SECTION 144 – PRESCRIPTIVE REQUIREMENTS FOR SPACE CONDITIONING SYSTEMS

A building complies with this section by being designed with and having constructed and installed a space-conditioning system that meets the requirements of Subsections (a) through (k).

(a) **Sizing and Equipment Selection**. Mechanical heating and mechanical cooling equipment shall be the smallest size, within the available options of the desired equipment line, necessary to meet the design heating and cooling loads of the building, as calculated according to Subsection (b).

EXCEPTION 1 to Section 144 (a): Where it can be demonstrated to the satisfaction of the enforcing agency that oversizing will not increase building TDV energy use.

EXCEPTION 2 to Section 144 (a): Standby equipment with controls that allow the standby equipment to operate only when the primary equipment is not operating.

EXCEPTION 3 to Section 144 (a): Multiple units of the same equipment type, such as multiple chillers and boilers, having combined capacities exceeding the design load, if they have controls that sequence or otherwise optimally control the operation of each unit based on load.

(b) **Calculations**. In making equipment sizing calculations under Subsection (a), all of the following rules shall apply:

1. **Methodology**. The methodologies, computer programs, inputs, and assumptions approved by the commission shall be used.
2. **Heating and cooling loads**. Heating and cooling system design loads shall be determined in accordance with the procedures described in the ASHRAE Handbook, Fundamentals Volume, or as specified in a method approved by the commission.
3. **Indoor design conditions**. Indoor design temperature and humidity conditions for general comfort applications shall be determined in accordance with ASHRAE 55 or the ASHRAE Handbook, Fundamentals Volume, Chapter 8 except that winter humidification and summer dehumidification shall not be required.
4. **Outdoor design conditions**. Outdoor design conditions shall be selected from Joint Appendix ~~H~~2, which is based on data from the ASHRAE Climatic Data for Region X. Heating design temperatures shall be no lower than the Heating Winter Median of Extremes values. Cooling design temperatures shall be no greater than the 0.5 percent Cooling Dry Bulb and Mean Coincident Wet Bulb values.

   EXCEPTION to Section 144 (b) 4: Cooling design temperatures for cooling towers shall be no greater than the 0.5 percent Cooling Design Wet bulb values.
5. **Ventilation**. Outdoor air ventilation loads shall be calculated using the ventilation rates required in Section 121.
6. **Envelope**. Envelope heating and cooling loads shall be calculated using envelope characteristics, including square footage, thermal conductance, solar heat gain coefficient or shading coefficient, and air leakage, consistent with the proposed design.
7. **Lighting**. Lighting loads shall be based on actual design lighting levels or power densities as specified in Section 146.
8. **People**. Occupant density shall be based on the expected occupancy of the building and shall be the same as determined under Section 121 (b) 2 B, if used. Sensible and latent heat gains shall be as listed in the 2005 ASHRAE Handbook~~,~~ Fundamentals ~~Volume~~, Chapter ~~29~~30, Table 1.
9. **Process loads.** Loads caused by a process shall be based upon actual information on the intended use of the building.
10. **Miscellaneous equipment**. Equipment loads shall be calculated using design data compiled from one or more of the following sources:
    A. Actual information based on the intended use of the building; or
    B. Published data from manufacturer's technical publications and from technical societies, such as the ASHRAE Handbook, Applications Volume; or

C. Other data based on the designer's experience of expected loads and occupancy patterns.

11. **Internal heat gains**. Internal heat gains may be ignored for heating load calculations.

12. **Safety factor**. Design loads may be increased by up to 10 percent to account for unexpected loads or changes in space usage.

13. **Other loads.** Loads such as warm-up or cool-down shall be calculated from principles based on the heat capacity of the building and its contents, the degree of setback, and desired recovery time; or may be assumed to be no more than 30 percent for heating and 10 percent for cooling of the steady-state design loads. The steady-state load may include a safety factor in accordance with Section 144 (b) 12.

(c) **Power Consumption of Fans.** Each fan system used for comfort space conditioning shall meet the requirements of Item 1 or 2 below, as applicable. Total fan system power demand equals the sum of the power demand of all fans in the system that are required to operate at design conditions in order to supply air from the heating or cooling source to the conditioned space, and to return it back to the source or to exhaust it to the outdoors; however, total fan system power demand need not include the additional power demand caused solely by air treatment or filtering systems with final pressure drops more than 245 pascals or one-inch water column (only the energy accounted for by the amount of pressure drop that is over one inch may be excluded), or fan system power caused solely by process loads.

1. **Constant volume fan systems.** The total fan power index at design conditions of each fan system with total horsepower over 25 horsepower shall not exceed 0.8 watts per cfm of supply air.

2. **Variable air volume (VAV) systems.**

A. The total fan power index at design conditions of each fan system with total horsepower over 25 horsepower shall not exceed 1.25 watts per cfm of supply air; and

B. Individual VAV fans with motors 10 horsepower or larger shall meet one of the following:

i. The fan motor shall be driven by a mechanical or electrical variable speed drive.

ii. The fan shall be a vane-axial fan with variable pitch blades.

iii. For prescriptive compliance, 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 when static pressure set point equals 1/3 of the total design static pressure, based on certified manufacturer's test data.

C. Static Pressure Sensor Location. Static pressure sensors used to control variable air volume fans shall be placed in a position such that the controller set point is no greater than one-third the total design fan static pressure, except for systems with zone reset control complying with 144 (c) 2 D. If this results in the sensor being located downstream of major duct splits, multiple sensors shall be installed in each major branch with fan capacity controlled to satisfy the sensor furthest below its setpoint.

D. Set Point Reset. For systems with direct digital control of individual zone boxes reporting to the central control panel, static pressure set point shall be reset based on the zone requiring the most pressure; i.e., the set point is reset lower until one zone damper is nearly wide open.

3. **Air-treatment or filtering systems.** For systems with air-treatment or filtering systems, calculate the adjusted fan power index using equation 144-A:

EQUATION 144-A ADJUSTED FAN POWER INDEX

Adjusted fan power index = Fan power index x Fan Adjustment

$$\text{Fan Adjustment} = 1-\left(\frac{SP_a - 1}{SP_f}\right)$$

WHERE:

SP_a	=	Air pressure drop across the air-treatment or filtering system.
SP_f	=	Total pressure drop across the fan.

4. **Fan motors of series fan-powered terminal units.** Fan motors of series fan-powered terminal units 1 horsepower or less in shall be electronically-commutated motors or shall have a minimum motor efficiency of 70% when rated in accordance with NEMA Standard MG 1-~~1998 Rev. 2~~2006 at full load rating conditions.

(d) **Space-conditioning Zone Controls**. Each space-conditioning zone shall have controls that prevent:

1. Reheating; and
2. Recooling; and
3. 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.

~~**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, re cooled, or mixed air supply. For each zone, this minimum volume shall be no greater than the largest of the following:~~

~~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.~~

EXCEPTION 1 to Section 144 (d): Zones served by variable air-volume systems that are designed and controlled to reduce, to a minimum, the volume of reheated, re-cooled, or mixed air supply are allowed only if the controls meet the following requirements:[JA1]

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

1. The volume of primary air that is reheated, re-cooled, or mixed air supply shall not exceed the larger of:[TMM2]
   a. 50 percent of the peak primary airflow, or
   b. The design zone outdoor airflow rate per Section 121
2. The primary airflow in the deadband shall not exceed the larger of:
   a. 20 percent of the peak primary airflow; or
   b. The design zone outdoor airflow rate per Section 121
3. Airflow between deadband and full heating or full cooling must be modulated.

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

1. 30 percent of the peak primary airflow; or
2. The design zone outdoor airflow rate per Section 121

EXCEPTION 2 to Section 144 (d): Zones with special pressurization relationships or cross-contamination control needs.

EXCEPTION 3 to Section 144 (d): Zones served by space-conditioning systems in which at least 75 percent of the energy for reheating, or providing warm air in mixing systems, is provided from a site-recovered or site-solar energy source.

EXCEPTION 4 to Section 144 (d): Zones in which specific humidity levels are required to satisfy process needs.

EXCEPTION 5 to Section 144 (d): Zones with a peak supply-air quantity of 300 cfm or less.

(e) Economizers.

1. Each individual cooling fan system that has a design supply capacity over 2,500 cfm and a total mechanical cooling capacity over 75,000 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.

EXCEPTION 1 to Section 144 (e) 1: Where it can be shown to the satisfaction of the enforcing agency that special outside air filtration and treatment, for the reduction and treatment of unusual outdoor contaminants, makes compliance infeasible.

EXCEPTION 2 to Section 144 (e) 1: Where the use of outdoor air for cooling will affect other systems, such as humidification, dehumidification, or supermarket refrigeration systems, so as to increase overall building TDV energy use.

EXCEPTION 3 to Section 144 (e) 1: Systems serving high-rise residential living quarters and hotel/motel guest rooms.

EXCEPTION 4 to Section 144 (e) 1: Where it can be shown to the satisfaction of the enforcing agency that the use of outdoor air is detrimental to equipment or materials in a space or room served by a dedicated space-conditioning system, such as a computer room or telecommunications equipment room.

EXCEPTION 5 to Section 144 (e) 1: Where electrically operated unitary air conditioners and heat pumps have cooling efficiencies that meet or exceed the efficiency requirements of TABLE 144-A and

TABLE 144-B.

2. If an economizer is required by Subparagraph 1, it shall be:

   A. Designed and equipped with controls so that economizer operation does not increase the building heating energy use during normal operation; and

      EXCEPTION to Section 144 (e) 2 A: Systems that provide 75 percent of the annual energy used for mechanical heating from site-recovered energy or a site-solar energy source.

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

3. Air-side economizers shall have high limit shutoff controls complying with TABLE 144-C.

(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.

Air distribution systems serving zones that are likely to have constant loads, such as interior zones, shall be designed for the air flows resulting from ~~for~~ the fully reset supply air temperature.[1]

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[2].~~

(g) **Electric Resistance Heating**. Electric resistance heating systems shall not be used for space heating.

EXCEPTION 1 to Section 144 (g): Where an electric-resistance heating system supplements a heating system in which at least 60 percent of the annual energy requirement is supplied by site-solar or recovered energy.

EXCEPTION 2 to Section 144 (g): Where an electric-resistance heating system supplements a heat pump heating system, and the heating capacity of the heat pump is more than 75 percent of the design heating load calculated in accordance with Section 144 (a) at the design outdoor temperature specified in Section 144 (b) 4.

EXCEPTION 3 to Section 144 (g): Where the total capacity of all electric-resistance heating systems serving the entire building is less than 10 percent of the total design output capacity of all heating equipment serving the entire building.

EXCEPTION 4 to Section 144 (g): Where the total capacity of all electric-resistance heating systems serving the building, excluding those allowed under Exception 2, is no more than 3 kW.

EXCEPTION 5 to Section 144 (g): Where an electric resistance heating system serves an entire building that is not a high-rise residential or hotel/motel building; and has a conditioned floor area no greater than 5,000 square feet; and has no mechanical cooling; and is in an area where natural gas is not currently available and an extension of a natural gas system is impractical, as determined by the natural gas utility.

(h) **Heat Rejection Systems.**

1 **General.** Subsection 144(h) applies to heat rejection equipment used in comfort cooling systems such as air-cooled condensers, open cooling towers, closed-circuit cooling towers, and evaporative condensers.

2 **Fan Speed Control.** Each fan powered by a motor of 7.5 hp (5.6 kW) or larger shall have the capability to operate that fan at two-thirds of full speed or less, and shall have controls that automatically change the fan speed to control the leaving fluid temperature or condensing temperature/pressure of the heat rejection device.

EXCEPTION 1 to Section 144(h) 2: Heat rejection devices included as an integral part of the equipment listed in Table 112-A through Table 112-E.

EXCEPTION 2 to Section 144(h) 2: Condenser fans serving multiple refrigerant circuits.

EXCEPTION 3 to Section 144(h) 2: Condenser fans serving flooded condensers.

EXCEPTION 4 to Section 144(h) 2: Up to 1/3 of the fans on a condenser or tower with multiple fans where the lead fans comply with the speed control requirement.

3 **Tower Flow Turndown**. Open cooling towers configured with multiple condenser water pumps shall be designed so that all cells can be run in parallel with the larger of:

A. The flow that's produced by the smallest pump, or

B. 33% of the design flow for the cell.

4 **Limitation on Centrifugal Fan Cooling Towers.** Open cooling towers with a combined rated capacity of 900 gpm and greater at 95°F condenser water return, 85°F condenser water supply and 75°F outdoor wet-bulb temperature shall use propeller fans and shall not use centrifugal fans.

EXCEPTION 1 to Section 144 (h) 4: Cooling towers that are ducted (inlet or discharge) or have an external sound trap that requires external static pressure capability.

EXCEPTION 2 to Section 144 (h) 4: Cooling towers that meet the energy efficiency requirement for propeller fan towers in Section 112, Table 112-G[JA3].

(i) **Limitation of Air-Cooled Chillers**

1. Chilled water plants with more than 300 tons total capacity shall not have more than 100 tons provided by air-cooled chillers.

EXCEPTION 1 to 144 (i): Where the designer demonstrates that the water quality at the building site fails to meet manufacturer's specifications for the use of water-cooled equipment.

EXCEPTION 2 to 144 (i): Plants that employ a cooling thermal energy storage system.

EXCEPTION 3 to Section 144 (i): Air cooled chillers with minimum efficiencies approved by the Commission pursuant to Section 10-109 (d).

(j) **Hydronic System Measures**

1. **Hydronic Variable Flow Systems.** HVAC chilled and hot water pumping shall be designed for variable fluid flow and shall be capable of reducing pump flow rates to no more than the larger of: a) 50% or less of the design flow rate; or b) the minimum flow required by the equipment manufacturer for the proper operation of equipment served by the system.

EXCEPTION to Section 144 (j) 1: Systems that include no more than three control valves.

2. **Chiller Isolation.** When a chilled water plant includes more than one chiller, provisions shall be made so that flow through any chiller is automatically shut off when that chiller is shut off while still maintaining flow through other operating chiller(s). Chillers that are piped in series for the purpose of increased temperature differential shall be considered as one chiller.

3. **Boiler Isolation.** When a hot water plant includes more than one boiler, provisions shall be made so that flow through any boiler is automatically shut off when that boiler is shut off while still maintaining flow through other operating boiler(s).

4. **Chilled and Hot Water Temperature Reset Controls.** Chilled and hot water systems with a design capacity exceeding 500,000 Btu/h supplying chilled or heated water (or both) shall include controls that automatically reset supply water temperatures as a function of representative building loads or outside air temperature.

EXCEPTION to Section 144 (j) 4: Hydronic systems that use variable flow to reduce pumping energy in accordance with 144 (j) 1.

5. **Water Loop Heat Pump Systems.** Water-Loop Heat Pump Systems having a total pump system power exceeding 5 hp shall have flow controls that meet the requirements of 144 (j) 6. Each heat pump shall have a two-position automatic valve interlocked to shut off water flow when the compressor is off.

6. **Variable ~~Speed Drives~~Flow Controls**.

   A. 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~~pumps shall be controlled as a function of ~~desired flow or to maintain a minimum~~ required differential pressure.

   B. Pressure Sensor Location and Setpoint.

      i. For systems without direct digital control of individual coils reporting to the central control panel, d~~D~~ifferential pressure shall be measured at or near the most remote heat exchanger or the heat exchanger requiring the greatest differential pressure.

      ii. For systems [JA4]with direct digital control of individual coils with central control panel, the static pressure set point shall be reset based on the valve requiring the most pressure, and the setpoint shall be no less than 80% [JA5]open. The pressure sensor(s) may be mounted anywhere.[3]

   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.

7. **Hydronic Heat Pump (WLHP) Controls.** Hydronic heat pumps connected to a common heat pump water loop with central devices for heat rejection and heat addition shall have controls that are capable of providing a heat pump water supply temperature dead band of at least 20°F between initiation of heat rejection and heat addition by the central devices.

   EXCEPTION to Section 144 (j)7: Where a system loop temperature optimization controller is used to determine the most efficient operating temperature based on real-time conditions of demand and capacity, dead bands of less than 20°F shall be allowed.[4]

[MS7](k) **Air Distribution System Duct Leakage Sealing.** All duct systems shall be sealed to a leakage rate not to exceed 6% of the fan flow if the duct system:

1. Is connected to a constant volume, single zone, air conditioners, heat pumps or furnaces, and
2. Serving less than 5,000 square feet of floor area; and
3. Having more than 25% duct surface area located in one or more of the following spaces:
   A. Outdoors, or
   B. In a space directly under a roof where the U-factor of the roof is greater than the U-factor of the ceiling, or

      EXCEPTION to Section 144(k) 3 B: Where the roof meets the requirements of 143 (a) 1 C.

   C. In a space directly under a roof with fixed vents or openings to the outside or unconditioned spaces, or
   D. In an unconditioned crawlspace; or
   E. In other unconditioned spaces.

The leakage rate shall be confirmed through field verification and diagnostic testing, in accordance with procedures set forth in the Nonresidential ~~ACM Manual~~Appendix NA5.

(l) **Variable air volume control for single zone systems.** Effective January 1,2012 all unitary air conditioning equipment and air-handling units with mechanical cooling capacity at ARI conditions greater than or equal to 110,000 Btu/hr that serve single zones shall be designed for variable supply air volume with their supply fans controlled by two-speed motors, variable speed drives, or equipment that has been demonstrated to the Executive Director to use no more energy[JA8]. The supply fan controls shall modulate down to a minimum of two-thirds of the full fan speed or lower [JA9]at low cooling demand.[5]

TABLE 144-A ECONOMIZER TRADEOFF TABLE FOR ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS

	Size Category

Climate Zone	**≥760,000**	**≥240,000 and <760,000**	**≥135,000 and <240,000**	**≥65,000 and <135,000**[JA10]
1	N/A	N/A	N/A	N/A
2	N/A	N/A	N/A	N/A
3	N/A	N/A	N/A	N/A
4	11.9 (before 1/1/2010)[6] 12.5 (as of 1/1/2010)	12.2 (before 1/1/2010) 12.9 (as of 1/1/2010)	12.4 (before 1/1/2010) 14.1 (as of 1/1/2010)	N/A
5	N/A	N/A	N/A	N/A
6	N/A	N/A	N/A	N/A
7	N/A	N/A	N/A	N/A
8	11.9 (before 1/1/2010) 12.5 (as of 1/1/2010)	12.2 (before 1/1/2010) 12.9 (as of 1/1/2010)	12.4 (before 1/1/2010) 14.1 (as of 1/1/2010)	N/A
9	11.6 (before 1/1/2010) 12.2 (as of 1/1/2010)	11.9 (before 1/1/2010) 12.5 (as of 1/1/2010)	12.1 (before 1/1/2010) 13.7 (as of 1/1/2010)	N/A
10	11.4 (before 1/1/2010) 12.0 (as of 1/1/2010)	11.7 (before 1/1/2010) 12.3 (as of 1/1/2010)	11.9 (before 1/1/2010) 13.5 (as of 1/1/2010)	12.4 (before 1/1/2010) 13.5 (as of 1/1/2010)
11	11.5 (before 1/1/2010) 12.1 (as of 1/1/2010)	11.8 (before 1/1/2010) 12.4 (as of 1/1/2010)	12.0 (before 1/1/2010) 13.6 (as of 1/1/2010)	N/A
12	11.7 (before 1/1/2010) 12.3 (as of 1/1/2010)	12.0 (before 1/1/2010) 12.6 (as of 1/1/2010)	12.2 (before 1/1/2010) 13.8 (as of 1/1/2010)	N/A
13	11.2 (before 1/1/2010) 11.8 (as of 1/1/2010)	11.5 (before 1/1/2010) 12.1 (as of 1/1/2010)	11.7 (before 1/1/2010) 13.3 (as of 1/1/2010)	12.3 (before 1/1/2010) 13.4 (as of 1/1/2010)
14	11.7 (before 1/1/2010) 12.3 (as of 1/1/2010)	12.0 (before 1/1/2010) 12.6 (as of 1/1/2010)	12.2 (before 1/1/2010) 13.8 (as of 1/1/2010)	N/A
15	10.0 (before 1/1/2010) 10.6 (as of 1/1/2010)	10.4 (before 1/1/2010) 11.0 (as of 1/1/2010)	10.6 (before 1/1/2010) 12.0 (as of 1/1/2010)	11.3 (before 1/1/2010) 12.3 (as of 1/1/2010)
16	N/A	N/A	N/A	N/A

TABLE 144-B ECONOMIZER TRADEOFF TABLE FOR ELECTRICALLY OPERATED UNITARY HEAT PUMPS[JA11]

Climate Zone	Size Category		
	≥240,000	**≥135,000 and <240,000**	**≥65,000 and <135,000**
1	N/A	N/A	N/A
2	N/A	N/A	N/A
3	N/A	N/A	N/A
4	11.7 (before 1/1/2010)[7] 13.8 (as of 1/1/2010)	12.1 (before 1/1/2010) 13.8 (as of 1/1/2010)	N/A
5	N/A	N/A	N/A
6	N/A	N/A	N/A
7	12.3 (before 1/1/2010) 14.5 (as of 1/1/2010)	N/A	N/A
8	11.7 (before 1/1/2010) 13.8 (as of 1/1/2010)	12.0 (before /1/2010) 13.7 (as of 1/1/2010)	N/A
9	11.3 (before 1/1/2010) 13.3 (as of 1/1/2010)	11.7(before 1/1/2010) 13.3 (as of 1/1/2010)	12.5 (before 1/1/2010) 13.6 (as of 1/1/2010)
10	11.1 (before 1/1/2010) 13.1 (as of 1/1/2010)	11.5 (before 1/1/2010) 13.1 (as of 1/1/2010)	12.3 (before 1/1/2010) 13.4 (as of 1/1/2010)
11	11.3 (before 1/1/2010) 13.3 (as of 1/1/2010)	11.6 (before 1/1/2010) 13.2 (as of 1/1/2010)	12.4 (before 1/1/2010) 13.5 (as of 1/1/2010)
12	11.5 (before 1/1/2010) 13.5 (as of 1/1/2010)	11.8 (before 1/1/2010) 13.4 (as of 1/1/2010)	N/A
13	10.9 (before 1/1/2010) 12.8 (as of 1/1/2010)	11.3 (before 1/1/2010) 12.9 (as of 1/1/2010)	12.1 (before 1/1/2010) 13.2 (as of 1/1/2010)
14	11.5 (before 1/1/2010) 13.5 (as of 1/1/2010)	11.8 (before 1/1/2010) 13.4 (as of 1/1/2010)	N/A
15	9.8 (before 1/1/2010) 11.5 (as of 1/1/2010)	10.1 (before 1/1/2010) 11.5 (as of 1/1/2010)	11.1 (before 1/1/2010) 12.1 (as of 1/1/2010)
16	N/A	N/A	N/A

TABLE 144-C AIR ECONOMIZER HIGH LIMIT SHUT OFF CONTROL REQUIREMENTS

Device Type	**Climate Zones**	**Required High Limit (Economizer Off When):**	
		Equation	**Description**
Fixed Dry Bulb	1, 2, 3, 5, 11, 13, 14, 15 & 16	T_{OA} > 75°°F	Outside air temperature exceeds 75°F
	4, 6, 7, 8, 9, 10 & 12	T_{OA} > 70°°F	Outside air temperature exceeds 70°F
Differential Dry Bulb	All	$T_{OA} > T_{RA}$	Outside air temperature exceeds return air temperature
Fixed Enthalpy[a]	4, 6, 7, 8, 9, 10 & 12	h_{OA} > 28 Btu/lb[b]	Outside air enthalpy exceeds 28 Btu/lb of dry air[b]
Electronic Enthalpy	All	(T_{OA}, RH_{OA}) > A	Outside air temperature/RH exceeds the "A" set-point curve[c]

Device Type	Climate Zones	Required High Limit (Economizer Off When):	
		Equation	Description
Differential Enthalpy	All	$h_{OA} > h_{RA}$	Outside air enthalpy exceeds return air enthalpy

[a] Fixed Enthalpy Controls are prohibited in climate zones 1, 2, 3, 5, 11, 13, 14, 15 & 16.

[b] At altitudes substantially different than sea level, the Fixed Enthalpy limit value shall be set to the enthalpy value at 75°F and 50% relative humidity. As an example, at approximately 6000 foot elevation the fixed enthalpy limit is approximately 30.7 Btu/lb.

[c] Set point "A" corresponds to a curve on the psychometric chart that goes through a point at approximately 75°F and 40% relative humidity and is nearly parallel to dry bulb lines at low humidity levels and nearly parallel to enthalpy lines at high humidity levels.

SECTION 145 – PRESCRIPTIVE REQUIREMENTS FOR SERVICE WATER HEATING SYSTEMS

(a) **Nonresidential and Hotel/Motel Occupancies**. A service water heating system installed in a nonresidential building complies with this section if it is a gas, oil, or propane fired water heater or boiler which meets the efficiency ~~complies with the applicable~~ requirements of Section 111 or is a system that uses no more energy as determined by an approved calculation method or alternative component requirement. The system shall also meet the installation requirements of Section 113 and 123. A service water heating system installed in a hotel/motel building complies with this section if it meets the requirements of Section 151 (f) 8.

(b) **High-Rise Residential Occupancies**. A service water heating system installed in a high-rise residential building complies with this section if it meets the requirements of Section 151 (f) 8.

(c) **Water Heating Recirculation Loops Serving Multiple Dwelling Units, High-Rise Residential and Hotel/Motel Occupancies.** Water heating recirculation loops serving multiple dwelling units, high-rise residential and hotel/motel occupancies shall meet the requirements of Section 113(c)5. [ce13]

[1] Edited for clarity.

[2] PG&E CASE initiative from M. Hydeman, DDC to the Zone Level Measure 5, Supply Air Temperature Reset, http://www.energy.ca.gov/title24/2008standards/documents/2006-07-12_workshop/2006-07-11_DDC_MEASURE5.PDF

[3] From Hydeman, DDC to the Zone Level 3: Hydronic Pressure Reset, http://www.energy.ca.gov/title24/2008standards/documents/2006-07-12_workshop/2006-07-11_DDC_LEVEL3.PDF

[4] From AEC, Building Envelope and HVAC, http://www.energy.ca.gov/title24/2008standards/documents/2006-07-12_workshop/DRAFT_BUILDING_ENVELOPE_HVAC.PDF.

[5] From Hydeman, Single Zone VAV Systems, February Workshop Report. Succeeds earlier version, http://www.energy.ca.gov/title24/2008standards/documents/2006-07-12_workshop/SINGLE_ZONE_VAV_SYSTEMS.PDF

[6] Minimum efficiency requirements for economizer tradeoffs for unitary equipment have been revised to reflect increased efficiency requirements that take effect on 1/1/2010, per ASHRAE 90.1 Addendum g.

[7] Minimum efficiency requirements for economizer tradeoffs for unitary equipment have been revised to reflect increased efficiency requirements that take effect on 1/1/2010, per ASHRAE 90.1 Addendum g.