) and ~~strikethroughs~~ (deletions). Expected sections or tables of the proposed code (but not specific changes at this time) are highlighted in yellow.

### Standards

**10-102 – DEFINITIONS**

**ALTERNATING CURRENT-OUTPUT UNINTERRUPTIBLE POWER SUPPLY (UPS)**: An ac-output UPS is a UPS that supplies power with a continuous flow of electric charge that periodically reverses direction.

**MODULAR UNINTERRUPTIBLE POWER SUPPLY (UPS):** A Modular UPS is a UPS comprised of two or more single UPS units, sharing one or more common frames and a common energy storage system, whose outputs, in Normal Mode of operation, are connected to a common output bus contained entirely within the frame(s). The total quantity of single UPS units in a modular UPS equals "n + r" where n is the quantity of single UPS units required to support load; r is the quantity of redundant UPS units. Modular UPSs may be used to provide redundancy, to scale capacity, or both.

**UNINTERRUPTIBLE POWER SUPPLY (UPS):** Combination of convertors, switches, and energy storage devices (such as batteries) constituting a power system for maintaining continuity of load power in case of input power failure. Input power failure occurs when voltage and frequency are outside rated steady-state and transient tolerance bands or when distortion or interruptions are outside the limits specified for the UPS.

**UNINTERRUPTIBLE POWER SUPPLY (UPS) NORMAL MODE:** Stable mode of operation that the UPS attains under the following conditions:

a) Alternating current input power is within required tolerances and supplies of the UPS.
b) The energy storage system remains charged or is under recharge.
c) The load is within the specified rating of the UPS.
d) They Bypass is available and within specified tolerances (if applicable).

**VOLTAGE AND FREQUENCY DEPENDENT (VFD) UNINTERRUPTIBLE POWER SUPPLY (UPS):** A UPS that produces an Ac-output where the output voltage and frequency are dependent on the input voltage and frequency.

**VOLTAGE AND FREQUENCY INDEPENDENT (VFD) UNINTERRUPTIBLE POWER SUPPLY (UPS):** A UPS where the device remains in normal mode producing and ac-output voltage and frequency that is independent of input voltage and frequency variations and protects the load against adverse effects from such variations without depleting the stored energy source.

**VOLTAGE INDEPENDENT (VI) INTERRUPTIBLE POWER SUPPLY (UPS):** A UPS capable of protecting the load as required for a Variable Frequency Dependent UPS and from under-voltage applied continuously to the input and over-voltage applied continuously to the input.

**SECTION 140.9 – PRESCRIPTIVE REQUIREMENTS FOR COVERED PROCESSES**

**(a) Prescriptive Space Conditioning Requirements for Computer Rooms.** Space conditioning systems serving a computer room with a power density greater than 20 W/ft$^2$ shall comply with this section by being designed with and having constructed and installed a cooling system that meets the requirements of Subsections 1 through ~~6~~5. Energy use from prescriptive computer room requirements can only be traded off among other computer room requirements.

1. **Economizers.** Each individual cooling system primarily serving computer rooms shall include ~~either~~:

A. An integrated ~~air~~ economizer capable of providing 100 percent of the expected system cooling load as calculated in accordance with a method approved by the Commission, at outside air temperatures of ~~56~~5°F dry-bulb/50°F wet-bulb and below, and be equipped with a fault detection and diagnostic system as specified by Section 120.2(i)~~; or~~

~~B. An integrated water economizer capable of providing 100 percent of the expected system cooling load as calculated in accordance with a method approved by the Commission, at outside air temperatures of 40°F dry-bulb/35°F wet-bulb and below.~~

**EXCEPTION 1 to Section 140.9(a)1:** Individual computer rooms under 5 tons in a building that does not have any economizers.

**EXCEPTION 2 to Section 140.9(a)1:** New cooling systems serving an existing computer room in an existing building up to a total of 50 tons of total cooling equipment capacity serving the computer room of new cooling equipment per building.

**EXCEPTION 3 to Section 140.9(a)1:** New cooling systems serving a new computer room in an existing building up to a total of 20 tons of total cooling equipment capacity serving the computer room of new cooling equipment per building.

**EXCEPTION 4 to Section 140.9(a)1:** A computer room with a design cooling load less than 50 tons may be served by a fan system without an economizer if it is also served by a fan system with an economizer that also serves other spaces within the building provided that all of the following are met:

~~i. The economizer system is sized to meet the design cooling load of the computer room when the other spaces within the building are at 50 percent of their design load; and~~

~~i~~i. The economizer system has the ability to serve only the computer room, e.g. shut off flow to other spaces within the building when unoccupied; and

ii. The economizer system can deliver either (a) the design computer room load, or (b) the available economizer capacity, to the computer room at all times. Available economizer capacity is the total cooling capacity of the economizer system on the same floor as the computer room and within 30 ft of the computer room minus the current cooling load of other spaces on that floor.

iii. The economizer system can deliver either (a) the design computer room load, or (b) at least 5 tons, to the computer room when there is no cooling load in other spaces on the floor.

~~iii. The noneconomizer system does not operate when the outside air drybulb temperatures is below 605°F and, the cooling load of other spaces within the building served by the economizer system is less than 50 percent of design load.~~

**EXCEPTION 5 to Section 140.9(a)1:** Computer rooms where at least 80% of annual computer room heat output is recovered by a heat recovery system with a heating COP at design conditions of at least 4.0. This includes recovering heat from the computer room for use by industrial processes outside of the building.

~~2. **Reheat.** Each computer room zone shall have controls that prevent reheating, recooling and simultaneous provisions of heating and cooling to the same zone, such as mixing or simultaneous supply of air that has been previously mechanically heated and air that has been previously cooled, either by cooling equipment or by economizer systems.~~

~~3. **Humidification.** Nonadiabatic humidification (e.g. steam, infrared) is prohibited. Only adiabatic humidification (e.g. direct evaporative, ultrasonic) is permitted.~~

~~4~~2. **Power Consumption of Fans.** The total fan power at design conditions of each fan system shall not exceed 27 W/kBtu·h of net sensible cooling capacity.

~~5. **Fan Control.** Each unitary air conditioner with mechanical cooling capacity exceeding 60,000 Btu/hr and each chilled water fan system shall be designed to continuously vary the airflow rate as a function of actual load and shall have controls and/or devices (such as two-speed or variable speed control) that will result in fan motor demand of no more than 50 percent of design wattage at 66 percent of design fan speed.~~

~~6~~3. **Air Containment.** Computer rooms with air-cooled computers in racks and with a design load exceeding ~~175~~ 35 kW/room shall include air barriers such that there is no significant air path for computer discharge air to recirculate back to computer inlets without passing through a cooling system.

**EXCEPTION 1 to Section 140.9(a)~~6~~3:** Expansions of existing computer rooms.

**EXCEPTION 2 to Section 140.9(a)~~6~~3:** Computer racks with a design load less than 1 kW/rack.

**EXCEPTION 3 to Section 140.9(a)~~6~~3:** Equivalent energy performance based on computational fluid dynamics or other analysis.

4. **Heat Recovery.** A computer room with a total design IT load exceeding 500 kW located in a building with a design comfort or process heating load of over 500 kW shall have a heat recovery system capable of transferring at least 50% of the design IT load or at least 50% of the design heating load from the computer room to the space or process requiring heating.

   The heat recovery system shall have a heating coefficient of performance (COP) of at least 4.0 at design conditions. The heat recovery system consists of the energy consuming mechanical equipment (pumps, fans, etc.) which has a dedicated function of transferring heat from the computer room to a heating load. Heating COP = heat transfer in kW divided by total power of dedicated heat recovery equipment input power in kW.

   **EXCEPTION 1 to Section 140.9(a)4**: Buildings that use heating equipment with a design COP of 3.5 or greater, where COP equals design heating load in kW divided by the total input power of the heating equipment.

5. **Generator Crankcase Heating**. Generators serving computer rooms are required to be located in enclosures with a wall insulation U-value no greater than that for Heavy Mass Walls in Section 120.7(b). Generators must have dampers on both radiator intake and radiator exhaust. Generator crankcase heaters are required to be thermostatically controlled.

   **EXCEPTION 1 to Section 140.9(a)5:** Thermostatic controls are not required for generator heating provided by recovered heat.

**(b) Prescriptive Uninterruptible Power Supply (UPS) Requirements for Computer Rooms.** Alternating Current (Ac)-output uninterruptible power supply systems serving a computer room shall comply with Subsections 1 and 2 below. Energy use from prescriptive computer room requirements can only be traded off among other computer room requirements.

**1. Uninterruptible Power Supply Efficiency**. Ac-output UPS units must meet or exceed the efficiencies in Table 140.9-XX.

***Table 140.9 – XX** Minimum Average UPS Efficiency ($Eff_{ave}$):*

| Rated Output Power ("P") | Voltage and Frequency Dependent (VFD) | Voltage Independent (VI) | Voltage and Frequency Independent (VFI) |
|---|---|---|---|
| P ≤ 350W | $5.71 * 10^{-5} * P + 0.962$ | $5.71 * 10^{-5} * P + 0.964$ | $0.011 * LN(P) + 0.824$ |

| | | | |
|---|---|---|---|
| 350W < P ≤ 1500W | 0.982 | 0.984 | |
| 1,500W < P ≤ 10,000W | 0.981 - $E_{MOD}$ | 0.980 - $E_{MOD}$ | 0.0145 * LN(P) + 0.800 - $E_{MOD}$ |
| P > 10,000W | 0.970 | 0.940 | 0.0058 * LN(P) + 0.886 |

Where $Eff_{ave} = t_{25\%}*Eff_{25\%} + t_{50\%}*Eff_{50\%} + t_{75\%}*Eff_{75\%} + t_{100\%}*Eff_{100\%}$

$Eff_{xx\%}$ = UPS efficiency at *xx*% load
$t_{xx\%}$ = proportion of time spent at *xx*% load
$E_{MOD}$ = allowance of 0.004 for Modular UPSs applicable in the 1500–10,000W range.
*LN* = natural log

Inputs for $t_{xx\%}$ follow the table below.

| **Rated Output Power ("P"), Watts** | **Input Dependency Characteristic** | **25% Load** | **50% Load** | **75% Load** | **100% Load** |
|---|---|---|---|---|---|
| P ≤ 1,500W | VFD | 0.2 | 0.2 | 0.3 | 0.3 |
| | VI or VFI | 0.0 | 0.3 | 0.4 | 0.3 |
| 1,500W < P ≤ 10,000W | VFD, VI, or VFI | 0.0 | 0.3 | 0.4 | 0.3 |
| P > 10,000W | VFD, VI, or VFI | 0.25 | 0.5 | 0.25 | 0.0 |

**2. Testing**. UPS efficiency shall be tested and calculated in accordance with ENERGY STAR Program Requirements for Uninterruptible Power Supplies (UPSs) - Eligibility Criteria Version 2.0.

**(c) Prescriptive Monitoring Requirements for Computer Rooms.** Computer rooms shall have monitoring systems that comply with Subsections 1 and 2 below. Energy use from prescriptive computer room requirements can only be traded off among other computer room requirements.

1. **Power Usage Effectiveness (PUE) Monitoring.** Computer rooms exceeding 200 kW/room of design IT load and where at least 50% of the total building cooling capacity serves computer rooms shall include a power usage effectiveness monitoring system with the following minimum requirements:

   a. True root mean square (RMS) power measurements of total computer room IT power demand and total building power demand. IT power shall be measured immediately downstream of any UPS, such that UPS losses are not included in IT energy.

   b. Data transfer on a server capable of trending and storing data for a minimum of 18 months, with data collected at 15-minute intervals or less.

   c. Time series plots of hourly, daily, and monthly cumulative PUE are displayed on a visual dashboard visible to the building operator. Cumulative PUE is equal to total building cumulative kWh in the time period divided by total cumulative IT kWh in that time period.

2. **Server Utilization Monitoring.** Computer rooms exceeding 200 kW/room of design IT load shall include a server utilization monitoring system with the following minimum requirements:

   a. [Data measurement requirements]

   b. [Data storage requirements]

   c. [Data display requirements]

## Reference Appendices

The following Reference Appendices will be modified:

- JA1: new sections added for PUE Monitoring Acceptance Test and Server Utilization Acceptance Test
- NA7.5: modifications made for data center heat recovery and containment

# Proposal Summary

**2022 California Energy Code (Title 24, Part 6)**

## HVAC Controls – Dedicated Outside Air Systems

Updated: Monday, September 12, 2019

Prepared by: Neil Bulger, Red Car Analytics

## Introduction

The document summarizes proposed revisions to the California Energy Code (Title 24, Part 6) that will be discussed during a utility-sponsored stakeholder meeting on October 15, 2019. The Statewide Utility Codes and Standards Enhancement (CASE) Team is seeking input and feedback. To provide your comments, email info@title24stakeholders.com by October 29, 2019.

## Measure Description

This measure will add prescriptive requirements to Dedicated Outside Air Systems (DOAS) when used as the primary source of ventilation in nonresidential buildings to include a minimum level of efficiency criteria and control capabilities. This measure is based on research conducted by PG&E's Code Readiness project and code enhancements in Washington State Building Energy Code on DOAS in 2015 and 2017.

The measure will also add prescriptive requirements for exhaust air heat recovery previously presented in draft language from 2019 Title 24, Part 6 and similar to the requirements in the current version of ASHRAE 90.1.

Dedicated Outside Air Systems of a nominal size (xxxx cfm or greater) are being considered to include:

1. Ventilation heat recovery with a minimum level of sensible heat recovery ratio (to be determined) and an integrated bypass control.
2. Modulating fan speed control capabilities and for systems under 5 hp, a maximum W/cfm. Fans greater than 5 hp to meet existing requirements in 140.4 (c).
3. Zone heating and cooling equipment fan and/or pump controls configured to cycle off when no call for conditioning.
4. Increased space ventilation and/or exhaust minimums to 150% to 200% for buildings which are not required to have full economizing.
5. Maximum supply air temperature to avoid reheating ventilation air when in cooling mode.

Exhaust Air Heat Recovery based on criteria defined in ASHRAE 90.1 specific to California climate zones.

## Draft Code Language

The proposed changes to the Standards and Reference Appendices are provided below. Changes to the 2019 documents are marked with red underlining (new language) and ~~strikethroughs~~ (deletions). Expected sections or tables of the proposed code (but not specific changes at this time) are highlighted in yellow.

### Standards

**SECTION 140.4 – PRESCRIPTIVE REQUIREMENTS FOR SPACE CONDITIONING SYSTEMS**

**(p) Dedicated Outside Air Systems (DOAS).** Each individual dedicated outside air system (to be defined) greater than or equal to xxxx cfm which delivers 100 percent outside air for ventilation air delivery shall include:

1. An energy recovery system with a minimum xx% sensible effectiveness at design conditions in accordance with AHRI Standard 1060, 2013 and ability to bypass or control to enable economizer operations as required by section 140.4 (e). The bypass or control shall include the ability to modulate airflow bypass to achieve a supply air setpoint or outside air control setpoint for partial bypass.

**EXCEPTION to Section 140.4(p)1:** Systems installed for sole purpose of providing makeup air for exhausting toxic, flammable, paint, or corrosive fumes or dust, dryer exhaust, or commercial kitchen hoods used for collecting and removing grease vapors and smoke.

2. Fan systems shall be capable of fan speed control and for DOAS fans with a motor nameplate hp less than 5 hp shall not exceed a total combined fan power of xxx W/cfm of outdoor air. Fans greater than 5 hp shall meet requirements of Section 140.4 (c).
3. Systems dedicated to providing ventilation air to one zone meeting the criteria for occupied-standby control in Section 120.2(e)3, shall shut off the fan when the occupied standby control calls for ventilation air to be shut-off. Systems providing ventilation to multiple zones and at least zone meets the criteria for occupied-standby control in Section 120.2(e)3, when the occupied standby control calls for ventilation air to be shut-off, airflow to zone shall be shut off and fan speed reduced. If occupied standby control calls for ventilation air to be shut-off in all zones the fan shall be shut off.
4. Systems shall modulate airflow and control fan speed in response to demand ventilation controls complying with 120.1(d)4 for all spaces with a design occupant density, or a maximum occupant load factor for egress purposes in the CBC, greater than or equal to 25 people per 1000 square feet (40 square feet or less per person).

**EXCEPTION 1 to Section 140.4(p)4:** Where space exhaust is greater than the design ventilation rate specified in Section 120.1(c)3 minus 0.2 cfm per ft² of conditioned area.
**EXCEPTION 2 to Section 140.4(p)4:** Spaces that have processes or operations that generate dusts, fumes, mists, vapors, or gases and are not provided with local exhaust ventilation, such as indoor operation of internal combustion engines or areas designated for unvented food service preparation, daycare sickrooms, science labs, barber shops or beauty and nail salons shall not install demand control ventilation.
**EXCEPTION 3 to Section 140.4(p)4:** Spaces with an area of less than 150 square feet, or a design occupancy of less than 10 people as specified by Section 120.1(c)3.

5. Fans not required for ventilation shall cycle off and terminal unit primary cooling air shall be shut off when there is no call for heating or cooling in a zone.
6. Dedicated outside air systems installed with separate heating and cooling systems which do not meet 140.4 (e) 1 shall have a design airflow rate no less than 150 percent of outdoor airflow rate (Vz) to each zone.
   **EXCEPTION 1:** spaces meeting the criteria for natural ventilation per 120.1 (c) 2.
   **EXCEPTION 2:** DOAS serving unconditioned spaces.
7. Systems shall not use heating or heat recovery to warm the supply air above 60F when representative building loads or outdoor air temperatures indicate the majority of zones require cooling.

**(q) – Exhaust Air Heat Recovery.**

1. Each fan system shall have an energy recovery system with a minimum xx% apparent sensible effectiveness at design conditions in accordance with AHRI Standard 1060 when the design supply fan airflow rate exceeds the value listed in TABLE 140.4-H and TABLE 140.4-I, based on operating hours, the climate zone and percentage of outdoor air at design airflow conditions. TABLE 140.4-H shall be used for all ventilation systems that operate less than 8,000 hours per year, and TABLE 140.4-I shall be used for all ventilation systems that operate 8,000 or more hours per year.

2. For systems required by Section 140.4 (e) to have an economizer the system shall have a control to bypass the heat exchanger or reduce overall heat exchange effectiveness to less than 10%.

3. The pressure drop of the outdoor air through the energy recovery exchanger shall not exceed xx in. H2O (xxx Pa); the pressure drop of the exhaust air through the energy recovery exchanger shall not exceed xx in. H2O (xxx Pa).

**EXCEPTION 1 to Section 140.4(q):** Systems serving spaces that are not cooled and that are heated to less than 60°F.
**EXCEPTION 2 to Section 140.4(q):** Where more than 60% of the outdoor air heating energy is provided from site-recovered energy or site-solar energy.
**EXCEPTION 3 to Section 140.4(q):** Heating energy recovery in Climate Zones ___
**EXCEPTION 4 to Section 140.4(q):** Cooling energy recovery in Climate Zones ___
**EXCEPTION 5 to Section 140.4(q):** Where the sum of the airflow rates exhausted and relieved within 20 ft. of each other is less than 25% of the design outdoor airflow rate, excluding exhaust air that is
   a) used for another heat or energy recovery system
   b) not allowed by ASHRAE Standard 170 (or CA equivalent code) for use in heat or energy recovery systems with leakage potential, or
   c) of Class 4 as defined in ASHRAE Standard 62.1.
**EXCEPTION 6 to Section 140.4(q):** Systems expected to operate less than 20 hours per week

*TABLE 140.4-H EXHAUST AIR HEAT RECOVERY REQUIREMENTS FOR VENTILATION SYSTEMS OPERATING LESS THAN 8000 HOURS PER YEAR*

| Climate Zone | % Outdoor Air at Full Design Airflow Rate | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | > 10% and <20% | > 20% and <30% | > 30% and <40% | > 40% and <50% | > 50% and <60% | > 60% and <70% | > 70% and <80% | > 80% and <90% | > 90% |
| | Design Supply Fan Airflow Rate, cfm | | | | | | | | |
| 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16 | NR | NR | NR | NR | NR | NR | NR | NR | xxxx cfm |
| 15 | NR | NR | NR | NR | 26,000 cfm | 12,000 cfm | 5,000 cfm | 4,000 cfm | xxxx cfm |

NR-Not Required

*TABLE 140.4-I EXHAUST AIR HEAT OR ENERGY RECOVERY REQUIREMENTS FOR VENTILATION SYSTEMS OPERATING GREATER THAN OR EQUAL TO 8000 HOURS PER YEAR*

| Climate Zone | % Outdoor Air at Full Design Airflow Rate | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | > 10% and <20% | > 20% and <30% | > 30% and <40% | > 40% and <50% | > 50% and <60% | > 60% and <70% | > 70% and <80% | > 80% and <90% | > 90% |
| | Design Supply Fan Airflow Rate, cfm | | | | | | | | |
| 2, 3, 4, 5, 6 | NR | NR | NR | NR | NR | NR | NR | NR | xxxx cfm |
| 1, 7, 8, 9, 10, 11, 12, 13, 14, 16 | NR | 19,500 cfm | 9000 cfm | 5000 cfm | 4000 cfm | 3000 cfm | 1500 cfm | 120 cfm | xxxx cfm |
| 15 | 2,500 cfm | 2,000 cfm | 1,000 cfm | 500 cfm | 140 cfm | 120 cfm | 100 cfm | 80 cfm | xxxx cfm |

NR-Not Required

***In Section 140.4 (c) Fan Power Limitations.***

*TABLE 140.4-B – Fan Power Limitation Pressure Drop Adjustment*

| **Device** | **Adjustment Credits** |
|---|---|
| Return or exhaust systems required by code or accreditation standards to be fully ducted, or systems required to maintain air pressure differentials between adjacent rooms | 0.5 in. of water |
| Return and/or exhaust airflow control devices | 0.5 in. of water |
| Exhaust filters, scrubbers, or other exhaust treatment | The pressure drop of device calculated at fan system design condition |
| Particulate Filtration Credit: MERV 16 and greater and electronically enhanced filters | Pressure drop calculated at 2 x clean filter pressure drop at fan system design condition |
| Carbon and other gas-phase air cleaners | Clean filter pressure drop at fan system design condition |

| | |
|---|---|
| Biosafety cabinet | Pressure drop of device at fan system design condition |
| Energy recovery device, other than coil runaround loop | For each airstream [(2.2 x Energy Recovery Effectiveness) – 0.5] in. of water |
| Coil runaround loop | 0.6 in. of water for each airstream |
| Exhaust systems serving fume hoods | 0.35 in. of water |
| **Device** | **Adjustment Deductions** |
| Systems without central mechanical cooling device | –0.6 in. of water |
| Systems without central mechanical heating device | –0.3 in. of water |
| Systems with central electric resistance heat | –0.2 in. of water |

***In Section 140.4 (e) Economizers.***

**EXCEPTION 6 to Section 140.4(e)1:** Systems design to operate at 100 percent outside air at all times which meet the requirements of Section 140.4 (p).

## Reference Appendices

There are no proposed changes to the Reference Appendices.

# Proposal Summary

**2022 California Energy Code (Title 24, Part 6)**

## Nonresidential High-Efficiency Boilers and High-Capacity Service Water Heating Systems

Updated: October 14, 2019

Prepared by: Shaojie Wang, George Chapman, Sam Chussid, Simon Silverberg

## Introduction

The document summarizes proposed revisions to the California Energy Code (Title 24, Part 6) that will be discussed during a utility-sponsored stakeholder meeting on October 15, 2019. The Statewide Utility Codes and Standards Enhancement (CASE) Team is seeking input and feedback. To provide your comments, email info@title24stakeholders.com by October 29, 2019.

## Measure Description

### High Efficiency Boilers

This measure would update the boiler efficiency and service water heating system requirements to harmonize with the requirements proposed for Addendum BC to ASHRAE Standard 90.1-2016 and section 7.5.3 of ASHRAE Standard 90.1-2016 respectively. The ASHRAE proposal increases the minimum thermal efficiency for gas hot water boiler systems for space heating (1,000,000 – 10,000,000 Btu/hr) to a weighted-thermal efficiency of 90 percent (90%$E_t$). while section 7.5.3 requires the same 90%$E_t$ for gas service water heating systems.

Additionally, Addendum BC includes the following design requirements for the hot water distribution systems for large boiler systems:

- Hot water return entering the boiler(s) be 120°F or less,
- Establish flow rate requirements for supply hot water that recirculates directly into the return system to ensure flow rates are slow enough that condensing occurs. The tentative requirements are that flow rates be no greater than a) 20 percent of the design flow of the operating boiler.

The ASHRAE proposal includes an exception that boiler systems do not need to meet the equipment efficiency or hot water distribution system design requirements if 25 percent of the annual space heating requirement is provided by on site renewable energy, site-recovered energy, or heat recovery chillers or where half or more of the design heating load is served using perimeter convective heating, radiant ceiling panels, or both. Exceptions also exist for space heating boilers installed in individual dwelling. Furthermore, the ASHRAE proposal notes that individual gas boilers with input capacity less than 300,000 Btu/hr should not be included in calculations of total system input or efficiency. The Statewide CASE Team will explore these exceptions and whether they would apply for California.

**Oxygen Trim Control**

The measure proposes that newly installed commercial and process boilers with an input capacity of 5 MMBtu/h (5,000,000 Btu/h) to 10 MMBtu/h (10,000,000 Btu/h) shall maintain excess (stack-gas) oxygen concentrations at less than or equal to 5 percent by volume on a dry basis over firing rates of 20 percent to 100 percent. Combustion air volume shall be controlled with respect to firing rate or measured flue gas oxygen concentration. Use of a common gas and combustion air control linkage or jack shaft is prohibited. Commercial boilers with steady state full-load thermal efficiency of 85 percent or higher are exempt from this requirement. The Statewide CASE Team will explore if it is feasible and cost-effective to lower the excess oxygen requirements below 5 percent and/or expanding the requirement to boilers with input capacity lower than 5 MMBtu/h.

**Service Water Heating System Efficiency**

This measure would update the gas service hot water heating requirements to harmonize with section 7.5.3 of ASHRAE Standard 90.1-2016. The ASHRAE proposal requires systems with 1,000,000 Btu/h or greater shall have a minimum thermal efficiency ($E_t$) of 90% or have a weighted $E_t$ of 90%. Multiple units may meet this requirement if the water-heating input provided by the equipment with $E_t$ above and below 90% provides an input capacity-weighted average $E_t$ of at least 90%. This measure includes combination (integrated) systems that provide both service water-heating and space heating.

The ASHRAE proposal includes an exception that service hot water heating systems do not need to meet efficiency requirements if 25 percent of the annual service water-heating requirement is provided by site-solar energy or site-recovered energy, or if water heaters are installed in individual dwelling units, or if individual gas water heaters have an input capacity not greater than 100,000 Btu/h. The Statewide CASE Team will explore these exceptions and whether they would apply for California.

## Draft Code Language

The proposed changes to the Standards and Reference Appendices are provided below. Changes to the 2019 documents are marked with red underlining (new language) and ~~strikethroughs~~ (deletions). Expected sections or tables of the proposed code (but not specific changes at this time) are highlighted in yellow.

### Standards

#### SECTION 110.2 – MANDATORY REQUIREMENTS FOR SPACE- CONDITIONING EQUIPMENT

**Certification by Manufacturers.** Any space-conditioning equipment listed in this section may be installed only if the manufacturer has certified to the Commission that the equipment complies with all the applicable requirements of this section.

**(a) Efficiency.** Equipment shall meet the applicable efficiency requirements in TABLE 110.2-A through TABLE 110.2-K subject to the following:

1. If more than one efficiency standard is listed for any equipment in TABLE 110.2-A through TABLE 110.2- K, the equipment shall meet all the applicable standards that are listed; and
2. If more than one test method is listed in TABLE 110.2-A through TABLE 110.2-K, the equipment shall comply with the applicable efficiency standard when tested with each listed test method; and

3. Where equipment serves more than one function, it shall comply with the efficiency standards applicable to each function; and
4. Where a requirement is for equipment rated at its "maximum rated capacity" or "minimum rated capacity," the capacity shall be as provided for and allowed by the controls, during steady-state operation.

**EXCEPTION 4 to Section 110.2(a):** Systems with multiple boilers are allowed to meet this requirement if the space-heating input provided by equipment with thermal *efficiency* ($E_t$) above and below 90% provides an input capacity-weighted average thermal *efficiency* of at least 90%. For boilers rated only for combustion *efficiency* or *AFUE*, the calculation for the input capacity-weighted average thermal *efficiency* shall use the combustion *efficiency* value or the *AFUE*, respectively.

*TABLE 110.2-K Gas- and Oil-Fired Boilers, Minimum Efficiency requirements*

| Equipment Type | Sub Category | Size Category (Input) | Minimum Efficiency [b,c] | | Test Procedure [a] |
|---|---|---|---|---|---|
| | | | ~~Before 3/2/2020~~ | ~~After 3/2/2020~~ | |
| Boiler, hot water | Gas-Fired | < 300,000 Btu/h | ~~82% AFUE~~ | 82% AFUE | DOE 10 CFR Part 430 |
| | | ≥ 300,000 Btu/h and ≤ ~~2,500,000~~ 1,000,000 Btu/h [d] | ~~80% $E_t$~~ | 80% $E_t$ | DOE 10 CFR Part 431 |
| | | > ~~2,500,000~~ 1,000,000 and ≤ 10,000,000 Btu/h [e] | ~~82% $E_c$~~ | ~~82% $E_c$~~ 90% $E_t$ | |
| | Oil-Fired | < 300,000 Btu/h | ~~84% AFUE~~ | 84% AFUE | DOE 10 CFR Part 430 |
| | | ≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h [d] | ~~82% $E_t$~~ | 82% $E_t$ | DOE 10 CFR Part 431 |
| | | > 2,500,000 Btu/h [e] | ~~84% $E_c$~~ | 84% $E_c$ | |
| Boiler, steam | Gas-Fired | < 300,000 Btu/h | ~~80% AFUE~~ | 80% AFUE | DOE 10 CFR Part 430 |
| | Gas-Fired all, except natural draft | ≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h [d] | ~~79% $E_t$~~ | 79% $E_t$ | DOE 10 CFR Part 431 |
| | | > 2,500,000 Btu/h [e] | ~~79% $E_t$~~ | 79% $E_t$ | DOE 10 CFR Part 431 |
| | Gas-Fired, natural draft | ≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h [d] | ~~77% $E_t$~~ | 79% $E_t$ | DOE 10 CFR Part 431 |
| | | > 2,500,000 Btu/h [e] | ~~77% $E_t$~~ | 79% $E_t$ | DOE 10 CFR Part 431 |
| | Oil-Fired | < 300,000 Btu/h | ~~82% AFUE~~ | 82% AFUE | DOE 10 CFR Part 430 |
| | | ≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h [d] | ~~81% $E_t$~~ | 81% $E_t$ | DOE 10 CFR Part 431 |
| | | > 2,500,000 Btu/h [e] | ~~81% $E_t$~~ | 81% $E_t$ | DOE 10 CFR Part 431 |

[a] Applicable test procedure and reference year are provided under the definitions.
[b] $E_c$ = combustion efficiency (100% less flue losses) See reference document for detailed information.
[c] $E_t$= thermal efficiency. See test procedure for detailed information.
[d] Maximum capacity - minimum and maximum ratings as provided for and allowed by the unit's controls.
[e] Included oil-fired (residual).

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

**SECTION 120.9 – MANDATORY REQUIREMENTS FOR COMMERCIAL BOILERS.**

(a) Combustion air positive shut-off shall be provided on all newly installed boilers as follows:
    1. All boilers with an input capacity of 2.5 MMBtu/h (2,500,000 Btu/h) and above, in which the boiler is designed to operate with a nonpositive vent static pressure.
    2. All boilers where one stack serves two or more boilers with a total combined input capacity per stack of 2.5 MMBtu/h (2,500,000 Btu/h).

(b) Boiler combustion air fans with motors 10 horsepower or larger shall meet one of the following for newly installed boilers:
    1. The fan motor shall be driven by a variable speed drive, or
    2. The fan motor shall include controls that limit the fan motor demand to no more than 30 percent of the total design wattage at 50 percent of design air volume.

(c) Newly installed boilers with an input capacity 5 MMBtu/h (5,000,000 Btu/h) and greater shall maintain excess (stackgas) oxygen concentration at less than or equal to 3.0 percent by volume on a dry basis over firing rates of 20 percent to 100 percent. Combustion air volume shall be controlled with respect to firing rate or flue gas oxygen concentration. Use of a common gas and combustion air control linkage or jack shift is prohibited.

**EXCEPTION to Section 120.9(c):** Boilers with steady state full-load thermal efficiency 85 percent or higher.

SECTION 120.6 – MANDATORY REQUIREMENTS FOR COVERED PROCESSES

(d) Mandatory Requirements for Process Boilers

1. Combustion air positive shut-off shall be provided on all newly installed process boilers as follows:

A. All process boilers with an input capacity of 2.5 MMBtu/h (2,500,000 Btu/h) and above, in which the boiler is designed to operate with a non-positive vent static pressure.

B. All process boilers where one stack serves two or more boilers with a total combined input capacity per stack of 2.5 MMBtu/h (2,500,000 Btu/h).

2. Process boiler combustion air fans with motors 10 horsepower or larger shall meet one of the following for newly installed boilers:

A. The fan motor shall be driven by a variable speed drive; or

B. The fan motor shall include controls that limit the fan motor demand to no more than 30 percent of the total design wattage at 50 percent of design air volume.

3. Newly installed process boilers with an input capacity of 5 MMBtu/h (5,000,000 Btu/h) and greater shall maintain excess (stackgas) oxygen concentrations at less than or equal to 3.0 percent by volume on a dry basis over firing rates of 20 percent to 100 percent. Combustion air volume shall be controlled with respect to firing rate or measured flue gas oxygen concentration. Use of a common gas and combustion air control linkage or jack shaft is prohibited.

(a) The hot water distribution system for boiler systems for space heating with a total system input of at least 1,000,000 Btu/h (290 kW) but not more than 10,000,000 Btu/h (2900 kW) shall be designed to meet all of the following:

1. Coils and other heat exchangers shall be selected so that at design conditions:
    A. the hot water return temperature entering the boilers is 120°F (49°C) or less, and
    B. the temperature difference between the hot water supply temperature leaving the boiler and the hot water return temperature entering the boilers is 40°F (22°C) or higher.
2. Under all operating conditions, the water temperature entering any boiler is 120°F (49°C) or less or the flow rate of the boiler is less than 20% of the design flow rate. .

# Proposal Summary

**2022 California Energy Code (Title 24, Part 6)**

## Nonresidential HVAC Controls - Variable Air Volume (VAV) Minimum Airflow Rates

Updated: Friday, September 6, 2019

Prepared by: Shaojie Wang and Tim Minezaki, Energy Solutions

## Introduction

The document summarizes proposed revisions to the California Energy Code (Title 24, Part 6) that will be discussed during a utility-sponsored stakeholder meeting on October 15, 2019. The Statewide Utility Codes and Standards Enhancement (CASE) Team is seeking input and feedback. To provide your comments, email info@title24stakeholders.com by October 29, 2019.

## Measure Description

This measure would allow terminal box minimum airflow requirements to be based on outdoor flow rate as opposed to a fixed minimum. The measure is based on research conducted for ASHRAE Research Project (RP)-1515, which was co-funded by the California Energy Commission PIER program and evaluated occupants' thermal comfort and air quality satisfaction of reduced airflows using lab and field studies. Findings from RP-1515 resulted in the approval of Addendum AU to ASHRAE 90.1-2016, which reduced minimum airflow requirements. This measure proposes to align Title 24, Part 6 with ASHRAE Standard 90.1

## Draft Code Language

The proposed changes to the Standards and Reference Appendices are provided below. Changes to the 2019 documents are marked with red underlining (new language) and ~~strikethroughs~~ (deletions). Expected sections or tables of the proposed code (but not specific changes at this time) are highlighted in yellow.

**SECTION 140.4 – PRESCRIPTIVE REQUIREMENTS FOR SPACE CONDITIONING SYSTEMS**

**(d) Space-conditioning Zone Controls.** Each space-conditioning zone shall have controls designed in accordance with 1 or 2:

1. Each space-conditioning zone shall have controls that prevent:

   A. Reheating; and

   B. Recooling; and

   C. Simultaneous provisions of heating and cooling to the same zone, such as mixing or simultaneous supply of air that has been previously mechanically heated and air that has been previously cooled either by cooling equipment or by economizer systems; or

2. Zones served by VAV systems that are designed and controlled to reduce, to a minimum, the volume of reheated, re-cooled, or mixed air are allowed only if the controls meet all the following requirements:

A. For each zone with direct digital controls (DDC):

i. The volume of primary air that is reheated, recooled or mixed air supply shall not exceed the larger of:

a. 50 percent of the peak primary airflow; or

b. The design zone outdoor airflow rate as specified by Section 120.1(c)3.

ii. The volume of primary air in the dead band shall not exceed ~~the larger of:~~

~~a. 20 percent of the peak primary airflow; or~~

~~b. T~~ the design zone outdoor airflow rate as specified by Section 120.1(c)3.

iii. The first stage of heating consists of modulating the zone supply air temperature setpoint up to a maximum setpoint no higher than 95ºF while the airflow is maintained at the dead band flow rate.

iv. The second stage of heating consists of modulating the airflow rate from the dead band flow rate up to the heating maximum flow rate.

B. For each zone without DDC, the volume of primary air that is reheated, re-cooled, or mixed air supply shall not exceed the larger of the following:

i. 30 percent of the peak primary airflow; or

ii. The design zone outdoor airflow rate as specified by Section 120.1(c)3.