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Case Initiatives for DDC to the Zone Level

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In support of
PG&E Codes & Standards Program

Pacific Gas and Electric Company
Codes & Standards Enhancement Project

Acknowledgements & Contacts

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Overview of Proposal

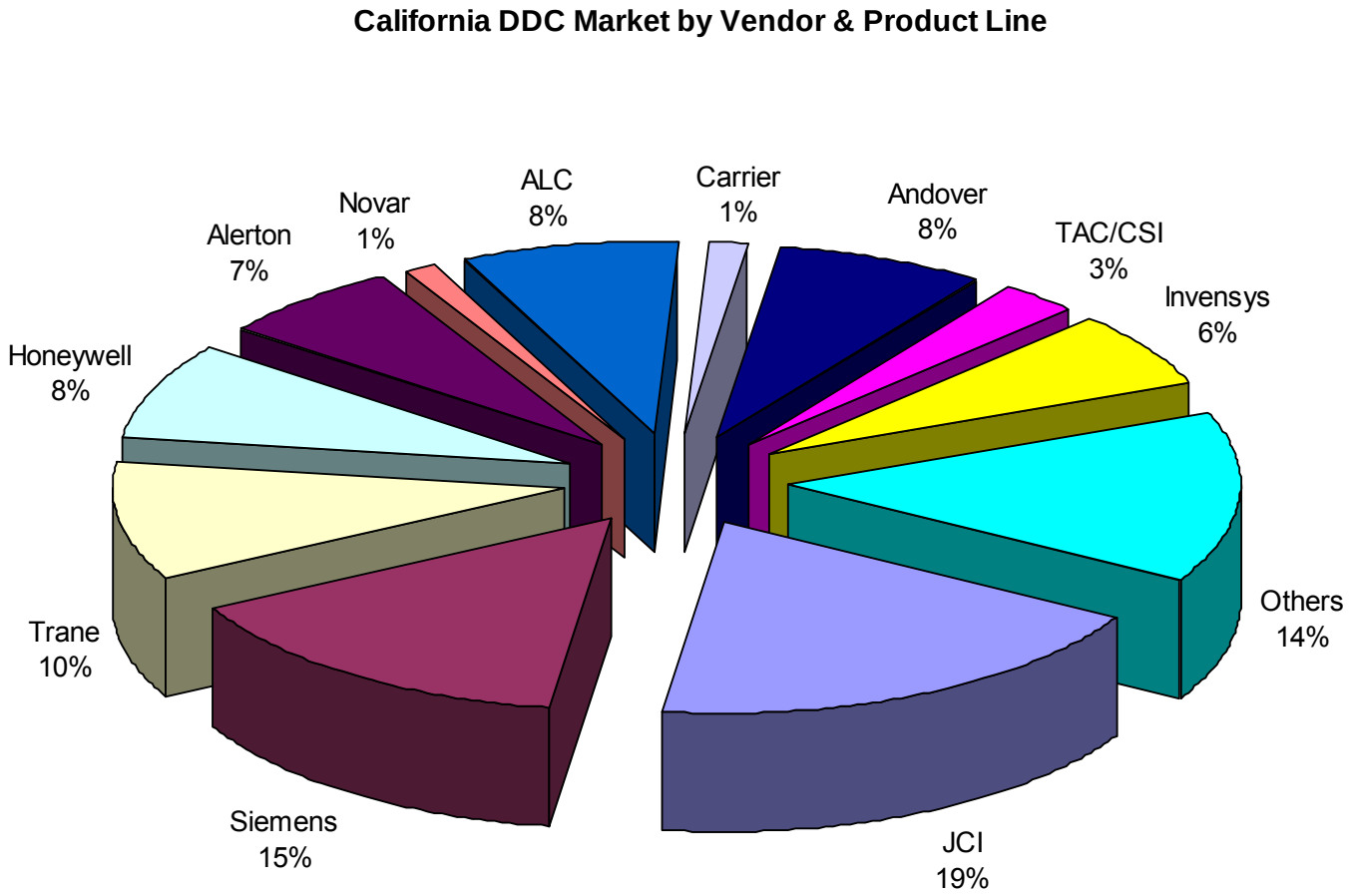
- Provide energy and demand reduction control requirements for systems with DDC to the zone level
- 5 distinct proposals:
  1. VAV Zone Minimums
  2. Demand Shed Controls
  3. Hydronic Pressure Reset
  4. Demand Control Ventilation
  5. Supply Air Temperature Reset

Overview

DDC Market in California

- Literature Search and Survey of Major DDC Manufacturers
  - 2 reports
  - 3 of 7 manufacturers responded to survey
- Excluding programmable thermostats
  - ~90%-95% of controls are DDC to the zone level

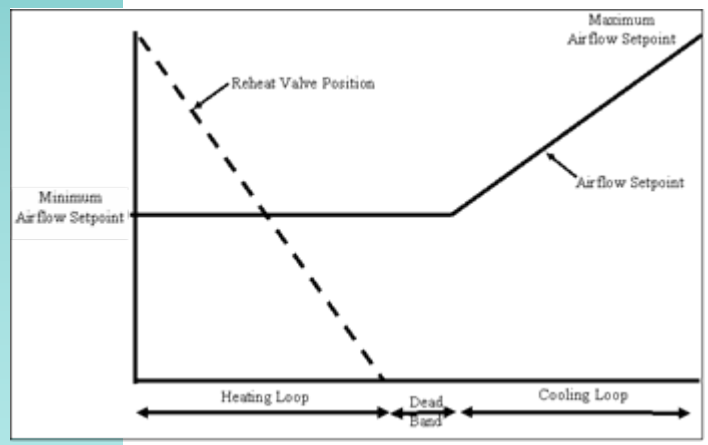
DDC Market in California

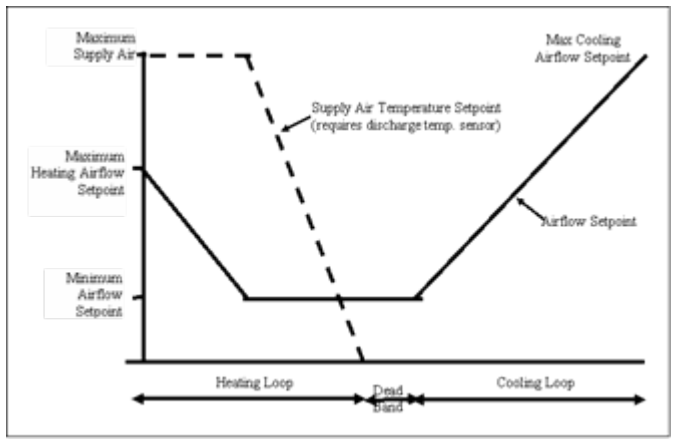


Scope of Proposed Measures

- Measures apply to systems with DDC to the zone level
- DDC to the zone level is not required
  - It is already the standard for new construction
- All three respondents to the survey support the proposed changes

DDC 1: VAV Zone Minimums





DDC 1: VAV Zone Minimums Overview

- Modifies existing Prescriptive Requirement 144(d)
- Require new minimums for VAV boxes with DDC controls
  - In deadband, the maximum of
    - 20% of cooling design airflow and
    - the zone ventilation requirements
  - In heating, up to 50% of cooling design airflow
- Get rid of two exceptions for reheat:
  - ≤0.4 cfm/ft2
  - 300 cfm
- Applies to new construction and retrofit

DDC 1: VAV Zone Minimums Acknowledgements

Recommendations are the result of the following research projects

- Public Interest Energy Research (PIER) Program
  - Integrated Energy Systems — Productivity and Building Science project, CEC contract No. 400-99-013
  - VAV Design Guide: http://www.energy.ca.gov/reports/2003-11-17_500-03-082_A-11.PDF
- PG&E Emerging Technology Program
  - Steve Blanc, Project Manager

DDC 1: VAV Zone Minimums Results

- TDV cost savings
  - $2.6/ft2 in Climate Zone 12 (Sacramento)
- Improved comfort & IAQ
  - Reduced stratification in heating mode
- LCC Effectiveness
  - $0.75/ft2 installed costs ≤ $2.6/ft2 TDV cost savings

DDC 1: VAV Zone Minimums Proposed Changes

EXCEPTION 1 to Section 144 (d): Zones served by a variable air-volume system that is designed and controlled to reduce, to a minimum, the volume of reheated, recooled, or mixed air supply as follows. ~~For each zone, this minimum volume shall be no greater than the largest of the following:~~

A. For each zone with direct digital controls, this minimum volume shall be no greater than the following:

1. 50 percent of the peak supply volume during heating.
2. No greater than the largest of the following in the dead band:
   a. 20 percent of the peak supply volume; or
   b. The minimum required to meet the ventilation requirements of Section 121

B. For each zone without direct digital controls, this minimum volume shall be no greater than the largest of the following:

1. 30 percent of the peak supply volume; or
2. The minimum required to meet the ventilation requirements of Section 121

~~A. 30 percent of the peak supply volume; or~~
~~B. The minimum required to meet the ventilation requirements of Section 121; or~~
~~C. 0.4 cubic feet per minute (cfm) per square foot of conditioned floor area of the zone; or~~
~~D. 300 cfm.~~

DDC 2: Demand Shed Controls

DDC 2: Demand Shed Controls Overview

- New Mandatory Requirement
- Requires ability to centrally reset thermostat setpoints of all non-critical zones by up to 4°F **on remote contact closure**
- Applies to new construction and retrofit

DDC 2: Demand Shed Controls Related Research

Related Research

- Proposal for 2008 Title 24 Global Temperature Adjustment (GTA). David Watson, Lawrence Berkeley National Lab. February 23rd, 2006. http://www.energy.ca.gov/title24/2008standards/documents/2006-02-22+23_workshop/presentations/2006-02-23_GLOBAL_TEMP_ADJUST.PDF.
- PIER Demand Response Research Center website, http://drrc.lbl.gov/autodr2/autodr2.html
- Peak Demand Reduction from Pre-Cooling with Zone Temperature Reset in an Office Building. Xu, P., P. Haves, and M.A. Piette, (Lawrence Berkeley National Laboratory) and J.E. Braun, (Purdue University). Proceedings,ACEEE 2004 Summer Study on Energy Efficiency in Buildings: Breaking out of the Box, August 22-27, 2004, Asilomar, Pacific Grove, CA. Washington, D.C.: American Council for an Energy-Efficient Economy. LBNL-55800. August 2004
- Demand Responsive Control of Air-Conditional via Programmable Communicating Thermostats (PCTs). SCE Case Initiative. February 14th, 2006

DDC 2: Demand Shed Controls Results

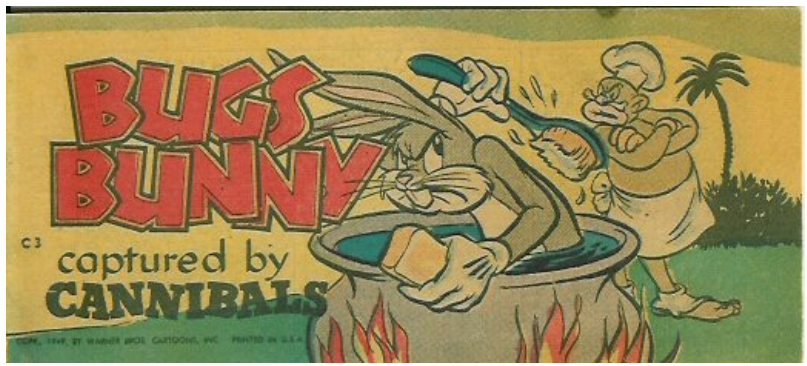
- TDV cost savings
  - Existing research (PIER DRRC) documents between 1 to 2.4 W/sf of peak demand shed potential. At 1 W/sf savings and **$600/kW** (Title 24 2008, PCT report) this translates to $0.6/sf of savings.
- Comfort
  - ASHRAE Standard 55-2004 (Table 5.2.5.2) allows for shift in zone temperature if the rate of change is controlled.
- LCC Effectiveness
  - **Installed costs (~$1,000/system)**
  - **$0.6/ft2 TDV cost savings**
  - **Cost effective down to systems serving 1,700 sf**

DDC 2: Demand Shed Controls ASHRAE Standard 55-2004

Table 5.2.5.2
Limits on Temperature Drifts and Ramps

Time Period	1/4 h	1/2 h	1 h	2 h	4 h
Maximum Operative Temperature Change Allowed	2.0°F	3.0°F	4.0°F	5.0°F	6.0°F

The most restrictive change rate rules



DDC 2: Demand Shed Controls Proposed Changes

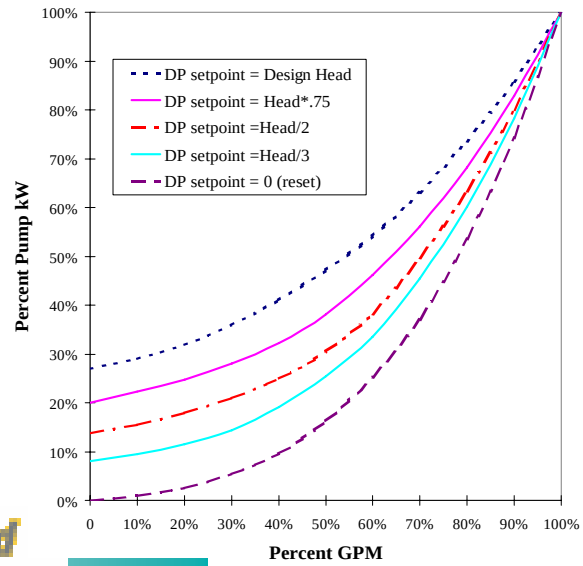
122(h). Automatic Demand Shed Controls. HVAC systems with DDC to the zone level shall be programmed to allow centralized demand shed for non-critical zones as follows:

1. All current zone cooling temperature setpoints in non-critical zones shall be capable of being reset upwards by up to four degrees on remote contact closure.

2. The system shall be capable of restoring the original cooling temperature setpoints on remote contact opening.

3. The system shall be programmed to provide an adjustable rate of change limiter on the zone reset signals.

DDC 3: Hydronic Pressure Reset



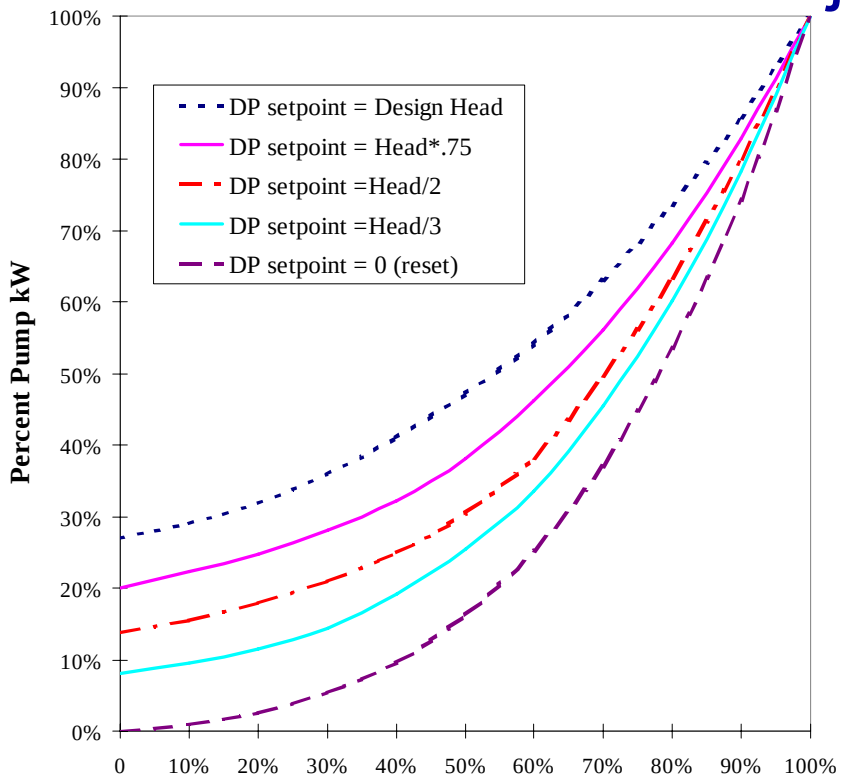
DDC 3: Hydronic Pressure Reset Overview

- Modification of existing Prescriptive Requirement 144(j)6
- Requires reset by valve demand for pump pressure setpoint on variable flow systems
- Applies to new construction and retrofit where pumps and all valves are controlled by DDC

DDC 3: Hydronic Pressure Reset Related Research

Related Research

- PG&E's CoolTools™ Project



DDC 3: Hydronic Pressure Reset Results

- TDV cost savings
  - $1.2/sf average over the 16 California Climate Zones
- Other
  - Less acoustic noise
  - Reduces valve leakage
  - Reduces wear on pump and motor
- LCC Effectiveness
  - Installed costs ~ $2,500/system
  - $1.2/ft2 TDV cost savings
  - Cost effective if system serves more that 2,000 sf

DDC 3: Hydronic Pressure Reset Proposed Changes

144(j)6. **Variable Speed Drives.** Individual pumps serving variable flow systems and having a motor horsepower exceeding 5 hp shall have controls and/or devices (such as variable speed control) that will result in pump motor demand of no more than 30% of design wattage at 50% of design water flow. The controls or devices shall be controlled as a function of desired flow or to maintain a minimum required differential pressure as follows:

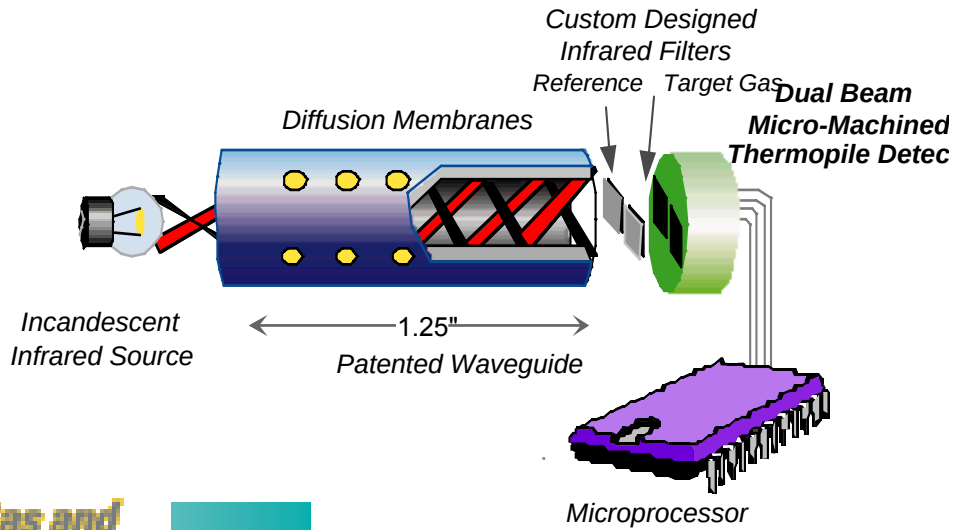
A. Variable flow systems with direct digital control of individual coils reporting to the central control panel, static pressure set point shall be reset based on the valve requiring the most pressure; i.e., the set point is reset lower until one valve is nearly wide open.

B. On all other variable flow systems d~~D~~ifferential pressure shall be measured at or near the most remote heat exchanger or the heat exchanger requiring the greatest differential pressure.

EXCEPTION 1 to Section 144 (j) 6: Heating hot water systems.

EXCEPTION 2 to Section 144 (j) 6: Condenser water systems serving only water-cooled chillers.

DDC 4:
Demand Control Ventilation



DDC 4: Demand Control Ventilation Overview

- Modification of existing Mandatory Requirement 121(c)3
- Extends existing requirement to multiple zone system with DDC controls to the zone level
- Applies to new construction and retrofit where AC/AH unit and all zones are controlled by DDC

DDC 4: Demand Control Ventilation Related Research

Related Research Includes:

- Public Interest Energy Research (PIER) Program
  - Integrated Energy Systems — Productivity and Building Science project, CEC contract No. 400-99-013
  - VAV Design Guide: http://www.energy.ca.gov/reports/2003-11-17_500-03-082_A-11.PDF
- Part I: Measure Analysis and Life Cycle Cost for the 2005 California Building Energy Efficiency Standards. April 11thth, 2002. California Energy Commission. P400-02-011.

DDC 4: Demand Control Ventilation Results

- TDV cost savings
  - $1,000/zone average over the 16 California Climate Zones using a 400 sf zone.
- LCC Effectiveness
  - Installed costs $575/zone ≤ $1,000/zone TDV cost savings

DDC 4: Demand Control Ventilation Proposed Changes

121(c)3. **Required Demand Control Ventilation**. HVAC ~~single zone~~ systems with the following characteristics shall have demand ventilation controls complying with 121 (c) 4:

A. They have an outdoor air economizer; and

B. They serve a space 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 ft2 (40 square foot per person)~~.~~; and

C. They are either:

i. Single zone systems with any controls; or

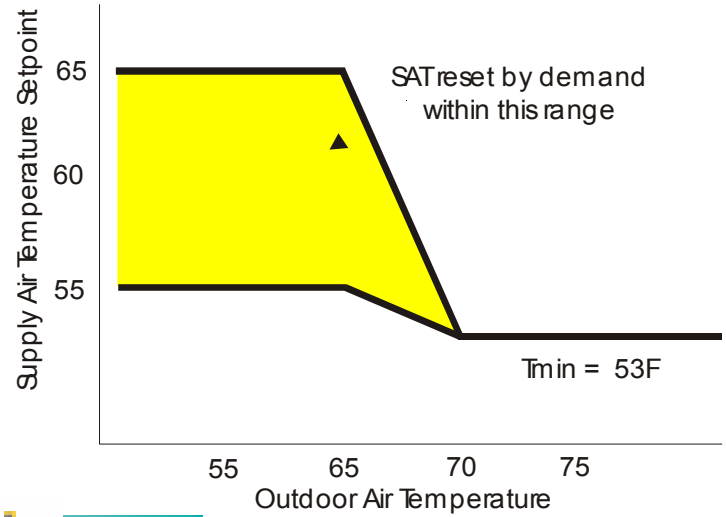
ii. Multiple zone systems with DDC controls to the zone level.

EXCEPTION 1 to Section 121 (c) 3 B: Classrooms are not required to have demand control ventilation.

EXCEPTION 2 to Section 121 (c) 3 B: Where space exhaust is greater than the design ventilation rate specified in 121 (b) 2 B minus 0.2 cfm per ft2 of conditioned area.

EXCEPTION 3 to Section 121 (c) 3 B: 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).

DDC 5:
Supply Air Temperature Reset



DDC 5: Supply Air Temperature Reset Overview

- Modification of existing Prescriptive Requirement 144(f)
- Removes exception to the supply air temperature reset for VAV systems with variable speed drives
- Applies to new construction and retrofit where AC/AH units and all zones are controlled by DDC

DDC 5: Supply Air Temperature Reset Related Research

Recommendation is the result of the following research projects

- Public Interest Energy Research (PIER) Program
  - Integrated Energy Systems — Productivity and Building Science project, CEC contract No. 400-99-013
  - VAV Design Guide: http://www.energy.ca.gov/reports/2003-11-17_500-03-082_A-11.PDF

DDC 5: Supply Air Temperature Reset Related Research

Table 1 – Source Energy Savings for Supply Air Temperature Reset Controls
Table 30 from PIER VAV Guide (CEC Oct. 2003)

SAT Control Method	Cooling kWh/ft2	Fans kWh/ft2	Total kWh kWh/ft2	Heating kBtu/ft2	Total Source kBtu/ft2
San Francisco Climate					
1. Constant 55	2.43	0.38	2.81	5.23	33.9
2. Reset by zone demand	1.75	0.47	2.22	4.45	27.2
3. Switch to T-min when chiller runs	1.82	0.4	2.22	4.64	27.3
4. Switch to T-min when OAT > 60	1.88	0.4	2.28	4.58	27.9
5. Switch to T-min when OAT > 65	1.76	0.43	2.19	4.49	26.9
6. Switch to T-min when OAT > 70	1.75	0.45	2.2	4.46	27
7. Switch to T-min when OAT > 75	1.75	0.46	2.21	4.45	27.1
Sacramento Climate					
1. Constant 55	2.76	0.52	3.28	7.38	41
2. Reset by zone demand	2.3	0.63	2.93	6.55	36.5
3. Switch to T-min when chiller runs	2.33	0.52	2.85	6.8	36
4. Switch to T-min when OAT > 60	2.39	0.52	2.91	6.79	36.6
5. Switch to T-min when OAT > 65	2.3	0.54	2.84	6.6	35.7
6. Switch to T-min when OAT > 70	2.29	0.55	2.84	6.56	35.7
7. Switch to T-min when OAT > 75	2.29	0.57	2.86	6.55	35.9

DDC 5: Supply Air Temperature Reset Results

- LCC Effectiveness
  - Savings established in PIER research
  - Cost is negligible as it does not require zone feedback

DDC 5: Supply Air Temperature Reset Proposed Changes

Modification of Existing Prescriptive Requirement 144(f)

(f) Supply Air Temperature Reset Controls. Mechanical space-conditioning systems supplying heated or cooled air to multiple zones shall include controls that automatically reset supply-air temperatures:

1. In response to representative building loads or to outdoor air temperature; and

2. By at least 25 percent of the difference between the design supply-air temperature and the design room air temperature.

Right-click to display grammar suggestions

Air distribution to zones that are likely to have constant loads, such as interior zones, shall be designed for the fully reset supply temperature.

EXCEPTION 1 to Section 144 (f): Systems that meet the requirements of Section 144 (d), without using Exception 1 or 2 to that section.

EXCEPTION 2 to Section 144 (f): Where supply-air temperature reset would increase overall building energy use.

EXCEPTION 3 to Section 144 (f): Zones in which specific humidity levels are required to satisfy process needs.

~~EXCEPTION 4 to Section 144 (f): Variable air volume space-conditioning systems with variable speed drives.~~

Questions