THERMA-FUSER VAV SYSTEMS
CALIFORNIA TITLE 24

Title 24 Performance Approach and Office Building Air Systems with Therma-Fuser™ Diffusers

California Title 24 2013 offers two ways to comply; the Performance Approach and the Prescriptive Approach. Specific requirements are mandatory for both approaches 140.0(a) and (b)[1]. Additional requirements and restrictions are mandatory only for the Prescriptive Approach 140.2[2] whereas the Performance Approach requires modeling to show that the proposed design uses less energy than the standard design 140.1. Acutherm recommends using the Performance Approach for two reasons:

1. More flexibility in design because the requirements and restrictions mandatory for the Prescriptive Approach are optional.

2. Therma-Fuser systems use less fan energy than standard (baseline) air systems which along with other space conditioning, indoor lighting, mechanical ventilation and service water heating that are equal to or better than the standard design will result in a modeled energy budget for the proposed design lower than for the standard design.

Of the sections listed as applicable to nonresidential HVAC in Title 24 Table 100.0A, two have almost all the office building air system requirements that are mandatory for both approaches:

- Section 120.1, Ventilation, describes the requirements for indoor air quality and
- Section 120.2, Required Controls for Space Air Conditioning Systems, describes the mandatory controls for energy savings.

Satisfying the portions of these pertaining to office building air systems and mechanical equipment certification to 110.2 will allow an air system to comply when using the Title 24 Performance Approach, 140.1.

[1]Denotes the reference section of Title 24.

[2]Air system compliance with Section 140.4, Prescriptive Requirements for Space Conditioning Systems, is optional when using the Performance Approach and is mandatory only when using the Prescriptive Approach. Title 24 Section 140.4 design issues for office building air systems are: Economizers 140.4(e), Supply Air Temperature Reset 140.4(f), Static Pressure Reset 140.4(c)2, Reheat Restrictions 140.4(d) and Electric Heat Restrictions 140.4(g).

PERFORMANCE APPROACH

Title 24 design issues for office building air systems to be addressed with the Performance Approach are:

1. **Ventilation**
   a. During occupied hours, control outside, return and exhaust air for minimum OA the larger of 0.15 cfm/ft^2 or 15 cfm/person 120.1(b).

   b. During a one hour preoccupancy 120.1(c)2, control for OA the lesser of:
      - the larger of 0.15 cfm/ft^2 or 15 cfm/person, or
      - 3 complete air changes

   c. Set minimum flow on each Acutherm VAV diffuser at the larger of 0.15 cfm/ft^2 or 15 cfm/person.

2. **Thermostats**
   a. For constant supply air temperature (SAT), preferred for Acutherm VAV diffusers, control cooling and heating with a discharge air thermostat capable of a 5°F dead band between cooling and heating, 120.2(b)3.
      - May be reset to another constant SAT.
      - Design cooling SAT at 50°F and reset to 58-61°F depending on climate zone. For SAT reset in humid climates use at least one zone humidity sensor to disable reset if humidity exceeds 60%.
      - The heating SAT must be as low as possible but no lower than 80°F.

   b. Prevent simultaneous heating and cooling by changeover between them using either a manual control, a room thermostat, or multiple voting room sensors. Locate the room thermostat in the room of "greatest need" or maybe the most important room.

3. **Automatic Shutoff, Restart and Isolation Areas***
   a. For systems (not buildings) serving 25000 ft2 or less
      i. Use any model of Acutherm VAV diffusers and use controls which shut off the system during non use, 120.2(e)1, and temporally restart with either an automatic timer 110.9 with up to 4 hour manual override, or an occupancy sensor or a manual 4 hour timer 120.2(e)1.
      ii. For buildings without a BMS use a 24/7 clock thermostat to shut off and restart the system, 110.2(c).

   b. For systems serving more than 25,000 ft^2
      i. Use Acutherm E-Series Interoperable (BACnet or LonTalk) VAV diffusers or Acutherm M-Series motorized VAV diffusers and use the BMS to shut off the system during non use 120.2(e)1 and use either automatic timers 110.9 with up to 4 hour manual override, or occupancy sensors or manual 4 hour timers 120.2(e)1 to temporally restart the system 120.2(e)1 or to isolate areas by closing individual diffusers or a block of diffusers (including any associated duct heat) serving areas of 25,000 ft^2 or less 120.2(g).
      ii. Use Acutherm T-Series standalone VAV diffusers or Acutherm M-Series motorized VAV diffusers without DDC along with isolation duct dampers serving areas of 25,000 ft^2 or less and use controls which shut off the system during non use and use either automatic timers 110.9 with up to 4 hour manual override, or occupancy sensors or manual 4 hour timers to temporally restart the system or to isolate areas by closing the isolation duct dampers 120.2(g) (including any associated duct heat).
      iii. For buildings without a BMS use a 24/7 clock thermostat to shut off and restart the system, 110.2(c).

   c. Automatically restart all systems for setup, except if summer design is less than 100°F, and for setback, except if winter median is above 32°F 120.2(e)2.. Setup and setback set points must be 85°F or higher in cooling and 55°F or lower in heating,

4. **Demand Shed***
   a. Demand shed is not mandatory for systems using Acutherm T-Series standalone VAV diffusers and some applications using Acutherm M-Series motorized VAV diffusers because neither have DDC to the zone level, 120.2(h).

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b. For systems using Acutherm E-Series Interoperable (BACnet or LonTalk) VAV diffusers or Acutherm M-Series motorized VAV diffusers (both with DDC to the zone level) program the BMS to reset the diffuser temperature set points in increments for an adjustable rate of change to 4 °F above the cooling set point and to 4 °F below the heating set point upon a signal from a centralized point within the BMS 120.2(h). Also upon a signal from the same point, program the BMS to reverse the process and restore the original set points.
Use controls that:
- allow building operators to disable demand shed, and
- allow manual global temperature set point adjustment by building operators, and
- activate demand shed upon receipt of a demand response signal.

5. Demand Control Ventilation (DCV)*

a. DCV is not mandatory for systems using Acutherm T-Series standalone VAV diffusers and some applications using Acutherm M-Series motorized VAV diffusers because neither have DDC to the zone level, one of the three requirements for mandatory DCV 120.1(c)3.

b. If a system using Acutherm E-Series Interoperable (BACnet or LonTalk) VAV diffusers with DDC to the zone and has an economizer, use CO2 sensors by others in spaces with a density of 40 ft^2/person (example 6'x7') or less (high density spaces).

i. DCV is not required in high density spaces with:
- Offices etc. greater than 40ft^2/person (example 6'x7'), or
- Rooms smaller than 150 ft^2 (example 10'x15') or less than 10 occupancy (most individual offices), or
- Spaces less than 1500 ft^2 (example 30'x50') with an occupancy sensor

Note DCV is not required in most private offices because typically they are larger than 40ft^2/person (example 6'x7'), smaller than 150 ft^2 (example 10'x15') or less than 10 occupancy.

ii. Program the BMS to increase the minimum air flow for the diffusers in the high density spaces from the larger of 0.15 cfm/ft^2 or 15 cfm/person to the diffuser design cooling air flow to maintain CO2 below 1000ppm, 120.1(c)3 and 4. Adjust the system OA for a minimum of 0.15 cfm/ ft^2 for the high density spaces plus the larger of 0.15 cfm/ ft^2 or 15 cfm/person for the other spaces.

iii. Locate the CO2 sensors in the high density spaces between 3"and 6' above the floor. Use at least one sensor for each 10,000 ft^2. In spaces with multiple sensors, control increases in diffuser air flow from the sensor with the highest CO2 measure. Use CO2 sensors that meet 120.1(c)4F an G and are certified by the manufacturer.

6. Conference Rooms*

For rooms in systems without DCV which are either:
- unoccupied multipurpose rooms less than 1000ft^2 (example 25'x40'), or
- conference/meeting rooms greater than 750 ft^2 (example 25'x30')

use either Acutherm E-Series Interoperable (BACnet or LonTalk) VAV diffusers or Acutherm M-Series motorized VAV diffusers along with an occupancy sensor 120.2(e)3 by others that meets110.9(b)4 and program the BMS to reset the diffuser temperature set points to 2°F or more above the cooling set point and to 2°F or more below the heating set point when the room is unoccupied 120.2(e)3. Also after the room is unoccupied for 30 minutes, program the BMS to reset minimum ventilation to 0 (close the diffuser) if the room temperature is within the set points 120.1(c)5C. When unoccupied during occupied hours and the room ventilation rate falls below the larger of 0.15 cfm/ft^2 or 15 cfm/person, program the BMS to periodically cycle the diffuser open to maintain the average OA rate over 120 minutes of 3.75 cfm/ ft^2 (25% of15 cfm/ ft^2) 120.1(c)5E. Program the BMS to override the occupancy sensor for the preoccupancy purge per Ventilation,1b above 120.1(c)5B.

* New or Modified 2013

7. Perimeter heat

Where independent perimeter heat is used with Therma-Fuser diffusers in both perimeter and interior zones, locate thermostats in the served zone. Separate thermostats for each exposure of 50 feet or more are required for perimeter heat, Exception to 120.2(a). Prevent simultaneous heating and cooling by establishing a dead band between the perimeter heat thermostat and the Therma-Fuser diffuser with the lowest cooling set point of those in the same heating zone.

8. Performance Approach— Proposed Design Energy Budget Less than Energy Budget for the Standard Design

Use certified compliance software to calculate the energy budgets and show that the Energy Budget for the proposed design is less than that for the standard design 140.1. Ensure that the energy budget for the proposed design is less by designing a low energy use air system along with other space-conditioning, indoor lighting, mechanical ventilation and service water heating that is equal to or better than the standard design.

Title 24 focuses on controls for low energy and not on designing a basic low energy air system. For a low energy air system we must go to ASHRAE's *Advanced Energy Design Guide for Small to Medium Office Buildings.* Two significant air system energy reducing methods are a low horsepower fan with a low pressure drop air system and eliminating reheat.

a. The key to a low horsepower fan is a low pressure drop air system. Select and design filters, coils, risers, supply air ducting and return air ducting for the lowest possible pressure drop and size the Therma-Fuser VAV diffusers as large as possible for the lowest possible inlet static pressure.

b. Eliminate reheat either by using separate air handling units for each heating zone such as one per exposure and one for the interior or by adding enough inexpensive insulation to the building envelope until the heat loss through the envelope at outside temperature below winter design is less than the heat gain of the occupants and other internal loads in perimeter spaces.

For more about low energy air systems see Acutherm documents:

- *HIGH PERFORMANCE AIR SYSTEMS USING LOW ENERGY AIR HANDLING UNITS Zoned with Therma-Fuser™ VAV Diffusers*
- *HIGH PERFORMANCE AIR SYSTEMS USING HIGH EFFICIENCY PACKAGED ROOFTOP UNITS Zoned with Therma-Fuser™ VAV Diffusers*

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Additional Title 24 design issues for office building air systems to be addressed with the Prescriptive Approach are:

Note steps 1-6 of the Performance Approach are also mandatory for the Prescriptive Approach.

9. Fan energy 140.4(c)2A
Use the design techniques for a Therma-Fuser system from step 7 of the Performance Approach to ensure that total system (supply, return and makeup) fan power consumption is not above 1.25 W/cfm of supply air.

10. Economizers 140.4(e)*
For systems over 54,000 Btu/hr use Economizers as described in 140.4(e). Fault detection for air cooled unitary equipment must meet 120.2(i)

Note that an economizer is one of three requirements for mandatory Demand Control Ventilation 120.1(c)

11. Supply Air Temperature (SAT) Reset 140.4(f)
a. Design cooling SAT at 50°F and when OA is below 58°F, reset to 58-61°F depending on climate zone. Reset must be at least 25 percent of the difference between the design SAT and the design room air temperature. For SAT reset in humid climates use at least one zone humidity sensor to disable reset if humidity exceeds 60%.
b. SAT reset is not required if:
   i. The system is designed with no reheat, recooling or simultaneous heating and cooling Exception 1 to 140.4(f). Eliminate reheat with either a well insulated building envelope or separate AHU's for each exposure and the interior.
   ii. An energy study shows that SAT reset would increase overall building energy use Exception 2 to 140.4(f).

Note that SAT reset could use more energy than allowing fan turn down with an efficient VSD.

12. Static Pressure (SP) Control 140.4(c)2
a. Locate the system SP sensor close to the last diffuser (well below the required 1/3 of the total design fan SP 140.4(c)2B).
b. SP reset is not required for VAV diffusers as it is specifically required only for DDC VAV boxes 140.4(c)2C.

Note that with duct design for a maximum SP of 0.25"wg at the first (upstream) diffuser, Therma-Fuser systems operate below the lowest reset SP for VAV boxes. In addition, location of the system SP sensor close to the last diffuser results in reset of all upstream diffusers downward toward the SP of the last diffuser (may be as low as 0.05"wg) as the system turns down.

13. Reheat 140.4(d)*
For any perimeter duct heat stations, zone with all Therma-Fuser VAV diffusers and:
a. Limit the heating zone size to 300 cfm satisfying Exception 5 to Section 140.4(d). This could be two to five individual offices depending on size and load, or
b. If more than 300 cfm per heating zone is required,
   i. use Acutherm model TF-HC standalone limited heat diffusers and, per 140.4(d) Exception 1B, limit maximum heating air flow to the larger of 30% peak flow or 15 cfm/person, or
   ii. use Acutherm E-Series Interoperable (BACnet or LonTalk) VAV diffusers and follow the control sequence described in 140.4(d) Exception 1A.

Reduce the need for reheat as much as possible in perimeter duct heat systems by one or more of the following:
- Use the lowest possible minimum flow set point. Must be the higher of the minimum ventilation requirement of 15 cfm/person or the lowest allowed by the Therma-Fuser diffuser (10% of design air flow).
- Use a slightly higher supply air temperature. An increase in the supply air temperature will require a larger volume of air. Use a model to find the ideal compromise between reheat energy and fan energy.
- Select all interior diffusers for 60°F or higher SAT and reset the SAT in steps up to 60°F before activating reheat.

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14. Electric heat 140.4(g)

Only use electric under the following conditions:

a. Supplement to a heating system with at least 60 percent of the annual energy requirement supplied by site-solar or recovered energy Exception 1 to 140.4(g).
b. Supplement to a heat pump where the heat pump heating capacity is more than 75 percent of the design heating load Exception 2 to 140.4(g).
c. The total electric heat is less than 10 percent of the total design output capacity of all heating in the building Exception 3 to140.4(g).
d. The total electric heat, excluding those allowed under Exception 2, is no more than 3kW.for the entire building Exception 4 to 140.4(g).

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