



# HVAC Controls & Economizing CEC Staff Workshop

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California Statewide Utility Codes and Standards Program

PECI  
April 27, 2011

## HVAC Controls & Economizing

# Summary of Code Change Proposals

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1. Revise the prescriptive baseline for economizers from 75,000 Btu/h to 54,000 Btu/h to match ASHRAE 90.1
  2. A thermostat with two stages of cooling is required for single zone systems whenever an outside air economizer is present
  3. Mandatory performance features for economizers
  4. Multipurpose rooms of less than 1000 square feet, and classrooms and conference rooms of any size, shall be equipped with occupant sensor(s) to setup/setdown the cooling/heating temperature set points
  5. Fault Detection and Diagnostics (FDD) is included in 2008 Title 24 as a compliance option. A proposal is to advance FDD as a prescriptive baseline
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## HVAC Controls & Economizing

# Code Change Proposal 1

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- Economizer on smaller AC along with compliant t-stats (2-stage or electronic)

2008 Title 24	$\geq 75,000$ Btu/h
2013 Title 24	$\geq 54,000$ Btu/h
ASHRAE 90.1-2010	$\geq 54,000$ Btu/h
ASHRAE 189, IECC-2012	$\geq 33,000$ Btu/h

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# HVAC Controls & Economizing

## Code Change Proposal 1

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### SECTION 144 – PRESCRIPTIVE REQUIREMENTS FOR SPACE CONDITIONING SYSTEMS

#### 144 (e) Economizers.

1. Each individual cooling fan system that has a design supply capacity over 1,800 cfm and a total mechanical cooling capacity over 54,000 Btu/hr shall include either:
    - A. An air economizer capable of modulating outside-air and return-air dampers to supply 100 percent of the design supply air quantity as outside-air; or
    - B. A water economizer capable of providing 100 percent of the expected system cooling load as calculated in accordance with a method approved by the Commission, at outside air temperatures of 50°F dry-bulb/45°F wet-bulb and below.
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## HVAC Controls & Economizing Data / Findings

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- Cost effective per T24 methodology
    - Cost effective to 50,000 Btu/h per analysis w/alternating integration and CA TDV costs
    - AHRI: “we recommend that you harmonize with ASHRAE 90.1 where a detailed economic analysis and review was done.”
    - 54,000 Btu/h matches ASHRAE 90.1-2010
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# HVAC Controls & Economizing

## Code Change Proposal 2

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### 144 (e) Economizers.

2. If an economizer is installed, it shall be:

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B. Capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load.

i. Unitary systems with an economizer shall have control systems, including two-stage or electronic thermostats, that cycle compressors off when economizers can provide partial cooling.

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# HVAC Controls & Economizing

## Code Change Proposal 2

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### SECTION 149 – ADDITIONS, ALTERATIONS, AND REPAIRS TO EXISTING BUILDINGS THAT WILL BE NONRESIDENTIAL, HIGH-RISE RESIDENTIAL, AND HOTEL/MOTEL OCCUPANCIES AND TO EXISTING OUTDOOR LIGHTING FOR THESE OCCUPANCIES AND TO INTERNALLY AND EXTERNALLY ILLUMINATED SIGNS

#### Section 149(b)1E

- E. When a space conditioning system is altered by the installation or replacement of space conditioning equipment (including replacement of the air handler, outdoor condensing unit of a split system air conditioner or heat pump, cooling or heating coil, or the furnace heat exchanger);
1. Existing non-setback thermostats shall be replaced with setback thermostats for all altered units. All newly installed space conditioning systems requiring a thermostat shall be equipped with a setback thermostat. All setback thermostats shall meet the requirements of Section 112(c); and
  2. Unitary systems with an economizer shall have control systems, including two-stage or electronic thermostats, that cycle compressors off when economizers can provide partial cooling; and
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## HVAC Controls & Economizing

# Code Change Proposal 3

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- Economizer performance features: Air economizers and return air dampers on an individual cooling fan system that has a design supply capacity over 1,500 cfm and a total mechanical cooling capacity over 45,000 Btu/hr shall have the following features:
    - Warranty. 5-year performance warranty of economizer assembly
    - Drive mechanism. Economizer and return dampers have a direct drive modulating actuator with gear driven interconnections
    - Damper reliability testing. Economizer and return damper certified that representative products have been tested and are able to open against the rated airflow and pressure of the system after 100,000 damper opening and closing cycles.
    - Damper leakage. Economizer and return dampers shall be certified to have a maximum leakage rate of 10 cfm/sf at 1.0 in. w.g. when tested in accordance with AMCA Standard 500.
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## HVAC Controls & Economizing

# Code Change Proposal 3 (cont...)

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- Adjustable setpoint. If the high-limit control is fixed dry-bulb, or fixed enthalpy it shall have an adjustable or selectable setpoint
  - Damper control sensor location. Primary damper control temperature sensor located after the cooling coil to maintain comfort
  - Sensor accuracy. Outdoor air, return air and supply air sensors are calibrated within the following accuracies.
    - Drybulb and wetbulb temperatures accurate to  $\pm 1^{\circ}\text{F}$
    - Enthalpy accurate to within  $\pm 1$  Btu/lb
    - Relative humidity accurate to within 5%
  - Sensor calibration data of sensors used for control of economizer are plotted on sensor performance curve.
  - Sensors used for the high limit control are located to prevent false readings, e.g. properly shielded from direct sunlight.
  - Relief air. System is designed to provide up to 100% outside air without over-pressurizing the building
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# HVAC Controls & Economizing

## Code Change Proposal 4

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### SECTION 121 – REQUIREMENTS FOR VENTILATION

#### 121 (c) Operation and Control Requirements for Minimum Quantities of Outdoor Air

5. Occupant Sensor Ventilation Control Devices. Occupant sensors may be used to turn off ventilation dampers or fans when occupants are not present in accordance with the following:

A. Occupant sensors shall meet requirements in Section 119 (d) and shall have suitable coverage and placement to detect occupants in the entire space ventilated. Occupant sensors controlling lighting may be used for ventilation as long as the ventilation signal is independent of daylighting or manual lighting overrides. Manual-on type lighting occupant sensors are not suitable for ventilation control.

B. Where multiple rooms are served by a single zone box or ventilation fan, then each room shall have an occupant sensor and occupant detection in any room shall cause the fan and ventilation or zone box ventilation to operate and required ventilation shall continue for 15 minutes after all rooms served are vacant.

C. Provisions shall be made for the daily building purge when required in Section 121(c)2 to override occupant sensor ventilation lockout.

D. Occupant sensor ventilation control may be used in conjunction with a demand control ventilation device complying with Section 121(c)4 that operates when occupancy is detected.

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## HVAC Controls & Economizing

# Code Change Proposal 4

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### SECTION 122 – REQUIRED CONTROLS FOR SPACE-CONDITIONING SYSTEMS

**122 (e) Shut-off and Reset Controls for Space-conditioning Systems.** Each space-conditioning system shall be installed with controls that comply with Items 1, 2, and 3 below:

3. Multipurpose rooms of less than 1000 square feet, and classrooms and conference rooms of any size, when served by a variable air volume (VAV) reheat system, shall be equipped with occupant sensor(s) to accomplish the following during unoccupied periods:

A. Setup the operating cooling temperature set point to 75°F or higher and setback the operating heating temperature set point to 68 ° F or lower; and

B. Close the zone damper.

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## HVAC Controls & Economizing

# Code Change Proposal 5: FDD

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- Currently a compliance credit in the performance calculation method
    - Not required by Title 24
    - Credit toward complying with energy budget
  - Transition to a prescriptive requirement
    - Not required by Title 24
    - Sets the basis of performance standard
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## HVAC Controls & Economizing

# Code Change Proposal 5

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### SECTION 144 – PRESCRIPTIVE REQUIREMENTS FOR SPACE CONDITIONING SYSTEMS

**144 (m) Fault Detection and Diagnostics (FDD) for Packaged Direct-Expansion Units.** All packaged direct-expansion units with mechanical cooling capacity at ARI conditions greater than or equal to 54,000 Btu/hr shall include a Fault Detection and Diagnostics (FDD) system in accordance with NA9 – Fault Detection and Diagnostics.

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# HVAC Controls & Economizing

## Code Change Proposal 5

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### Nonresidential Appendix NA9 – 2013

### Appendix NA9 – Fault Detection and Diagnostics

#### NA9.1 System Requirements

The following sensors should be permanently installed to monitor system operation and the controller should have the capability of displaying the value of each parameter:

- Refrigerant Pressure: Suction Line, Liquid Line
  - Refrigerant Temperature: Suction Line, Liquid Line
  - Air Relative Humidity: Outside Air, Supply Air
  - Air Temperature: Outside Air, Supply Air, Return Air
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# HVAC Controls & Economizing

## Code Change Proposal 5

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### NA9.1 – System Requirements

The controller shall provide system status by indicating the following conditions:

- Compressor Enabled
- Free Cooling Available
- Economizer Enabled
- Heating Enabled
- Mixed Air Low Limit Cycle Active

The unit controller shall manually initiate each operating mode so that the operation of compressors, economizers, fans, and heating system can be independently tested and verified.

Faults shall be reported to a fault management application accessible by day-to-day operating or service personnel, or annunciated locally on zone thermostats.

A performance indicator shall be provided, which will allow tracking of efficiency.

The FDD System used shall be certified by the CEC and verified to be installed correctly.

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# HVAC Controls & Economizing

## Code Change Proposal 5

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### NA9.2 – Faults to be Detected

The FDD system shall detect the following faults:

1. Air temperature sensor failure/fault
  2. Low refrigerant charge
  3. Not economizing when it should
  4. Economizing when it should not
  5. Damper not modulating
  6. Excess outdoor air
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## HVAC Controls & Economizing

# Summary of FDD Products

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- Currently available fault detection by OEMs (matches NA9.2 Faults to be Detected)
    - Air temperature sensor failure/fault
    - Low refrigerant charge
    - Not economizing when it should
    - Economizing when it should not
    - Damper not modulating
    - Excess outdoor air
  - Currently available products by third parties
    - ClimaCheck by ClimaCheck, Inc.
    - FDSI Synergy by Field Diagnostics, Inc.
    - Sensus MI, developed by Univ. Nebraska
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## HVAC Controls & Economizing

# Summary of FDD Products

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- Third party products currently in development
    - SMDS by PNNL
    - Low cost SMDS by PNNL
    - Low cost NILM by MIT
    - Virtjoule by Virtjoule, Inc.
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**QUESTIONS & COMMENTS**

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