Submitted by Reid Hart on 06-26-09

MECHANICAL AMENDMENTS
PECI as Amended up to 06/26/09

SECTION 1302
DEFINITIONS

COLD STORAGE SPACE. Spaces that are mechanically cooled and designed to be maintained at a temperature below 45°F (7°C) and at or above 28°F (-2.2°C).

FROZEN STORAGE SPACE. Spaces that are mechanically cooled and designed to be maintained at a temperature below 28°F (-2.2°C).

REFRIGERATED WAREHOUSES. Buildings that contain cold storage spaces or frozen storage spaces that have total area exceeding 3,000 square feet.

SEMI-CONDITIONED SPACES. Spaces that have a limited heating system output capacity that does not exceed the values listed below, and where each heating system is controlled by a thermostat with a maximum setpoint capacity of 45°F (7°C), mounted no lower than heating unit for convection systems or below the heating unit for radiation systems**, excluding Cold Storage Space and Frozen Storage Space.**

Climate Zone 1: 15 Btu/hr.ft.^{2} (47 W/m^2) or 4 Watts/ft.^{2} (47 W/m^2) of heated floor area.

Climate Zone 2: 20 Btu/hr.ft.^{2} (63 W/m^2) or 5.86 W/ft.^{2} (63 W/m^2) of heated floor area.

SENSIBLE ENERGY RECOVERY EFFECTIVENESS. Change in the dry-bulb temperature of the outdoor air supply divided by the difference between the outdoor air and return air dry-bulb temperatures, expressed as a percentage.

DIVISION III — OTHER BUILDINGS

SECTION 1311
OTHER BUILDINGS

1311.1 Alternate method of compliance using the whole building approach. Alternative building systems and equipment designs may be approved by the building official for other buildings. Applicants shall demonstrate that the whole building annual energy consumption will not exceed that used by a similar building using similar forms of energy designed in accordance with the prescriptive requirements of this chapter. Compliance under this section allows trade–offs between the performance requirements in all sections of this chapter using 8,760–hour annual building simulation. The building official may require review of the simulation results by an independent reviewer.

1311.2. Optional compliance approach. All buildings, except occupancy group R, four stories and greater in height, with up to 40 percent window area (as a relationship to total exterior wall area) may demonstrate compliance with this approach by following the values in Table 1312.2(1) for Climate Zone 1 and Table 1312(2) for Climate Zone 2. The mechanical system efficiency shall be from the Optional Efficiency column in Tables 1317.5.1(1), 1317.5.1(2), 1317.5.1(3), 1317.5.1(5), 1317.5.1(6), and 1317.5. (7).**When the Optional Efficiency column is used for building envelope compliance, it shall not be used for other compliance alternatives as**

specified in either section 1317.4.1, 1317.3.1 exception 1, 1317.3.6 exception 4, or 1318.2.2.2 exception. If a nonstandard condition, water-cooled, centrifugal chilling package that is not designed for operation at ARI Standard 550/590 test conditions is installed, the full load kW/ton rating and NPLV rating shall be 10 percent better than the required calculation. If packaged terminal units are installed, they shall be packaged terminal heat pumps.

Occupancy group R buildings, four stories and greater in height, with up to 40 percent window area (as a relationship to total exterior wall area) may demonstrate compliance with this approach by following the values in Table 1312.2(1) for Climate Zone 1 and Table 1312.2(2) for Climate Zone 2. The mechanical system efficiency shall be from the Optional Efficiency column in Tables 1317.5.1(1), 1317.5.1(2), 1317.5.1(3), 1317.5.1(5), 1317.5.1(6), and 1317.5.1(7). **When the Optional Efficiency column is used for building envelope compliance, it shall not be used for other compliance alternatives as specified in either section 1317.4.1, 1317.3.1, 1317.3.6 exception 4, or 1318.2.2.2 exception.** If a nonstandard condition, water-cooled, centrifugal chilling package that is not designed for operation at ARI Standard 550/590 test conditions is installed, the full load kW/ton rating and NPLV rating shall be 10 percent better than the required calculation. If packaged terminal units are installed, they shall be packaged terminal heat pumps. For HVAC systems not listed above, or HVAC does not provide conditioning for entire building, the lighting power density for dwelling units and guest rooms shall not exceed 0.7 watts per square foot of floor area.

SECTION 1312
EXTERIOR ENVELOPE — OTHER BUILDINGS

1312.3 Building envelope thermal performance. All heated or mechanically cooled buildings and structures, or portions thereof, shall be constructed so as to provide the required thermal performance of the various components as set forth in this subsection and 1312.4. **Refrigerated Warehouses shall comply by using Section 1312.3.3.**

Exception: Glazing up to 1 percent of the exterior wall area is exempt from the *U*-factor and shading coefficient requirements of this code.

Buildings shall comply by using either Section 1312.3.1 or 1312.3.2.

1312.3.1 Prescriptive path approach. Buildings in Zone 1 shall meet the Prescriptive Path Approach if they comply with the values in Table ~~13-E~~1312.3.1(1). Buildings in Zone 2 shall meet the Prescriptive Path Approach if they comply with the values in Table ~~13-F~~1312.3.1(2). Each component (walls, roofs, etc.) shall meet either the *U*–factor standard for the assembly or the *R*–value standard for the insulation in the table.

Glazing and skylight fractions shall be calculated separately for conditioned spaces, semi-conditioned spaces, mechanical penthouses, and parking garages**.**

Trade-offs between components ~~or averaging of component *U*-factors~~ is not allowed.

1312.3.2 Simplified trade–off approach. Buildings may demonstrate compliance with the thermal performance standards of this section by using the Simplified Trade–off Approach (STA). The STA is an analytical method to determine if a proposed building has no larger annual heating load through the exterior envelope and no larger annual cooling load through the exterior envelope than a similar building meeting the Prescriptive Path Approach.

1312.3.3 Refrigerated Warehouse Approach. Exterior and interior surfaces of Frozen Storage Spaces or Cold Storage Spaces in refrigerated warehouses shall be insulated at least to the R-values in Table 1312.3.3. The remainder of refrigerated warehouse area containing conditioned or semi-conditioned spaces shall comply by using either Section 1312.3.1 or 1312.3.2.

Exception: Areas within refrigerated warehouses that are designed solely for the purpose of quick chilling or freezing of products with design cooling capacities of greater than 240 Btu/hr-ft2 (2 tons per 100 ft2).

Table 1312.3.3 Refrigerated Warehouse Insulation

SPACE	SURFACE	MINIMUM R-VALUE (°F-hr-sf/Btu)
Frozen Storage Spaces	Exterior Roof/Ceiling	R-36
	Exterior Wall	R-36
	Exterior Floor	R-20
	Interior Partition [1]	R-28
Cold Storage Spaces	Exterior Roof/Ceiling	R-28
	Exterior Wall	R-28
	Interior Partition [1]	R-19

[1] Interior partitions include any wall, floor, or ceiling that divides Frozen Storage Spaces or Cold Storage Spaces from each other, conditioned spaces, unconditioned spaces, or semi-conditioned spaces.

SECTION 1315
SERVICE WATER HEATING EQUIPMENT — OTHER BUILDINGS

1315.1 Requirements. All service water heating equipment including water heaters, hot water storage tanks and pool heaters in other buildings shall meet the requirements of this section and the criteria of Table ~~13-I~~1315.1. Where multiple criteria are listed in the table, all criteria shall be met.

Exception: Storage water heaters and hot water storage tanks having more than 140 gallons (530 L) of storage capacity need no**t** meet the standby loss (SL) or heat loss (HL) requirements of Table ~~13-I~~1315.1 if the tank surface area is thermally insulated to ~~R-12.5~~ **R-24** and if a standing pilot light is not used.

1315.2 Alterations. The requirements of this section apply to other buildings where new water heating equipment including water heaters, hot water storage tanks, and pool heaters are installed in existing buildings.

1315.2~~2~~3 Related Requirements.

(1) **Showers**. (See *Plumbing Specialty Code*).

(2) **Lavatories**. (See *Plumbing Specialty Code*).

(3) **Piping insulation**. (See Section 1314 of this code).

(4) **Integrated systems**. Service water heating equipment used to provide additional functions (e.g., space heating) as part of a combination (integrated) system shall comply with minimum performance requirements for water heating equipment. (See also Section 1318.4.1.)

TABLE ~~13-I~~1315.1
WATER HEATING EQUIPMENT

~~CATEGORY~~	~~TYPE~~	~~FUEL~~	~~INPUT RATING~~[1]	~~V_T~~[1]	~~INPUT TO V_T RATIO (BTU/GAL)~~	~~TEST METHOD~~	~~ENERGY FACTOR~~[2]	~~THERMAL EFFICIENCY E_T%~~	~~STANDBY LOSS %HR~~ [3]
~~NAECA Covered Water Heating Equipment~~[3]	~~All~~	~~Electric~~	~~≤12 kW~~	~~all~~[4]		~~DOE Test Proc. 10 CFR, Part 430~~	~~≥ 0.93-0.00132V~~		
	~~Storage~~	~~Gas~~	~~≤ 75,000 Btuh~~	~~all~~[4]			~~≥ 0.62-0.0019V~~		
	~~Instan-taneous~~	~~Gas~~	~~≤ 200,000 Btuh~~	~~all~~			~~≥ 0.62-0.0019V~~		
	~~Storage~~	~~Oil~~	~~≤ 105,000 Btuh~~[4]	~~all~~			~~≥ 0.59-0.0019V~~		
	~~Instan-taneous~~	~~Oil~~	~~≤ 210,000 Btuh~~	~~all~~			~~≥ 0.59-0.0019V~~		
	~~Pool Heater~~	~~Gas/Oil~~	~~All~~	~~all~~		~~ANSI Z21.56-1989~~		~~≥ 78%~~	
~~Other Water Heating Equipment~~[5]	~~Storage~~	~~Electric~~	~~All~~	~~all~~		~~ANSI Z21.10.3, 1990~~[6]			~~≤ 0.30+27/V_T~~
	~~Storage/ Instan-taneous~~	~~Gas/Oil~~	~~≤ 155,000 Btuh~~[4]	~~all~~	~~< 4,000~~			~~≥ 78%~~	~~≤1.3+114/V_T~~
			~~> 155,000 Btuh~~[4]	~~all~~	~~< 4,000~~			~~≥ 78%~~	~~≤1.3+95/V_T~~
				~~< 10~~	~~≥ 4,000~~			~~≥ 80%~~	
				~~≥ 10~~	~~≥ 4,000~~			~~≥ 77%~~	~~≤ 2.3+67/V_T~~
~~Unfired Storage Tanks~~				~~all~~					~~≤6.5 Btu/ft.~~[2 7]

~~For SI: 1 Btu/hr = 0.2931 W,°F = 1.8°C + 32, 1 ton = 3517 W.~~

~~[1] V_T is the storage volume in gallons measured during the test to determine the standby loss. V_T may differ from V, but it is within tolerances allowed by the applicable ANSI Z21 and UL Standards. Accordingly, for the purpose of estimating the standby loss requirement using the rated volume shown on the rating plate. V_T should be considered as no less than 0.95 V for gas and oil water heaters and no less than 90 V for electric water heaters.~~

~~[2] V is rated storage volume in gallons as specified by the manufacturer.~~

~~[3] Consistent with National Appliance Energy Conservation Act (NAECA) of 1987.~~

~~[4] DOE test procedures apply to electric and gas storage water heaters with rated volumes > 20 gallons and gas instantaneous water heaters with input ratings of 50,000 to 200,000 Btu/h.~~

~~[5] All those except water heaters covered by NAECA.~~

~~[6] When testing an electric storage water heater for standby loss using the test procedure of Section 2.9 of ANSI Z21.10.3-1990, the electrical supply voltage shall be maintained within +/- 1 percent of the center of the voltage range specified on the water heater nameplate. Also, when needed for calculations, the thermal efficiency (E_T) shall be 98 percent. When testing an oil water heater the test procedures of Section 2.8 and 2.9 of ANSI Z21.10.3-1990, the following modifications will be made.~~

~~6.1 A vertical length of flue gas outlet of sufficient height to establish the minimum draft specified in the manufacturer's installation instructions. All measurements of oil consumption will be taken by instruments with an accuracy of +/- 1 percent or better.~~

~~6.2 The burner rate shall be adjusted to achieve an hourly Btu input rate within +/- 2 percent of the manufacturer's specified input rate with the CO_2 reading as specified by the manufacturer with smoke no greater than 1 and the fuel pump pressure within +/- 1 percent of the manufacturer's specifications.~~

~~[7] Heat loss of tank surface area Btu/(hr. ft^2) based on 80°F water-air temperature difference.~~

Entire Table is new format – following Standard 90.1-07 format
Underlined "Equipment Type" and "Size Category" are new compared to current Oregon Table

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	PERFORMANCE REQUIRED[1]	TEST PROCEDURE[2]
Electric Water Heaters	≤12 kW	Resistance ≥20 gal	0.93-0.0132V EF	DOE 10 CFR Part 430
	>12 kW	Resistance ≥ gal	20 + 35√V SL, Btu/h	Section G.2 of ANSI Z21.10.3-1998
	≤24 Amps and ≤150 Volts	Heat Pump	0.93-0.00132V EF	DOE 10 CFR Part 430
Gas Storage Water Heaters	≤75,000 Btu.h	≥20 gal	0.62-0.0019V EF	DOE 10 CFR Part 430
	>75,000 Btu/h	<4,000 (Btu/h)/gal	80% E_t (Q/800 + 110 √V) SL, Btu/h	Sections G.1 and G.2 of ANSI Z21.10.3-1998
Gas Instantaneous Water Heaters	>50,000 Btu/h and <200,000 Btu/h	≥4,000 (Btu/h)/gal and <2 gal	0.62-0.0019V EF	DOE 10 CFR Part 430
	≥200,000 Btu/h[3]	≥4,000 (Btu/h)/gal and <10 gal	80% E_t	
	200,000 Btu/h	≥4,000 (Btu/h)/gal and ≥10 gal	80% E_t (Q/800 + 110 √V) SL, Btu/h	Sections G.1 and G.2 of ANSI Z21.10.3-1998
Oil Storage Water Heaters	≤105,000 Btu/h	≥20 gal	0.59-0.0019V EF	DOE 10 CFR Part 430
	>105,000 Btu/h	<4,000 (Btu/h)/gal	78% E_t (Q/800 + 110 √V) SL, Btu/h	Sections G.1 and G.2 of ANSI Z21.10.3-1998
Oil Instantaneous Water Heaters	<210,000 Btu/h	≥4,000 (Btu/h)/gal and <2 gal	0.59-0.0019V EF	DOE 10 CFR Part 430
	>210,000 Btu/h	≥4,000 (Btu/h)/gal and <10 gal	80% E_t	
	>200,000 Btu/h	≥4,000 (Btu/h)/gal and ≥10 gal	78% E_t (Q/800 + 110 √V) SL, Btu/h	Sections G.1 and G.2 of ANSI Z21.10.3-1998
Hot Water Supply Boilers, Gas and Oil	≥300,000 Btu/h and <12,500,000 Btu/h	≥4,000 (Btu/h)/gal and <10 gal	80% E_t	Sections G.1 and G.2 of ANSI Z21.10.3-1998
Hot Water Supply Boilers, Gas		≥4,000 (Btu/h)/gal and ≥10 gal	80% E_t (Q/800 + 110 √V) SL, Btu/h	
Hot Water Supply Boilers, Oil		≥4,000 (Btu/h)/gal and ≥10 gal	78% E_t (Q/800 + 110 √V) SL, Btu/h	
Pool Heaters, Gas and Oil	All		78% E_t	ANSI/ASHRAE 146-1998
Heat Pump Pool Heaters	All	50.0 °F [10.0°C] db 44.2 °F [6.78°C] db Outdoor air 80.0 °F [26.7°C] db Entering water	4.0 COP	ARI 1160-2008
Unfired Storage Tanks	All		R-12.5	(none)

[1] Energy Factor (EF) and thermal efficiency E_t are minimum requirements, while standby loss (SL) is maximum Btu/h based on a 70°F temperature difference between stored water and ambient requirements. In the EF equation, V is the rated volume in gallons and Q is the nameplate input rate in Btu/h.

[2] Section G1 is titled "Test Method for Measuring Thermal Efficiency" and Section G2 is titled "Test Method for Measuring Standby Loss.

[3] Instantaneous water heaters with input rates below 200,000 Btu/h shall comply with these requirements if the water heater is designed to.heat water to temperatures 180°F or higher.

1315.~~3~~4 Noncirculating systems. The first 8 feet (2.4 m) of outlet piping from the hot water storage tank, and the piping between the storage tank and a heat trap, shall be insulated as specified in Table ~~13-D~~1314.1.

Storage water heaters for noncirculating systems which are not equipped with integral heat traps and which have vertical pipe risers shall be installed with insulated heat traps as close as possible to both the inlet and outlet connections.

Systems without a heat trap to prevent circulation due to natural convection shall be considered circulating systems. See Section 1314.1 for circulating service water heating system piping insulation requirements.

1315.4~~5~~ Controls.

1315.5.1 Pump operation. Circulating service hot water systems shall be equipped with**:** ~~automatic time switches or other controls that can be set to turn off the system when use of hot water is not required.~~

A control that monitors hot water demand (e.g., flow switch in cold water make-up pipe) and during periods of no hot water demand, either: a) automatically turns off the circulator pump, or b) resets down the hot water storage tank temperature.

A check valve or similar device shall be located between the circulator pump and the water heating equipment to prevent water from flowing backwards though the recirculation loop.

Exceptions:

1. Where public health standards require 24 hours per day operation of pumps for uses such as swimming pools **and**~~,~~ spas ~~and hospitals~~.
2. Pumps required to operate solar or waste-heat-recovery pool heating systems.
3. **Service water heating systems used to provide multiple functions (e.g., space heating and DHW) as part of an integrated system.**
4. **Circulating service hot water systems where the pump is controlled by an aquastat in the following occupancies, as defined in the Oregon Structural Specialty Code: clinic-outpatient, ambulatory health care facility, nursing home, hospital, and child care facility.**
5. **Where coupled with water heating capacity less than 100,000 Btu/h (29 kW).**

1315.4~~5~~.2 Electric heat tapes. Electric heat tapes installed to maintain water temperatures in pipes shall have automatic time switches or other controls that can be set to turn off the electricity to the heat tapes when use of hot water is not required.

Exception: Heat tapes installed for freeze protection **provided they are equipped with temperature controls.**

1315.~~5~~6 Swimming pools, hot tubs and spas. The provisions of this section shall apply to all swimming pools, hot tubs and spas.

1315.~~5~~6.1 Controls. All Spa or Hot Tub heaters shall be equipped with a readily accessible ON/OFF switch to allow shutting off operation of heater without adjusting the thermostat setting and to allow restarting without re-lighting the pilot light. A humidity control system shall be used to control ventilating systems serving indoor pools.

1315.~~5~~6.2. Cover. All heated pools, hot tubs or spas shall be equipped with a cover capable of reducing vapor and heat transmission.

1315.~~5~~6.3 Heat recovery. Heated indoor swimming pools ~~and~~ Spas**, or** ~~and~~ Hot tubs **with water surface area greater than** ~~over~~ 200 square feet ~~in size~~ shall provide for energy conservation by ~~at least one of the following methods:~~

~~(1) The ventilating system shall provide a~~ **an exhaust air** heat recovery ~~of 70 percent at winter design conditions~~ **system that heats ventilation air, pool water, or domestic hot water. The heat recovery system shall be capable of decreasing the exhaust air temperature at design heating conditions by 28°F (15.5°C) in Climate Zone 1 and 42°F (23.3°C) in Climate Zone 2.**~~;~~

~~(2) Heat recovered through dehumidification shall be used to heat pool, spa or hot tub room supply air.~~

Exception: Pools**, spas, or Hot tubs that include system(s) that provide equivalent recovered energy on an annual basis through one of the following methods:**

(1) ~~heated by~~ renewable energy**,**

(2) dehumidification heat recovery, ~~or~~

(3) waste heat recovery**, or**

(4) a combination of these system(s) sources capable of providing at least 70 percent of the heating energy required over an operating season.

1315.6.4. Required heat recovery for service water heating. Condenser heat recovery systems shall be installed for heating or preheating of service hot water under one of the following.

1315.6.4.1. In facilities that have more than 840,000 Btu/hr (2867 kW) of refrigeration or water-cooled chiller capacity, service water heat recovery shall be employed to recover the lesser of 20% of cooling design day refrigeration or chiller output or 70% of daily service hot water load.

Exceptions:

1. **The design service water heating capacity** ~~load~~ **is less than 500,000 Btu/h (146 kW).**
2. **Buildings already employing recovery of at least 20% of available refrigeration or chiller heat rejection for some other purpose.**
3. **Chiller or refrigeration alterations or retrofits where the service water heating system is located more than 100 feet from the chiller or refrigeration system.**
4. **Buildings where the primary service water heater is a condensing boilers or heat pump water heater, or point-of-use water heaters that eliminate hot water supply and recirculation piping.**
5. **75 percent of the energy for service water heating is from site solar or geothermal energy sources.**

1315.6.4.2. In facilities where the total installed heat rejection capacity of the water-cooled systems exceeds 6,000,000 Btu/h of heat rejection, condenser heat recovery systems shall be installed for heating or preheating of service hot water. The required heat recovery system shall have the capacity to provide the smaller of:

60% of the peak heat rejection load at design conditions or

preheat of the peak service hot water draw to 85°F.

Exceptions:

1. **The design service water heating load is less than 1,000,000 Btu/h.**
2. **Facilities that employ condenser heat recovery for space heating with a heat recovery design exceeding 30% of the peak water-cooled condenser load at design conditions.**
3. **Facilities that provide 60% of their service water heating from site-solar or site-recovered energy or from other renewable sources.**

~~**1315.6 Alterations**. The requirements of this section apply to other buildings where new water heating equipment including water heaters, hot water storage tanks, and pool heaters are installed in existing buildings.~~

HEATING, VENTILATING AND AIR CONDITIONING (HVAC) — OTHER BUILDINGS

1317.1 General. Heating, ventilating and air–conditioning (HVAC) systems installed in other buildings shall comply with this section and with one of the following paths:

(1) Simple Systems (Packaged Unitary Equipment) of Section 1317.~~9~~10, ~~or~~

(2) Complex Systems of Section 1317.~~10~~11, **or**

(3) Systems serving cold storage spaces and frozen storage spaces in refrigerated warehouses shall meet the requirements of Section 1317.16.

Exceptions:

1. Systems for the removal of flammable vapors or residues.
2. Systems for conveying dust, stock or refuse by means of air currents.
3. Systems for manufacturing and industrial processes.

The following sections are same code requirements but in a new, logical order. Only the "new" underlined, stricken, and (new) numbering is identified:

1317.2 Additions and alterations. The requirements of Sections 1317 and 1318 apply to new HVAC systems and replaced system components.

Either Section ~~1317.7~~ 1317.8 or ~~1317.8~~ 1317.9 as appropriate, applies to the insulation of new ductwork installed in existing buildings, and to new insulation installed on existing ductwork in existing buildings.

Sections ~~1317.4~~ 1317.5 and 1318.2 apply to controls for all new HVAC equipment or systems installed in an existing building.

Exceptions:

1. Transport energy requirements of Section 1318.4.2 do not apply when any of the following is true:
   1.1. Less than 50 percent of the air distribution system is altered.
   1.2. The air handler is not replaced.
   1.3. It can be demonstrated to the building official that space constraint in an existing building makes this requirement impractical.
2. **New cooling systems that meet one of the following conditions shall be exempt from the economizer requirements of Section 1317.4 providing the mechanical cooling**

system efficiency meets the Optional Compliance Efficiency column in Tables 1317.6.1(1), 1317.6.1(2), and 1317.6.1(3). When the Optional Efficiency column is used for compliance, it shall not be used for compliance with 1311.2, Optional compliance approach.

2.1 Economizer cooling is not required for new cooling systems serving an existing dedicated computer server room, electronic equipment room or telecom switch room in existing buildings up to a total of 600,000 Btu/hr (17 586 W) of new cooling equipment.

~~3.~~ **2.2** Economizer cooling is not required for new cooling systems serving a new dedicated computer server room, electronic equipment room or telecom switch room in existing buildings up to a total of 240,000 Btu/hr (70 344 W) of new cooling equipment.

3. Temperature and pump speed reset control required in sections 1318.2.4 and 1318.2.9 do not apply when all of the following are true:

3.1 The building is not equipped with a direct digital control system,

3.2 The pump is not replaced,

3.3 New pumps larger than 1-1/2 horsepower are not added to the hydronic system, and

3.4 Extensions of the existing system do not add more than 100 gpm (380 L/m) of system flow at design.

4. Temperature and fan speed reset control required in sections 1318.2.3 and 1318.2.5 do not apply when all of the following are true:

4.1 The building is not equipped with a direct digital control system,

4.2 The supply fan is not replaced,

4.3 New fans larger than 1-1/2 horsepower are not added to the fan system, and

4.4 Extensions of the existing system do not add more than 15,000 cfm (7 080 L/s) of system flow at design conditions.

1317.3 Mechanical ventilation. Ventilation shall be provided as specified in the *Oregon Mechanical Specialty Code* and this section.

Note: Fume hood requirements replaced by laboratory exhaust at 1317.3.6

1317.3.1. ~~Fume hoods~~ Design Ventilation and Exhaust Rates. ~~Buildings with fume hood systems having a total exhaust rate greater than 15,000 cfm (7 m3/s) shall include at least one of the following features:~~ **Design outdoor air ventilation and exhaust rates shall not exceed the minimum requirements specified in the *Oregon Mechanical Specialty Code* or other governing code by more than 15 percent.**

Exceptions:

1. ~~Variable air volume hood exhaust and room supply systems capable of reducing exhaust and makeup air volume to 50 percent or less of design values; or~~ **Heating and cooling unitary systems or primary sources complying with the Optional Compliance Efficiency column in Tables 1317.6.1(1), 1317.6.1(2), 1317.6.1(3), 1317.6.1(5), and 1317.6.1(6). When the Optional Efficiency column is used for compliance, it shall not be used for compliance with 1311.2, Optional compliance approach.**

2. ~~Direct makeup (auxiliary) air supply equal to at least 75 percent of the exhaust rate, heated no warmer than 2°F (-17°C) below room set point, cooled to no cooler than 3°F (-16°C) above room set point, no humidification added, and no simultaneous heating and cooling used for dehumidification control; or~~ **Systems equipped with a means to automatically reduce outside air intake in proportion to occupancy below design rates when spaces are partially occupied.**
3. ~~Heat recovery systems to precondition makeup air from fume hood exhaust in accordance with Section 1318.3 Exhaust air energy recovery, without using any exception.~~ **Systems equipped with an energy recovery device with at least 50 percent sensible energy recovery effectiveness.**

1317.3.2 Ventilation controls for high occupancy areas. HVAC systems with ventilation air capacities of at least ~~1,500~~ **1000** CFM and serving areas having an average occupant load factor of ~~20~~ **40** or less (as established in Table 1004.1.2) shall include a means to automatically reduce outside air intake below design rates when spaces are partially occupied. Large rooms served by multiple systems with a combined ventilation air capacity of ~~1,500~~ **1000** CFM and an occupant load factor of ~~20~~ **40** or less must also meet this requirement.

Exception: Systems equipped with an energy recovery device with at least 50% **sensible energy** recovery effectiveness.

Note: *Parking garage moved to 1317.3.5 to coordinate numbering*

1317.3.3 Ventilation controls for high occupancy zones ~~**Enclosed parking garage ventilation controls.** In Group S-2 parking garages, other than open parking garages, used for storing or handling automobiles operating under their own power having ventilation exhaust rates 30,000 cfm and greater shall employ automatic carbon monoxide sensing devices. These devices shall modulate the ventilation system to maintain a maximum average concentration of carbon monoxide of 50 parts per million during any eight hour period, with a maximum concentration not greater than 200 parts per million for a period not exceeding one hour. Such system shall be designed to exhaust a minimum of 14,000 cfm (6,608 L/s) for each operating vehicle, but not less than 2.5 percent (or one vehicle) of the garage capacity. Failure of such devices shall cause the exhaust fans to operate in the on position.~~ **For HVAC systems serving multiple zones, including variable air volume (VAV) systems, three-deck multi-zone (MZ) systems, and Variable Volume and Temperature (VVT) systems, zones for which the minimum air flow of at least 150 CFM (71 L/s) and serving areas having an average occupant load factor of 40 or less (as established in Table 1004.1.2) shall include a means to automatically reduce outside air intake below design rates when spaces are partially occupied. Large rooms served by multiple zone controls with a combined minimum air flow of at least 150 CFM (71 L/s) and an occupant load factor of 40 or less must also meet this requirement.**

1317.3.4 Exhaust air-heat recovery: An exhaust air heat recovery system shall be installed for each HVAC fan system that has all of the following:

(1) A design supply air capacity of 10,000 cfm (4720 L/s) or greater,

(2) A minimum outside air supply of 70 percent or greater,

(3) At least one exhaust fan rated at 75 percent of the minimum outside air supply.

The heat recovery system shall be capable of increasing the outside air supply temperature at design heating conditions by 20°F in Climate Zone 1 and 30°F (-1°C) in Climate Zone 2. A provision shall be made to bypass or control the heat recovery system to permit air economizer operation as required by Section 1317.4.

Exceptions:

1. HVAC systems with ventilation controls for high occupancy areas per Section 1317.3.2.
2. Laboratory systems meeting Section 1317.3.1.
3. Systems serving spaces which are not cooled and which are heated to less than 55°F (12.78°C).
4. Systems exhausting toxic, flammable, paint exhaust, corrosive fumes, or dust.
5. Type 1 kitchen exhaust hoods.
6. Where more than 60 percent of the outdoor heating energy is provided from site-recovered or site solar energy.
7. Systems that only provide cooling.

The following is the same as above but with improved efficiency requirements: Changed text is indicated with double-underline.

1317.3.4 Exhaust air-heat recovery: An exhaust air heat recovery system shall be installed for each HVAC fan system with a**n outside** air capacity of **5000 cfm (2360 L/s)** or greater **in climate zone 1 and 3000 cfm (1416 L/s) or greater in climate zone 2. Where a single room or space is supplied by multiple units, the aggregate supply (cfm) of those units shall be used in applying this requirement**. The heat recovery system shall be capable of increasing the outside air supply temperature at design heating conditions by 20°F **(11°C)** in Climate Zone 1 and 30°F **(17°C)** in Climate Zone 2. A provision shall be made to bypass or control the heat recovery system to permit air economizer operation as required by Section 1317.3.

Exceptions:

1. HVAC systems with ventilation controls for high occupancy areas per Section 1317.2.2 **where the outside air volume at low occupancy is less than 5000 cfm (2360 L/s) in climate zone 1 and less than 3000 cfm (1416 L/s) in climate zone 2 .**
2. Laboratory systems meeting Section 1317.3**.6.**
3. Systems serving spaces which are not cooled and which are heated to less than 55°F (12.78°C).
4. Systems exhausting toxic, flammable, paint exhaust, corrosive fumes, or dust.
5. Type 1 kitchen exhaust hoods.
6. Where more than 60 percent of the outdoor heating energy is provided from site-recovered or site solar energy.
7. Systems that only provide cooling.
8. **HVAC systems serving multiple zones** ~~systems~~ **sharing a common outdoor air supply less than 70% of total supply air.**

1317.3.5 Enclosed parking garage ventilation controls. Mechanical ventilation systems in Group S-2 parking garages, other than open parking garages, used for storing or handling automobiles operating under their own power, shall meet the requirements of OMSC Section 404. Systems having ventilation exhaust rates 15,000 cfm and greater shall employ automatic carbon monoxide sensing devices. These devices shall modulate the ventilation system to

maintain a maximum average concentration of carbon monoxide of 50 parts per million during any eight-hour period, with a maximum concentration not greater than 200 parts per million for a period not exceeding one hour. Failure of such devices shall cause the exhaust fans to operate in the on position.

The following is the same as the prior version moved from section 1317.3.1 with changed text indicated with bold underline

1317.3.6 Laboratory Exhaust Systems. Buildings with **laboratory exhaust** systems having a total exhaust rate greater than **5,000** cfm **(2,360** L/s) shall include **heat recovery systems to precondition makeup air from laboratory exhaust The heat recovery system shall be capable of increasing the outside air supply temperature at design heating conditions by 25°F (13.9°C) in Climate Zone 1 and 35°F (19.4°C) in Climate Zone 2. A provision shall be made to bypass or control the heat recovery system to permit air economizer operation as required by Section 1317.3.**

Exceptions:

1. Variable air volume **laboratory** exhaust and room supply systems capable of reducing exhaust and makeup air volume to 50 percent or less of design values; or
2. Direct makeup (auxiliary) air supply equal to at least 75 percent of the exhaust rate, heated no warmer than 2ºF **(1.1°C)** below room set point, cooled to no cooler than 3ºF **(1.7ºC)** above room set point, no humidification added, and no simultaneous heating and cooling used for dehumidification control; or
3. **Combined Energy Reduction Method: VAV laboratory exhaust and room supply system capable of reducing exhaust and makeup air flow rates ~~volumes~~ and/or incorporate a heat recovery system to precondition makeup air from laboratory exhaust that shall meet the following:**

   A + B*(X) ≥ 60%

   Where:

   A = Percentage that the exhaust and makeup air flow rates can be reduced from design conditions.

   B = Percentage *sensible energy recovery effectiveness*.

   X = Exhaust airflow rate through the heat recovery device at *design conditions*/makeup air flow rate of the *system* at design conditions.
4. **Optional Compliance Efficiency Method: Provided that heating and cooling unitary systems or primary sources meet the Optional Compliance Efficiency column in Tables 1317.6.1 (1), 1317.6.1 (2), 1317.6.1 (4), 1317.6.1 (5), and 1317.6.1 (6), apply the combined energy reduction method above so that:**

   A + B*(X) ≥ 50%

   When the Optional Efficiency column is used for compliance, it shall not be used for compliance with 1311.2, Optional compliance approach.

1317.4 Economizer cooling. Each fan system with mechanical cooling shall have an air economizer system capable of modulating outside air and return dampers to provide up to 100 percent of the design supply air quantity as outdoor air.

Exceptions:

~~1. Systems at locations where the quality of the outdoor air is so poor as to require extensive treatment of the air.~~

~~2~~**1**. Systems **with direct expansion coils rated at less than 35,000 Btu/hr** serving only residential spaces and hotel or motel guest rooms.

~~3. Cooling equipment with direct expansion coils rated at less than 54,000 Btu/hr. (15,827 W) total cooling capacity. The total capacity of all such units without economizers shall not exceed 240,000 Btu/hr. (70,342 W) per building area served by one utility meter or service, or 10 percent of its total installed cooling capacity, whichever is greater. That portion of the equipment serving dwelling units and guest rooms is not included in determining the total capacity of units without economizers.~~

~~4. Systems having a water economizer system capable of cooling air by direct and/or indirect evaporation and providing 100 percent of the expected systems cooling load at outside air temperatures of 50ºF (10ºC) dry bulb and 45ºF (7ºC) wet bulb and below.~~

~~5. Ground-coupled heat pumps with cooling capacity of 54,000 Btu/hr. (15,827 W) or less.~~

~~6. Internal/external zone heat recovery is used.~~

~~7~~**2**. Systems used to cool any dedicated computer server room, electronic equipment room or telecom switch room having a water economizer system capable of cooling air by direct and/or indirect evaporation and providing 100 percent of the expected systems cooling load at outside air temperatures of 45°F (70°C) dry bulb and 40°F (8O°C) wet bulb and below.

1317.4.1 Optional economizer compliance. When the Optional Efficiency column is used for compliance, it shall not be used for compliance with 1311.2, Optional compliance approach. HVAC systems specified in Tables 1317.6.1(1), 1317.6.1(2), and 1317.6.1(3) that comply with the Optional Compliance Efficiency column requirements are not required to comply with 1317.4 providing the mechanical cooling system meets one of the following conditions:

(1) Cooling equipment with direct expansion coils rated at less than 54,000 Btu/hr. (15,827 W) total cooling capacity. The total capacity of all such units without economizers shall not exceed 240,000 Btu/hr. (70,342 W) per building area served by one utility meter or service, or 10 percent of its total installed cooling capacity, whichever is greater. That portion of the equipment serving dwelling units and guest rooms is not included in determining the total capacity of units without economizers.

(2) Systems having a water economizer system capable of cooling air by direct and/or indirect evaporation and providing 100 percent of the expected systems cooling load at outside air temperatures of 50ºF (10ºC) dry bulb and 45ºF (7ºC) wet bulb and below.

(3) Systems at locations where the quality of the outdoor air is so poor as to require extensive treatment of the air.

(4) Ground-coupled heat pumps with cooling capacity of 54,000 Btu/hr. (15,827 W) or less.

(5) Internal/external zone heat recovery is used.

1317.4.2 Pressure relief. The fan system or building envelope shall provide a means of preventing over-pressuring the building envelope during air economizer operation. Drawings shall specifically identify the pressure relief mechanism for each fan system. **The relief air outlet shall be located to avoid recirculation into the building.**

1317.4.3 Integration. Economizer systems shall be capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load.

Exception~~s~~: ~~1.~~ Direct–expansion systems may include controls to reduce the quantity of outdoor air as required to prevent coil frosting, but not less than required by this code, at the lowest step of compressor unloading.

~~2. Individual direct–expansion units that have a cooling capacity of 15 tons (53 kW) (nominal) or less may use economizer controls that preclude economizer operation whenever mechanical cooling is required simultaneously.~~

1317.4.4 Control Signal. Economizer dampers shall be sequenced with the mechanical cooling equipment. HVAC systems serving multiple zones shall not be controlled by only mixed air temperature. HVAC systems serving single zones shall include controls that activate the economizer as a first stage of cooling before mechanical cooling is activated.

1317.4.5 High-Limit Shutoff. All air economizers shall automatically reduce outdoor air intake to the design minimum outdoor air quantity when outdoor air intake will no longer reduce cooling energy usage. High-limit shutoff control types and settings for specific climates shall be chosen from Table 1317.4.5. Systems serving multiple zones with independent temperature control shall require either Differential Dry Bulb or Differential Enthalpy controls.

Table 1317.4.5 High-Limit Shutoff Control Settings for Air Economizers

Device Type	Climate Zone	Description of Required High Limit, Economizer off when:
Fixed Dry Bulb	All	Outside air temperature exceeds 75° F [1]
Differential Dry Bulb	All	Outside air temperature exceeds return air temperature
Fixed Enthalpy	Not Allowed	NA
Electronic Enthalpy	All	Outside air temperature/RH exceeds the "A" set-point curve [1] [2]
Differential Enthalpy	All	Outside air enthalpy exceeds return air enthalpy
Dew-point and dry-bulb temperatures	All	Outdoor air dry bulb exceeds 75°F or outside dew point exceeds 55°F (65 gr/lb) [1]

[1] For zones where the cooling setpoint is normally below 72°F (fitness centers or cool warehouses for example) or setpoints options are limited the high limit setpoint may be reduced to the next lower setting or to a setting at or just below the normal zone setpoint.

[2] 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.

1317.4.6 Dampers. Both return exhaust air and outdoor supply air dampers shall meet the requirements of Section 1317.5.3.3.

1317.5 HVAC Controls.

1317.5.1 System control. Each HVAC system shall include at least one temperature control device.

1317.5.2 Zone temperature controls. The supply of heating and cooling energy to each zone shall be controlled by individual thermostatic controls responding to temperature within the zone. **Where separate secondary or terminal heating and cooling equipment serve the**

same temperature zone, thermostats shall be interlocked to prevent simultaneous heating and cooling.

Exceptions: Independent perimeter systems that offset only envelope heat losses or gains or both may serve one or more zones also served by an interior system with all of the following limitations:

(1) The perimeter system shall include at least one thermostatic control zone for each building exposure having exterior walls facing only one orientation for 50 contiguous feet (15 m) or more.

(2) The perimeter system heating and cooling supply shall be controlled by thermostat(s) located within the zone(s) served by the system.

(3) Where a perimeter zone overlaps multiple interior zones, systems must include controls that automatically reset the perimeter supply-air temperature or output in response to the interior zone loads.

1317.5.2.1 Control capabilities. Where used to control comfort heating, zone thermostatic controls shall be capable of being set locally or remotely down to 55ºF (13ºC).

Where used to control comfort cooling, zone thermostatic controls shall be capable of being set locally or remotely up to 85ºF (29ºC).

Where used to control both comfort heating and cooling, zone thermostatic controls shall be capable of providing a temperature range or dead band of at least 5ºF (3ºC) within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum. Variable air volume (VAV) terminal units shall be programmed to operate at the minimum airflow setting without addition of reheat when the zone temperature is within the set deadband.

Exceptions:

1. Special occupancy, special usage or code requirements where deadband controls are not appropriate (such as process applications and areas of hospitals normally used by patients).
2. Thermostats that require manual changeover between heating and cooling modes.

1317.5.3 Off–hour controls. HVAC systems shall be equipped with automatic controls capable of accomplishing a reduction of energy use through control setback or equipment shutdown during periods of nonuse or alternate use of the spaces served by the system.

Exceptions:

1. Equipment with full load demands of 2 kW (6826 Btu/hr.) or less may be controlled by readily accessible manual off–hour controls.
2. Systems intended to operate continuously.

1317.5.3.1 Automatic shutdown. To provide automatic shutdown, the HVAC system shall be equipped with at least one of the following:

(1) Controls that can start and stop the system under different time schedules for seven different day-types per week, are capable of retaining programming and time setting during loss of power for a period of at least 10 hours, and include an accessible manual override, or equivalent function, that allows temporary operation of the system for up to two hours.

(2) An occupant sensor that is capable of shutting the system off when no occupant is sensed for a period of up to 30 minutes.

(3) An interlock to a security system that shuts the system off when the security system is activated.

(4) Systems controlled only by manually activated timers with a maximum of two-hour operation.

1317.5.3.2 Optimum start controls. ~~Separate~~ **Each** HVAC system~~s with a design supply air capacity exceeding 10,000 cfm (4,720 L/s)~~ shall have controls that ~~are capable of varying~~ **vary** start-up time of system to just meet temperature set point at time of occupancy.

This provision may be met by warm up sequences typically available on commercial programmable thermostats that operate with or without reference to outside temperature.

1317.5.3.3 Shutoff dampers. ~~Outdoor air supply and exhaust systems shall be equipped with motorized dampers.~~ **All outdoor air intake and exhaust systems shall be equipped with motorized dampers that will automatically shut when the systems or spaces served are not in use.**

Exceptions:

1. **Heating-only s**ystems ~~with a design outside air intake or exhaust capacity of 300 cfm (141.6 L/s) or less~~ **equipped with backdraft gravity (nonmotorized) dampers are acceptable in systems with a design outdoor air intake or exhaust capacity of 300 cfm (140 L/s) or less.**
2. Combustion air intake.
3. Cooling equipment rated at less than **33**~~54~~,000 Btu/hr (~~15,827~~ **9669** W) total cooling capacity **equipped with gravity backdraft dampers**.
4. Power relief fans with gravity dampers for packaged HVAC systems under ~~300~~**190**,000 Btu/h cooling capacity.
5. Hood vents or ventilators with gravity dampers in buildings less than three stories in height above grade.
6. ~~Ventilation systems serving unconditioned spaces.~~ **Dampers are not required in ventilation or exhaust systems serving unconditioned spaces.**
7. ~~Type 1 kitchen exhaust hoods.~~ **Dampers are not required in exhaust systems serving Type 1 kitchen exhaust hoods.**

1317.5.3.3.1 Shutoff damper controls. **Ventilation outdoor air and exhaust/relief dampers shall automatically shut off during preoccupancy building warm-up, cool down, and setback, except when ventilation reduces energy costs or when ventilation must be supplied to meet code requirements.** ~~Dampers for outdoor air supply and exhaust systems shall automatically shut when the systems or spaces served are not in use or during building warm-up, cooldown, and setback.~~ **Classrooms, gyms, auditoriums and conference rooms larger than 500 square feet of floor area shall have occupancy sensor control that will either close outside air dampers or turn off serving equipment when the space is unoccupied except where equipped with**

another means to automatically reduce outside air intake below design rates when spaces are partially occupied.

Stair and **elevator** shaft vents shall be **equipped with motorized dampers that are** capable of being automatically closed during normal building operation and are interlocked to open as required by fire and smoke detection systems.

1317.4.3.3.2 ~~Motorized~~ Dampers leakage. **Where** ~~Leakage~~ outdoor air supply and exhaust**/relief** ~~air~~ dampers **are required by Section 1317.5.3.3, they** shall have a maximum leakage rate **in accordance with AMCA Standard 500-2007** of 4 cfm/ft^2 (20 L/s per m^2)~~at 1.0 in w.g. when tested in accordance with AMCA Standard 500D 1998~~ **of damper area at 1.0 in. w.g. (250 Pa) for motorized dampers and 20 cfm/ft^2 (100 L/s per m^2) of damper area at 1.0 in. w.g. (250 Pa) for non-motorized dampers**.

Exception: **Non-motorized dampers smaller than 24 in.(0.6 m) in either dimension may have leakage of 40 cfm/ft^2.(200 L/s per m^2)** ~~Packaged HVAC equipment 20 cfm/ft^2 (101.6 L/s per m^2) at 1.0 in w.g. when tested in accordance with AMCA Standard 500D 1998.~~

1317.5.4 Heat pump controls. Heat pumps equipped with supplementary heaters shall be installed with controls to prevent heater operation when the heating load can be met by the heat pump alone. Controls shall include microprocessor controls that minimize supplemental heat usage during start-up, set-up and defrost conditions. These controls shall anticipate need for heat and use compression heating as the first stage of heat. Controls shall indicate when supplemental heating is being used through visual means (e.g., LED indicators). **Controls shall use heat pump compressor in conjunction with supplementary heaters until outside temperature is below 10°F.**

Exception: Supplementary heater operation is permitted during short transient periods of less than 15 minutes, such as start–ups following room thermostat setpoint advance and during defrost cycles.

~~A two stage room thermostat which controls the supplementary heat in its second stage shall be accepted as meeting this requirement.~~

1317.5.5 Heating water pump control. Water circulation systems serving heating coil(s) shall have controls that lock out the hot water pump serving that coil(s) whenever outside air temperature is 70°F or higher.

Exceptions:

1. **Industrial process & humidity control process,**
2. **Hot water reheat for terminal units,**
3. **Pumps that also serve site solar or heat recovery systems., or**
4. **Hot water circulation systems used to provide multiple functions (e.g., space heating, service water heating, DHW) as an integrated system.**

1317.6 Equipment efficiencies, verification and labeling

1317.6.1 Minimum equipment ~~performance~~ efficiencies listed equipment standard rating and operating conditions. ~~The requirements of this section apply to equipment and component performance for HVAC systems. Where equipment efficiency levels are specified, data furnished by the equipment supplier or certified under a nationally recognized~~

~~certification program or rating procedure shall be used to satisfy these requirements.~~ Equipment shown in Tables 1317.6.1(1) through 1317.6.1(7) shall have a minimum performance at the specified rating conditions when tested in accordance with the specified test procedure. Where multiple rating conditions or performance requirements are provided, the equipment shall satisfy all stated requirements, unless otherwise exempted by footnotes in the table. Equipment covered under the Federal Energy Policy Act of 1992 (EPACT) shall have no minimum efficiency requirements for operation at minimum capacity or other than standard rating conditions. Equipment used to provide water heating functions as part of a combination system shall satisfy all stated requirements for the appropriate space heating or cooling category.

Tables are as follows:

(1) Table 1317.6.1(1) – Unitary Air Conditioners and Condensing Units, see sections 1317.6.1.1 and 1317.6.1.2

(2) Table 1317.6.1(2) – Unitary and Applied Heat Pumps

(3) Table 1317.6.1(3) – Water Chilling Packages (see section 1317.5.2 for water-cooled centrifugal water-chilling packages that are designed to operate at nonstandard conditions)

(4) Table 1317.6.1(4) – Packaged Terminal Air Conditioners and Heat Pumps, and Single-Package Vertical Air Conditioners and Heat Pumps.

(5) Table 1317.6.1(5) – Furnaces, Duct Furnaces, and Unit Heaters

(6) Table 1317.6.1(6) – Boilers

(7) Table 1317.6.1(7) – Heat Rejection Equipment

Exceptions:

1. Equipment performance requirements for Occupancy Group R-3~~, Division 3 Occupancies~~, three stories and less in height shall be as specified in Section 1308.2.
2. Heat rejection devices whose energy usage is included in the equipment efficiency rating listed in Tables 1317.6.1(1) through 1317.6.1(4) are not required to comply with Table 1317.6.1(7).

1317.6.1.1 Packaged electric equipment providing both electric heating and cooling with a total cooling capacity greater than 20,000 Btu/h shall have a heat pump as the primary heating source.

Exception: Unstaffed equipment shelters or cabinets used solely for personal wireless service facilities.

1317.6.1.2 Limited use of air-cooled chillers. Chilled water plants with more than 300 tons total capacity shall not have more than 100 tons provided by air-cooled chillers.

Exceptions:

1. **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.**
2. **Air-cooled chillers with minimum efficiencies equal to or greater than approved water-cooled equipment.**

1317.6.1.3 Limitation on centrifugal fan cooling towers. Open cooling towers with a combined rated capacity of 1,100 gpm and greater at 95°F condenser water return, 85°F condenser water supply and 75°F outdoor wet-bulb temperature shall meet the energy efficiency requirement for axial fan or propeller fan open circuit cooling towers.

Exception. Open circuit cooling towers that are ducted (inlet or discharge) or have external sound attenuation that requires external static pressure capability.

1317.6.2 Minimum equipment efficiencies–listed equipment–nonstandard conditions. Water-cooled centrifugal water chilling packages that are not designed for operation at ARI Standard 550/590 test conditions, thus cannot be tested to meet the requirements of Table 1317.5.2, of 44°F leaving chilled-water temperature and 85°F entering condenser water temperature with 3 gpm/ton condenser water flow shall have maximum full-load kW/ton and *NVLP* ratings adjusted using the following equation:

Adjusted maximum full load kW/ton rating = [full load kW/ton from Table 1317.5.1 (3)].K_{adj}

Adjusted maximum NPLV rating = [IPLV from Table 1317.5.1 (3)]/K_{adj}

Where:

$K_{adj} = 6.174722 - 0.00629466(X)^2 - 0.000045780(X)^3$

$X = DT_{std} + LIFT$

$DT_{std} = (24 + [\text{full load kW/ton from Table 1317.5.1 (3)}] \times 6.83)/Flow$

Flow = Condenser water flow (GPM)/Cooling Full Load Capacity (Tons)

LIFT = CEWT - CLWT

CEWT = Full Load Condenser Entering Water Temperature (°F)

CLWT = Full Load Leaving Chilled Water Temperature (°F)

The adjusted full load and NPLV values are only applicable over the following full-load design ranges:

- Minimum Leaving Chiller-Water Temperature: 38°F
- Maximum Condenser Entering Water Temperature 102°F
- Condenser Water Flow: 1 to 6 gpm/ton and
- $X \geq 39$ and ≤ 60

Chillers designed to operate outside of these ranges or applications utilizing fluids or solutions with secondary coolants (e.g., glycol solutions or brines) with a freeze point of 27°F or lower for freeze protection are not covered by this standard.

Example of applying formula specified in 1317.5.2:

Table 1317.5.1 (3) Efficiencies:

Full Load = 0.570 kw/ton

IPLV = 0.539 kW/ton

CEWT = 80^{o}F

Flow = 2.5 GPM/Ton

CLWT = 42^{o}F

LIFT = 80 - 42 = 38^{o}F

DT = (24 + 0.570 x 6.83)/2.5 = 11.1^{o}F

X = 38 + 11.16 = 49.16^{o}F

$K_{adj} = 6.174772-0.303668(49.16) + 0.00629466(49.16)^2-0.00004578(49.16)^3 = 1.020$

Adjusted Full Load = 0.570/1.020 = 0.559 kW/ton

NPLV = 0.539/1.020 = 0.528 kW/ton

1317.6.3 Packaged terminal air conditioners and heat pumps. Non-standard size packaged terminal air conditioners and heat pumps with existing sleeves having an external wall opening of less than 16 inches high or less than 42 inches wide, and having a cross-sectional area less than 670 in^2 shall be factory labeled as follows: Manufactured for non-standard size applications only: not to be installed in new construction projects.

TABLE ~~13-L~~1317.6.1(1)
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS

EQUIPMENT TYPE	SIZE CATEGORY AT COOLING CAPACITY	HEATING SECTION TYPE	SUB CATEGORY OR RATINGS CONDITIONS	MINIMUM EFFICIENCY ~~REQUIRED~~ [1]	OPTIONAL EFFICIENCY	TEST PROCEDURE
Air Conditioners, Air Cooled	~~Cooling Capacity less than~~ <65,000 Btu/h	All	Split Systems	13.0 SEER[2]	15.0 SEER 12.5 EER	ARI 210/240-94~~06~~
			Single Package	13.0 SEER[2]	15.0 SEER 12.0 EER	
Through-the-wall, air-cooled	≤65,000 Btu/h	All	Split Systems	12.0 SEER	14.0 SEER	
			Single Package	12.0 SEER	14.0 SEER	
Small-duct high velocity, air cooled	<65,000 Btu/h	All	Split System	10.0 SEER	12.0 SEER	
Air Conditioners, Air Cooled	~~Cooling Capacity equal to or greater than~~ ≥65,000 and ~~less than~~ <135,000 Btu/h	Electric Resistance or None	Split System and Single Package	~~10.3~~11.2 EER[3, 4] 11.4 IEER	12.0 EER 12.4 IEER	ARI 340/360-93~~07~~
		All Other	Split System and Single Package	11.0 EER 11.2 IEER	11.8 EER 12.2 IEER	
	~~Cooling Capacity equal to or greater than~~ ≥135,000 and ~~less than~~ ≤240,000 Btu/h	Electric Resistance or None	Split System and Single Package	~~9.7~~11.0 EER[3, 5] 11.2 IEER	12.0 EER 12.4 IEER	
		All Other	Split System and Single Package	10.8 EER 11.0 IEER	11.8 EER 12.2 IEER	
	~~Cooling Capacity equal to or greater than~~ ≥ 240,000 and ~~less than~~ <760,000 Btu/h	Electric Resistance or None	Split System and Single Package	~~9.5~~10.0 EER[3, 6] ~~9.7 IPLV[3]~~ 10.1 IEER	10.8 EER 12.0 IEER	
		All Other	Split System and Single Package	10.0 EER 9.9 IEER	10.6 EER 11.8 IEER	
	~~Cooling Capacity equal to or greater than~~ ≥760,000 Btu/h	Electric Resistance or None	Split System and Single Package	~~9.2~~9.7 EER[3] ~~9.4 IPLV[3]~~ 9.8 IEER	10.2 EER 11.0IEER	
		All Other	Split System and Single Package	9.5 EER 9.6 IEER	10.0 EER 10.8 IEER	
Air Conditioners, Water and Evaporatively Cooled	~~Cooling Capacity less than~~ <65,000 Btu/h	All	Split System and Single Package	12.1 EER 12.3 IEER	14.0 EER 14.3 IEER	ARI 210/240-94~~06~~
	~~Cooling Capacity equal to or greater than~~ ≥65,000 and ~~less than~~ ≤135,000 Btu/h	Electric Resistance or None	Split System and Single Package	11.5 EER[3] 11.7 IEER	14.0 EER 14.3 IEER	ARI 340/360-93~~07~~
		All Other	Split System and Single Package	11.3 EER[3] 11.5 IEER	13.8 EER 14.1 IEER	
	~~Cooling Capacity equal to or greater than~~ ≥135,000 and ~~less than~~ <240,000 Btu/h	Electric Resistance or None	Split System and Single Package	11.0 EER[3] 11.2 IEER	14.0 EER 14.3 IEER	
		All Other	Split System and Single Package	10.8 EER 11.0 IEER	13.8 EER 14.1 IEER	
	~~Cooling Capacity equal to or greater than~~ ≥240,000 Btu/h	Electric Resistance or None	Split System and Single Package	11.0 EER[3] ~~10.3 IPLV[3]~~ 11.1 IEER	14.0 EER 14.0 IEER	
		All Other	Split System and Single Package	10.8 EER 10.9 IEER	13.8 EER 13.8 IEER	
Condensing Units, Air Cooled	~~Cooling Capacity equal to or greater than~~ ≥135,000 Btu/h			10.1 EER 11.2 IPLV	Not applicable, match with indoor coil	ARI 365-94~~02~~
Condensing Units, Water or Evaporatively Cooled	~~Cooling Capacity equal to or greater than~~ ≥135,000 Btu/h			13.1 EER 13.1 IPLV	Not applicable, match with indoor coil	

For SI: 1 Btu/hr = 0.2931 W.

~~[1] IPLVs are only applicable to equipment with capacity modulation.~~

~~[2] Replacement equipment may use a minimum efficiency of 10.0 SEER for Split Systems and 9.7 EER for Single Package.~~

~~[3] Units with a heating section other than electric resistance heat may deduct 0.2 from the required EERs and IPLVs.~~

~~[4] Minimum efficiency required as of January 1, 2010 shall be 11.2 EER.~~

~~[5] Minimum efficiency required as of January 1, 2010 shall be 11.0 EER.~~
~~[6] Minimum efficiency required as of January 1, 2010 shall be 10.0 EER.~~

TABLE ~~13-M~~1317.6.1(2)
ELECTRICALLY OPERATED UNITARY AND APPLIED HEAT PUMPS

EQUIPMENT TYPE	SIZE CATEGORY AT COOLING CAPACITY	HEATING SECTION TYPE	SUB CATEGORY OR RATINGS CONDITIONS	MINIMUM EFFICIENCY ~~REQUIRED~~[1]	OPTIONAL EFFICIENCY	TEST PROCEDURE
Air Cooled (Cooling Mode)	~~Cooling Capacity less than~~ ≤65,000 Btu/h	All	Split Systems	13.0 SEER[2]	15.0 SEER 12.5 EER	ARI 210/240-~~94~~06
		All	Single Package	13.0 SEER[2]	15.0 SEER 12.5 EER	
Through-the-wall, air-cooled, cooling mode	≤35,000 Btu/h	All	Split Systems	12.0 SEER	14.0 SEER	
			Single Package	12.0 SEER	14.0 SEER	
Small-duct high velocity, air cooled	<65,000 Btu/h	All	Split System	10.0 SEER	12.0 SEER	
Air Cooled (Cooling Mode)	~~Cooling Capacity equal to or greater than~~ ≥65,000 and ~~less than~~ <135,000 Btu/h	Electric Resistance or None	Split System and Single Package	~~10.1~~11.0 EER[3, 4] 11.2 IEER	12.0 EER 12.4 IEER	ARI 340/360-~~93~~07
		All Other	Split System and Single Package	10.8 EER 11.0 IEER	11.8 EER 12.2 IEER	
	~~Cooling Capacity equal to or greater than~~ ≥135,000 and ~~less than~~ <240,000 Btu/h	Electric Resistance or None	Split System and Single Package	~~9.3~~10.6 EER[3 5] 10.7 IEER	12.0 EER 12.4 IEER	
		All Other	Split System and Single Package	10.4 EER 10.5 IEER	11.8 EER 12.2 IEER	
	~~Cooling Capacity equal to or greater than~~ ≥240,000 Btu/h	Electric Resistance or None	Split System and Single Package	~~9.0~~9.5 EER[3] ~~9.2 IPLV[3]~~ 9.6 IEER	10.8 EER 12.0 IEER	
		All Other	Split System and Single Package	9.3 EER 9.4 IEER	10.6 EER 11.8 IEER	
Water Source (Cooling Mode)	~~Cooling Capacity less than~~ <17,000 Btu/h	All	Entering Water: 86ºF	11.2 EER	14.0 EER	ARI/ISO-13256-1-98
	~~Cooling Capacity equal to or greater than~~ ≥17,000 ~~less than~~ ≤65,000 Btu/h	All	Entering Water: 86ºF	12.0 EER	14.0 EER	
	~~Cooling Capacity equal to or greater than~~ ≥65,000 and ~~less than~~ <135,000 Btu/h	All	Entering Water: 86ºF	12.0 EER	14.0 EER	
Groundwater Source (Cooling Mode)	~~Cooling Capacity less than~~ <135,000 Btu/h	All	Entering Water: 59ºF	16.2 EER	19.4 EER	ARI/ISO-13256-1-98
Ground Source (Cooling Mode)	~~Cooling Capacity less than~~ <135,000 Btu/h	All	Entering Water: 77ºF	13.4 EER	16.1 EER	ARI/ISO-13256-1-98
Air Cooled (Heating Mode)	~~Cooling Capacity less than~~ <65,000 Btu/h	All	Split System	7.7 HSPF[6]	9.0 HSPF	ARI 210/240-~~94~~06
			Single Package	7.7 HSPF[6]	8.5 HSPF	
Through-the-wall, air-cooled, heating mode	≤35,000 Btu/h	All	Split System	7.4 HSPF	8.8 HSPF	
			Single Package	7.4 HSPF	8.8 HSPF	
Small-duct high velocity, air cooled	≤65,000 Btu/h	All	Split System	6.8 HSPF	8.1 HSPF	
Air Cooled (Heating Mode)	~~Cooling Capacity equal to or greater than~~ ≥65,000 and ~~less than~~ <135,000 Btu/h	All	47°F db/43ºF wb Outdoor Air	~~3.2~~3.3 COP[7]	3.4 COP	ARI 340/360-~~93~~07
			17°F db/15ºF wb Outdoor Air	2.2 COP	2.4 COP	
	~~Cooling Capacity equal to or greater than~~ ≥135,000 Btu/h	All	47°F db/43ºF wb Outdoor Air	~~3.1~~3.3 COP[8]	3.3 COP	

			17°F db/15ºF wb Outdoor Air	2.0 COP	2.1 COP	
Water Source (Heating Mode)	~~Cooling Capacity less than~~ ≤135,000 Btu/h	All	68ºF Entering Water	4.2 COP	4.6 COP	ARI/ISO-13256-1-98
Ground Water Source (Heating Mode)	~~Cooling Capacity less than~~ ≤135,000 Btu/h	All	50ºF Entering Water	3.6 COP	4.1 COP	ARI/ISO-13256-1-98
Ground Source (Heating Mode)	Cooling Capacity less than ≤135,000 Btu/h	All	32ºF Entering Water	3.1 COP	3.4 COP	ARI/ISO-13256-1-98

For SI: 1 Btu/hr = 0.2931 W, ºF = 1.8 ºC + 32, 1 ton = 3517 W.

~~[1]. IPLVs and part load rating conditions are only applicable to equipment with capacity modulation.~~

~~[2]. Replacement equipment may use a minimum efficiency of 10.0 SEER for Split Systems and 9.7 EER for Single Package.~~

~~[3] Units with a heating section other than electric resistance heat may deduct 0.2 from the required EERs and IPLVs.~~

~~[4]. Minimum efficiency required as of January 1, 2010 shall be 11.0 EER.~~

~~[5]. Minimum efficiency required as of January 1, 2010 shall be 10.6 EER.~~

~~[6]. Replacement equipment may use a minimum efficiency of 6.6 HSPF for both Split Systems and Single Package.~~

~~[7]. Minimum efficiency required as of January 1, 2010 shall be 3.3 COP.~~

~~[8]. Minimum efficiency required as of January 1, 2010 shall be 3.3 COP.~~

~~TABLE 13-O~~
~~WATER CHILLING PACKAGES~~

~~EQUIPMENT TYPE~~	~~SIZE CATEGORY~~	~~MINIMUM EFFICIENCY REQUIRED[1]~~	~~TEST PROCEDURE~~
~~Air Cooled, With Condenser, Electrically Operated~~	~~Less than 150 tons~~	~~2.8 COP 2.8 IPLV~~	~~ARI 550-92 or ARI 590-92 as appropriate~~
	~~Equal to or greater than 150 tons~~		
~~Air Cooled, Without Condenser, Electrically Operated~~	~~All Capacities~~	~~3.10 COP 3.10 IPLV~~	
~~Water Cooled, Electrically Operated, Positive Displacement (Reciprocating)~~	~~All Capacities~~	~~4.20 COP 4.65 IPLV~~	~~ARI 550-92~~
~~Water Cooled, Electrically Operated, Positive Displacement (Rotary, Screw and Scroll)~~	~~Less than 150 tons~~	~~4.45 COP 4.50 IPLV~~	~~ARI 550-92 or ARI 590-92 as appropriate~~
	~~Equal to or greater than 150 tons and less than 300 tons~~	~~4.90 COP 4.95 IPLV~~	
	~~Equal to or greater than 300 tons~~	~~5.50 COP 5.60 IPLV~~	
~~Water Cooled, Electrically Operated, Centrifugal~~	~~Less than 150 tons~~	~~5.0 COP 5.0 IPLV~~	~~ARI 550-92~~
	~~Equal to or greater than 150 tons and less than 300 tons~~	~~5.5 COP 5.5 IPLV~~	
	~~Equal to or greater than 300 tons~~	~~6.1 COP 6.1 IPLV~~	
~~Air Cooled Absorption, Single Effect~~	~~All Capacities~~	~~0.60 COP~~	~~ARI 560-92~~
~~Water Cooled Absorption, Single Effect~~	~~All Capacities~~	~~0.70 COP~~	
~~Absorption Double Effect, Indirect Fired~~	~~All Capacities~~	~~1.0 COP 1.05 IPLV~~	
~~Absorption Double Effect, Direct Fired~~	~~All Capacities~~	~~1.0 COP 1.0 IPLV~~	

~~For SI: ºC = [(ºF) – 32]/1.8~~

~~[1] The chiller equipment requirements do not apply for chillers used in low temperature applications where the design leaving fluid temperature is less than or equal to 40°F.~~

TABLE 1317.6.1(3)
WATER CHILLING PACKAGES – EFFICIENCY REQUIREMENTS[1]

			PATH A[2]				PATH B[2]				
EQUIPMENT TYPE	SIZE CATEGORY	UNITS	FULL LOAD	OPTIONAL FULL LOAD	IPLV	OPTIONAL IPLV	FULL LOAD	OPTIONAL FULL LOAD	IPLV	OPTIONAL IPLV	TEST PROCEDURE
Air-Cooled Chillers	<150 tons	EER	≥9.562		≥12.500		NA[3]		NA[3]		ARI 550/590-03
	≥150 tons	EER	≥9.562		≥12.750		NA[3]		NA[3]		
Air-Cooled without Condenser, Electrically Operated	All Capacities	Air-cooled chillers without condensers must be rated with matching condensers and comply with the air-cooled chiller efficiency requirements									
Water-Cooled, Electrically Operated, Reciprocating	All Capacities	Reciprocating units must comply with water cooled positive displacement efficiency requirements									
Water-Cooled, Electrically Operated, Positive Displacement	<75 tons	kW/ton	≤0.780		≤0.630		≤0.800		<0.550		
	≥75 tons and <150 tons	kW/ton	≤0.775		≤0.615		≤0.790		<0.550		
	≥150 tons and <300 tons	kW/ton	≤0.680		≤0.580		≤0.718		<0.380		
	≥300 tons	kW/ton	≤0.620		≤0.540		≤0.639		<0.350		
Water-Cooled, Electrically Operated, Centrifugal	<150 tons	kW/ton	≤0.634		≤0.596		≤0.639		<0.400		
	≥150 tons and <300 tons	kW/ton									
	≥300 tons and <600 tons	kW/ton	≤0.576		≤0.549		≤0.600		<0.4000		
	≥600 tons	kW/ton	≤0.570		≤0.539		≤0.590		≤0.400		
Air-Cooled Absorption Single Effect	All Capacities	COP	≥0.600		NR[4]		NA[3]		NA[3]		ARI 560-92
Water-Cooled Absorption Single Effect	All Capacities	COP	≥0.700		NR[4]		NA[3]		NA[3]		
Absorption Double Effect	All Capacities	COP	≥1.000		≥1.050		NA[3]		NA[3]		
Absorption Double Effect Direct Fired	All Capacities	COP	≥1.000		≥1.000		NA[3]		NA[3]		

For SI: 1 Btu/hr. = 0.2931 W

[1] The chiller equipment requirements do not apply for chillers used in low temperature applications where the design leaving fluid temperature is <38°F.

[2] Compliance with this standard can be obtained by meeting the minimum requirements of Path A or Path B. However, both the full and IPLV must be met to fulfill the requirements of Path A or Path B.

[3] NA means that this requirement is not applicable an cannot be used for compliance.

[4] NR means that there are no minimum requirements for this category.

TABLE ~~13-N~~1317.6.1(4)
ELECTRICALLY OPERATED PACKAGED TERMINAL AIR CONDITIONERS (PTAC)~~, AND~~ PACKAGED TERMINAL HEAT PUMPS (PTHP), SINGLE-PACKAGE VERTICAL AIR CONDITIONERS (SPVAC) AND SINGLE-PACKAGE VERTICAL HEAT PUMPS (SPVHP)

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATINGS CONDITIONS	MINIMUM EFFICIENCY REQUIRED	TEST PROCEDURE
PTAC, Cooling Mode ~~New Construction~~ Standard Size	All Capacities	95°F db Outdoor Air	12.5–(0.213x Cap/1000) EER[1]	ARI 310/380-~~93~~04
PTAC, Cooling Mode ~~Replacements~~ Non-Standard Size[2]	All Capacities	95°F db Outdoor Air	10.9–(0.213x Cap/1000) EER[1]	
PTHP (Cooling Mode) ~~New Construction~~ Standard Size	All Capacities	95°F db Outdoor Air	12.3–(0.213x Cap/1000) EER[1]	ARI 310/380-~~93~~04
PTHP (Cooling Mode) ~~Replacements~~ Non-Standard Size[2]	All Capacities	95°F db Outdoor Air	10.8–(0.213x Cap/1000) EER[1]	
PTHP (Heating Mode) ~~New Construction~~ Standard Size	All Capacities		3.2 - (0.026 x Cap/1000) COP[1]	
PTHP (Heating Mode) ~~Replacements~~ Non-Standard Size[2]	All Capacities		2.9 - (0.026 x Cap/1000) COP[1]	
SPVAC (Cooling Mode)	≤65,000 Btu/h	95°F db/75°F wb Outdoor Air	9.0 EER	ARI 390-2003
	≥65,000 Btu/h and <135,000 Btu/h	95°F db/75°F wb Outdoor Air	8.9 EER	
	≥135,000 Btu/h and <240,000 Btu/h	95°F db/75°F wb Outdoor Air	8.6 EER	
SPVHP (Cooling Mode)	<65,000 Btu/h	95°F db/75°F wb Outdoor Air	9.0 EER	ARI 390-2003
	≥65,000 Btu/h and <135,000 Btu/h	95°F db/75°F wb Outdoor Air	8.9 EER	
	≥135,000 Btu/h and <240,000 Btu/h	95°F db/75°F wb Outdoor Air	8.6 EER	
SPVHP (Heating Mode)	<65,000 Btu/h	47°F db/43°F wb Outdoor Air	3.0 COP	ARI 390-2003
	≥65,000 Btu/h and <135,000 Btu/h	47°F db/43°F wb Outdoor Air	3.0 COP	
	≥135,000 Btu/h and <240,000 Btu/h	47°F db/43°F wb Outdoor Air	2.9 COP	

For SI: 1 Btu/hr = 0.2931 W, ºF = 1.8ºC + 32, 1 ton = 3517 W.

[1] Cap means the rated cooling capacity of the product in Btu/h. If the unit capacity is less than 7,000 Btu/h, use 7,000 Btu/h in the calculation. If the unit capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculation.

[2] ~~Replacement~~ Non-standard size ~~efficiencies shall only apply to~~ units ~~with existing sleeves less than 16 in. high and less than 42 in. wide. Replacement units~~ shall be factory labeled as follows: "MANUFACTURED FOR ~~REPLACEMENT~~ NON-STANDARD APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW CONSTRUCTION PROJECTS." Non-standard size efficiencies apply only to units being installed in existing sleeves having an external wall opening of less than 16 inches high or less than 42 inches wide and having a cross-sectional area less than 6710 in^2.

TABLE ~~13-P~~1317.6.1(5)
WARM AIR FURNACES, AND COMBINATION WARM AIR FURNACES/AIR-CONDITIONING UNITS, WARM AIR DUCT FURNACES AND UNIT HEATERS

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY ~~REQUIRED~~	OPTIONAL EFFICIENCY	TEST PROCEDURE
Warm Air Furnace, Gas-Fired	<225,000 Btu/h		78% AFUE or 80% E_t[1]	81% AFUE or 82% E_t[1]	DOE 10 CFR, Part 430, App N or ANSI Z21.47-~~1993~~2006 inc Addenda 1 & 2
	≥225,000 Btu/h	Maximum Capacity[1]	80% E_C[2]	87% E_C[2]	ANSI Z21.47-~~1993~~2006 inc Addenda 1 & 2
Warm Air Furnace, Oil-Fired	<225,000 Btu/h		78% AFUE or 80% E_t[1]	84% AFUE ~~or~~ ~~92% E_t~~[1]	DOE 10 CFR, Part 430, App N or UL 727-94
	≥225,000 Btu/h	Maximum Capacity[3]	81% E_t[34]	92% E_t[4]	UL 727-94
Warm Air Duct Furnaces, Gas-Fired	All Capacities	Maximum Capacity[3]	80% E_C[45]	85% E_C[5]	ANSI Z~~83.9 1990~~83.8-2002
Warm Air Unit Heaters, Gas-Fired	All Capacities	Maximum Capacity[3]	80% E_C[45, 6]	87% E_C[6]	ANSI Z~~83.9 1990~~83.8-2002
Warm Air Unit Heaters, Oil-Fired	All Capacities	Maximum Capacity[3]	80% E_C[45, 6]	90% E_C[5, 6]	UL 731-95

For SI: 1 Btu/hr. = 0.2931 W

[1] Combination units not covered by NAECA with 3-phase power or cooling capacity greater than or equal to 65,000 Btu/h (19 kW) may comply with either rating.

[2] E_C = Combustion efficiency (100% less flue losses). See test procedure for detailed discussion. These units must also include an Intermittent Ignition Device (IID), have jacket losses not exceeding 0.75% of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.

[3] Minimum and maximum ratings are provided for and allowed by the unit's controls.

[34] E_t = Thermal efficiency. Units must also include an Intermittent Ignition Device (IID), have jacket losses not exceeding 0.75% of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.

[45] E_C = Combustion efficiency (100% less flue losses). See test procedure for detailed discussion.

[6] Units must also include an uninterrupted or intermittent ignition device (IID) and have either power venting or an automatic flue damper. A vent damper is an acceptable alternative to a flue damper for those units where combustion air is drawn from the conditioned space.

TABLE ~~13-Q~~1317.6.1(6)
BOILERS, GAS-AND OIL-FIRED

~~EQUIPMENT TYPE~~	~~SIZE CATEGORY~~	~~SUBCATEGORY OR RATINGS CONDITIONS~~	~~MINIMUM EFFICIENCY REQUIRED[1, 2]~~	~~TEST PROCEDURE[3]~~
~~Boilers, Gas-Fired~~	~~Less than 300,000 Btu/h~~	~~Hot Water~~	~~80% AFUE~~	~~DOE Test Procedure 10 CFR, Part 430 App N~~
		~~Steam~~	~~75% AFUE~~	
	~~Equal to or greater than 300,000 Btu/h and less than or equal to 2,500,000 Btu/h~~	~~Maximum Capacity[4]~~	~~75% E_t~~	~~Hydronics Institute Heating Boiler Std. 86~~
	~~Greater than 2,500,000 Btu/h[5]~~	~~Hot Water~~	~~80% E_e~~	
	~~Greater than 2,500,000 Btu/h[5]~~	~~Steam~~	~~80% E_e~~	
~~Boilers, Oil-Fired~~	~~Less than 300,000 Btu/h~~		~~80% AFUE~~	~~DOE Test Procedure 10 CFR, Part 430 App N~~
	~~Equal to or greater than 300,000 Btu/h and less than or equal to 2,500,000 Btu/h~~	~~Maximum Capacity[4]~~	~~78% E_t~~	~~Hydronics Institute Heating Boiler Std. 86~~
	~~Greater than 2,500,000 Btu/h[5]~~	~~Hot Water~~	~~83% E_e~~	
	~~Greater than 2,500,000 Btu/h[5]~~	~~Steam~~	~~83% E_e~~	
~~Oil-Fired (Residual)~~	~~Equal to or greater than 300,000 Btu/h and less than or equal to 2,500,000 Btu/h~~	~~Maximum Capacity[4]~~	~~78% E_t~~	~~Hydronics Institute Heating Boiler Std. 86~~

	~~Greater than 2,500,000 Btu/h[5]~~	~~Hot Water~~	~~83% E_c~~	
	~~Greater than 2,500,000 Btu/h[5]~~	~~Steam~~	~~83% E_c~~	

~~For SI: 1 Btu/hr. = 0.2931 W~~

~~[1]. E_c = Combustion efficiency (100% less flue losses). See reference document for detailed information.~~

~~[2]. E_t = Thermal efficiency. See reference document for detailed information.~~

~~[3]. These requirements apply to all packaged boilers and to all other boilers with rated input of 8,000,000 Btu/h or less. The minimum efficiency requirements for boilers cover all capacities of packaged boilers.~~

~~[4]. Minimum and maximum ratings as provided for and allowed by the unit's controls.~~

~~[5]. These requirements apply to boilers with rated input of 8,000,000 Btu/h or less that are not packaged boilers, and to all packaged boilers. Minimum efficiency requirements for boilers cover all capacities of packaged boilers.~~

Per ASHRAE Standard 90.1-07 and Addendum "an" format.
Underlined "Subcategory or Ratings Conditions" and "Size Category" are new compared to current Oregon Table

EQUIPMENT TYPE[1]	SUBCATEGORY OR RATINGS CONDITIONS	SIZE CATEGORY (INPUT)	MINIMUM EFFICIENCY[2, 3]	OPTIONAL EFFICIENCY[2, 3]	TEST PROCEDURE
Boilers, Hot Water	Gas-Fired	<300,000 Btu/h	80% AFUE	90% AFUE	10 CFR Part 430
		≥300,000 and ≤2,500,000 Btu/h[4]	80% E_t	83% E_t	10 CFR Part 431
		≥2,500,000 Btu/h[1]	82% E_c	85% E_c	
	Oil-Fired[5]	<300,000 Btu/h	80% AFUE	84% AFUE	10 CFR Part 430
		≥300,000 and ≤2,500,000 Btu/h[4]	82% E_t	82% E_t	10 CFR Part 431
		≥2,500,000 Btu/h[1]	84% E_c	85% E_c	
Boilers, Steam	Gas-Fired	<300,000 Btu/h	75% AFUE	80% AFUE	10 CFR Part 430
	Gas-Fired–All, except Natural Draft	>300,000 and <2,500,000 Btu/h[4]	79% E_t	82% E_t	10 CFR Part 431
		>2,500,000 Btu/h[1]	79% E_t	80% E_t	
	Gas-Fired–Natural Draft	>300,000 and <2,500,000 Btu/h[4]	79% E_t	82% E_t	
		>2,500,000 Btu/h[1]	79% E_t	80% E_t	
	Oil-Fired[5]	<300,000 Btu/h	80% AFUE	82% AFUE	10 CFR Part 430
		≥300,000 and ≤2,500,000 Btu/h[4]	81% E_t	84% E_t	10 CFR Part 431
		≥2,500,000 Btu/h[1]	81% E_t	82% E_t	

For SI: 1 Btu/hr. = 0.2931 W

[1] These requirements apply to boilers with rated input of 8,000,000 Btu/h or less that are not packaged boilers, and to all packaged boilers. Minimum efficiency requirements for boilers cover all capacities of packaged boilers.

[2] E_C = Combustion efficiency (100% less flue losses). See reference document for detailed information.

[3] E_t = Thermal efficiency. See reference document for detailed information.

[4] Maximum capacity – minimum and maximum ratings as provided for and allowed by the unit's controls.

[5] Includes oil-fired (residual)

TABLE ~~13-R~~1317.6.1(7)
PERFORMANCE REQUIREMENTS FOR HEAT REJECTION EQUIPMENT

Equipment Type[1]	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Condition	Performance Required[1, 2, 3]	Optional Efficiency	Test Procedure
Propeller or Axial Fan Open-Circuit Cooling Towers	All	95ºF Entering Water 85ºF Leaving Water 75ºF *Entering wb* ~~Outdoor Air~~	>38.2 gpm/hp	>40.0 gpm/hp	CTI ATC-105(~~97~~00) and CTI STD-201(~~96~~04)
Propeller or Axial Fan Closed-Circuit Cooling Towers	All	102ºF Entering Water 90ºF Leaving Water 75ºF wb Outdoor Air	≥14.0 gpm/hp	≥15.0 gpm/hp	CTI ATC-105S(96) and CTI STD-201(04)
Centrifugal Fan Open-Circuit Cooling Towers	All	95ºF Entering Water 85ºF Leaving Water 75ºF *Entering wb* ~~Outdoor Air~~	>20.0 gpm/hp	>22.0 gpm/hp	CTI ATC-105(~~97~~00) and CTI STD-201(~~96~~04)
Centrifugal Fan Closed-Circuit Cooling Towers	All	102ºF Entering Water 90ºF Leaving Water 75ºF wb Outdoor Air	≥7.0 gpm/hp	≥8.0 gpm/hp	CTI ATC-105S(96) and CTI STD-201(04)
Air Cooled Condensers	All	125ºF Condensing Temperature R-22 Test Fluid 190ºF Entering Gas Temperature 15ºF Subcooling 95ºF Entering db	>176,000 Btu/h-hp	Not applicable. Air cooled condenser shall be matched to the HVAC system and rated per Table 1317.5.1(3)	ARI 460(~~00~~05)

For SI: $^{O}C = [(^{O}F) - 32]/1.8$

1 For purposes of this table, open-circuit cooling tower performance is defined as the process water ~~maximum~~ flow rating of tower at thermal rating conditions listed in this table divided by the sum of fan motor nameplate ~~rated motor~~ power.

2 For purposes of this table, closed-circuit cooling tower performance is defined as the process water flow rating of tower at thermal rating conditions listed in this table divided by the sum of fan motor nameplate power.

3. For purposes of this table, air-cooled condenser performance is defined as heat rejected from refrigerant divided by the fan motor nameplate ~~rated motor~~ power.

1317.6.4 Hot gas bypass limitation. **Cooling equipment with direct expansion coils rated at greater than 65,000 Btu/h total cooling capacity shall have a minimum of 2 stages of cooling capacity or capacity modulation other than hot gas bypass that is capable of reducing input and output by at least 50%.** Cooling systems shall not use hot gas bypass or other evaporative pressure control systems. ~~unless the system is designed with multiple steps of unloading or continuous capacity modulation. The capacity of hot gas bypass shall be limited as indicated below:~~

~~**Exception:** Unitary packaged systems with cooling capacity not greater than 90,000 Btu/hr.~~

~~Rated Capacity~~	~~Maximum Hot Gas Bypass Capacity (% of Total Capacity)~~
~~≤240,000 Btu/hr~~	~~50%~~
~~>240,000 Btu/hr~~	~~25%~~

~~**1317.5.1 Electric equipment.** HVAC system equipment for which energy input is electric shall have a minimum efficiency no less than values specified in Tables 13-L, 13-M, 13-N and 13-O.~~

~~**1317.5.2 Combustion heating equipment.** All gas- and oil-fired comfort heating equipment shall have combustion efficiency no less than specified in Tables 13-P and 13-Q.~~

~~**1317.5.3 Heat-operated cooling equipment.** Heat-operated cooling equipment shall have a minimum efficiency performance no less than values specified in Table 13-O. These requirements apply to, but are not limited to, absorption, engine-driven and turbine-driven equipment.~~

~~**1317.5.4 Heat rejection equipment.**~~

~~**1317.5.4.1 General.** Section 1317.5.4.1 applies to heat rejection equipment used in comfort cooling systems such as air-cooled condensors, open cooling towers, closed-circuit cooling towers, and evaporative condensors.~~

~~**Exception:** Heat rejection devices included as an integral part of equipment listed in Tables 13-L, 13-M and 13-O.~~

~~Heat rejection equipment shall have a minimum efficiency performance not less than values specified in Table 13-R. These requirements apply to all propeller, axial fan and centrifugal fan cooling towers. Table 13-R specifies requirements for air-cooled condensers that are within rating conditions specified within the table.~~

1317.6.4~~.2~~.5 Cooling tower variable flow controls. Cooling tower fans shall have control devices that vary flow by controlling leaving fluid temperature or condenser temperature/pressure of the heat rejection device.

1317.6.6 Cooling 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:

(1) The flow produced by the smallest pump, or

(2) 33% of the design flow for the cell.

1317.7 Piping insulation. See Section 1314.

1317.8 Insulation of ducts. All air–handling ducts and plenums installed as part of an HVAC air distribution system shall be thermally insulated according to Table ~~13-S~~1317.8 based on ductwork type and location.

> **Exception:** Factory–installed plenums, casings or ductwork furnished as a part of HVAC equipment.

Duct insulation materials shall be manufactured specifically for use as heating or cooling duct insulation and shall be installed according to manufacturer's recommended practices. Duct insulation *R*-values shown in Table ~~13-S~~1317.8 are for insulation as installed and do not include film resistance. Insulation resistance shall be determined in accordance with ASTM C518-02, *Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus*, at a mean temperature of 75ºF (24ºC) at the installed thickness.

TABLE ~~13-S~~1317.8
MINIMUM INSULATION R-VALUE FOR HVAC DUCT SYSTEMS IN OTHER BUILDINGS

DUCT LOCATION	CLIMATE ZONE	DUCT TYPE		
		Outside Air[1]	Cooling/Return[2]	Heating
Exterior of building	1	–	6.0	8.0
	2	–	8.0	12.0
Vented spaces[3]	All	–	3.5	8.0
Within or below slabs on grade	All	–	–	3.0
Unconditioned spaces & plenums[4]	All	1.9	1.9[5]	3.5
Fully conditioned spaces	All	3.5	–	–

For SI: ºC = [(ºF) – 32]/1.8

[1] Outside Air ducts conveying untempered, outside air.

[2] Includes cooling-only, return-air, and tempered-air ducts. Tempered air is within 15 degrees of conditioned space temperature.

[3] Includes unconditioned spaces (attics, crawl spaces, vented mechanical rooms) outside the building envelope.

[4] Includes unconditioned, unvented spaces such as unvented mechanical rooms, shafts, or plenums (with or without return air) within the building envelope.

[5] Insulation is not required for return-air and tempered-air ductwork in unconditioned spaces.

For ducts that convey both heated and cooled air, duct insulation shall be the highest *R*-value specified in Table ~~13-S~~1317.8. Insulation for ducts located outside of the insulated building envelope shall be covered by a vapor barrier having a perm rating not exceeding 0.5 perm.

Where exterior walls of a building are used as plenum walls, wall insulation shall be as required by this section or Section 1312, to the highest specified *R*-value.

1317.9 Duct sealing and testing. See the *Oregon Mechanical Specialty Code* (OMSC). **Ductwork and plenums shall be sealed in accordance with Table 1317.9(1), as required to meet the requirements of Sections 1317.9.1 and 1317.9.2. The specific requirements for level of duct sealing are specified in Table 1317.9(2).**

> **1317.9.1 Low pressure duct leak test. All duct systems, with the exception of ductwork located in the zone served, shall be sealed to a leakage rate not to exceed 6 percent of the fan flow if the duct system:**

(1) Is connected to a constant volume, single zone, air conditioner, heat pump or furnace; and

(2) Serves less than 5,000 square feet of floor area; and

(3) Has more than 25 percent duct surface area located in any unconditioned space or outside the bulding envelope excluding ductwork located in return air plenumns.

The leakage rate shall be confirmed through field verification and diagnostic testing, in accordance with SMACNA Duct Leakage Test Procedures - 1985.

1317.9.2 High pressure duct leak test. Ductwork that is designed to operate at static pressures in excess of 3 in. w.c. shall be leak-tested in accordance with SMACNA Duct Leakage Test Procedures – 1985. Representative sections totaling no less than 25 percent of the total installed duct area for the designated pressure class shall be tested. Duct systems with pressure ratings in excess of 3 in. w.c. shall be identified on the drawings. The maximum permitted duct leakage shall be:

$$L_{max} = C_L P^{0.65}$$

where

L_{max} = maximum permitted leakage in cfm/100 square feet duct surface area;

CL = duct leakage class, cfm/100 square feet at 1 in. w.c.,

CL = 6 for rectangular sheetmetal, rectangular fibrous, and round flexible ducts,

CL = 3 for round/flat oval sheetmetal or fibrous glass ducts; and

P = test pressure, which shall be equal to the design duct pressure class rating in in. w.c.

TABLE 1317.9(1) – MINIMUM DUCT SEALING LEVEL[1]

DUCT LOCATION	DUCT TYPE			
	Supply		Return	Exhaust
	≤2 in. w.c.[2]	>2 in. w.c.[2]		
Outdoor	A	A	A	C
Unconditioned Spaces	B	A	B	C
Conditioned Spaces[3]	C	B	C	B

[1] See Table 1317.8(2) for description of sealing level.
[2] Duct design static pressure classification.
[3] Includes indirectly conditioned spaces such as return air plenums but not ductwork located in the zone served.

TABLE 1317.9(2) – DUCT SEALING LEVELS

SEALING LEVEL	SEALING REQUIREMENTS[1]
A	All transverse joints, longitudinal seams, and duct wall penetrations. Pressure-sensitive tape shall not be used as the primary sealant, unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory and tape is used in accordance with that certification
B	All transverse joints, longitudinal seams. Pressure-sensitive tape shall not be used as the primary sealant, unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory and tape is used in accordance with that certification
C	Transverse joints only

[1] Longitudinal seams are joints oriented in the direction of airflow. Transverse joints are connections or two duct sections oriented perpendicular to airflow. Duct wall penetrations are openings made by any screw fastener, pipe, rod, or wire. Spiral lock seams in a round or flat oval duct need not be sealed. All other connections are considered transverse joints, including but not limited to spin-ins, taps, and other branch connections, access door frames and jambs, duct connections, and similar connections.

1317.10 Simple HVAC Systems. To qualify as a simple system, systems shall **serve a single zone, have no active humidification, have no simultaneous heating and cooling, and** be one of the following:

(1) Air cooled, constant volume packaged unitary equipment, packaged terminal air conditioners and packaged terminal heat pumps which provide heating, cooling or both and which requires only external connection to ductwork and energy services.

(2) Air cooled, constant volume split systems, which provide heating, cooling or both, with cooling capacity of 54,000 Btu/hr. (15,827 W) or less.

(3) Ground–coupled heat pumps with cooling capacity of 54,000 Btu/hr. (15,827 W) or less.

(4) Heating only systems which have a capacity of less than 5,000 cubic feet per minute (2,360 L/s) or which have a minimum outside air supply of less than 70 percent of the total air circulated.

1317.11 Complex HVAC systems. Complex HVAC systems shall be all field–fabricated systems and systems constructed of subsystem components and systems not qualifying under Section 1317.10 (Simple Systems).

1317.11.1 Controls. Complex systems shall provide controls as specified in Sections 1317.5 and 1318.2.

1317.11.2 Equipment performance. In addition to the requirements of Section 1317.6, equipment in complex systems shall also comply with Section 1318.3.

1317.11.3 Motor efficiency of electric motors serving built–up HVAC systems (fans, compressors, chillers and pumps). Electric motors, ~~which are NEMA Design A & B squirrel cage T frame induction permanently wired poly-phase motors of 1 horsepower or more and~~ which serve built–up HVAC systems, shall ~~have a nominal full load motor efficiency no less than corresponding values for energy efficient motors provided in~~ comply with Table ~~13 T~~1317.11.3(1) until December 18, 2010. Electric motors installed as of December 19, 2010, shall comply with the requirements specified in Table 1317.11.3(2). Motors that are not included in the scope of the Energy Independence and Security Act of 2007 do not have performance requirements regulated in this section.

~~**Exceptions:**~~

~~1. Motors used in systems designed to use more than one speed of a multispeed motor.~~

~~2. Factory installed motors for HVAC equipment meeting the equipment efficiency requirements of Section 1317.5.~~

TABLE ~~13-T~~1317.11.3(1)
~~ENERGY EFFICIENT ELECTRIC MOTORS~~
MINIMUM NOMINAL FULL-LOAD EFFICIENCY FOR GENERAL PURPOSE DESIGN A and DESIGN B MOTORS RATED 600 VOLTS AND LESS – Through 1/18/10

	OPEN DRIP-PROOF MOTORS			TOTALLY ENCLOSED FAN-COOLED MOTORS		
Number of Poles	2	4	6	2	4	6
Synchronous Speed (RPM)	~~3,000~~3,600	1,800	1,200	3,600	1,800	1,200
Motor Horsepower	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency
1	- -	82.5	80.0	75.5	82.5	80.0
1.5	82.5	84.0	84.0	82.5	84.0	85.5
2	84.0	84.0	85.5	84.0	84.0	86.5
3	84.0	86.5	86.5	85.5	87.5	87.5
5	85.5	87.5	87.5	87.5	87.5	87.5
7.5	87.5	88.5	88.5	88.5	89.5	89.5
10	88.5	89.5	90.2	89.2	89.5	89.5
15	89.2	91.0	90.2	90.2	91.0	90.2
20	90.2	91.0	91.0	90.2	91.0	90.2
25	91.0	91.7	91.7	91.0	92.4	91.7
30	91.0	92.4	92.4	91.0	92.4	91.7
40	91.7	93.0	93.0	91.7	93.0	93.0
50	92.4	93.0	93.0	92.4	93.0	93.0
60	93.0	93.6	93.6	93.0	93.6	93.6
75	93.0	94.1	93.6	93.0	94.1	93.6
100	93.0	94.1	94.1	93.6	94.5	94.1
125	93.6	94.5	94.1	94.5	94.5	94.1
150	93.6	95.0	94.5	94.5	95.0	95.0
200	94.5	95.0	94.5	95.0	95.0	95.0

TABLE 1317.11.3(2)
MINIMUM NOMINAL FULL-LOAD EFFICIENCY FOR GENERAL PURPOSE DESIGN A and DESIGN B MOTORS RATED 600 VOLTS AND LESS – After 1/18/10

	OPEN DRIP-PROOF MOTORS			TOTALLY ENCLOSED FAN-COOLED MOTORS		
Number of Poles	2	4	6	2	4	6
Synchronous Speed (RPM)	3,600	1,800	1,200	3,600	1,800	1,200
Motor Horsepower	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency
1	77.0	85.5	82.5	77.0	85.5	82.5
1.5	84.0	86.5	86.5	84.0	86.5	87.5
2	85.5	86.5	87.5	85.5	86.5	88.5
3	85.5	89.5	88.5	86.5	89.5	89.5
5	86.5	89.5	89.5	88.5	89.5	89.5
7.5	88.5	91.0	90.2	89.5	91.7	91.0
10	89.5	91.7	91.7	90.2	91.7	91.0
15	90.2	93.0	91.7	91.0	92.4	91.7
20	91.0	93.0	92.4	91.0	93.0	91.7
25	91.7	93.6	93.0	91.7	93.6	93.0
30	91.7	94.1	93.6	91.7	93.6	93.0
40	92.4	94.1	94.1	92.4	94.1	94.1
50	93.0	94.5	94.1	93.0	94.5	94.1
60	93.6	95.0	94.5	93.6	95.0	94.5
75	93.6	95.0	94.5	93.6	95.4	94.5
100	93.6	95.4	95.0	94.1	95.4	95.0
125	94.1	95.4	95.0	95.0	95.4	95.0
150	94.1	95.8	95.4	95.0	95.8	95.8
200	95.0	95.8	94.5	95.4	96.2	95.8
250	95.0	95.8	94.5	95.8	96.2	95.8
300	95.4	95.8	94.5	95.8	96.2	95.8
350	95.4	95.8	94.5	95.8	96.2	95.8
400	95.8	95.8	95.8	95.8	96.2	95.8
450	95.8	96.2	96.2	95.8	96.2	95.8
500	95.8	96.2	96.2	95.8	96.2	95.8

1317.11.3.1 Variable speed drives. Fan and pump motors of ~~10~~ **5** horsepower **(3.7 kW)** and greater ~~which serve variable flow air or liquid systems~~ shall be controlled by a variable speed drive. This includes custom and packaged air handlers serving variable air volume fan systems, **constant volume fans,** heating and cooling hydronic pumping systems, **pool and service water pumping systems, domestic water pressure boosting systems,** ~~with modulating control valves, and~~ cooling tower fans, and other pumps or fans where variable flows are required. **Units designed for constant volume fan operation during heating or cooling shall operate at 60% flow or less while not heating or cooling.** Variable inlet vanes, throttling valves (dampers), scroll dampers or bypass circuits shall not be allowed.

Exceptions:

1. Axial vane fans with variable pitch control.
2. ~~Dedicated equipment circulation pumps designed to meet minimum flow requirements established by manufacturer, such as boiler or chiller auxiliary circulation pumps.3.~~ Cooling towers designed with two **fan** motors (main and small auxiliary motor) or multi-speed **fan** motors.
3. **Backup pumps or fans intended only for use in case of failure of a variable speed drive equipped pump or fan.**
4. **Pumps or fans intended only for use in case of emergency such as a fire pump or smoke evacuation fan.**
5. **Fans that operate in constant flow during heating and cooling that are equipped with a multiple-speed motor and operate at 60 percent or less while not heating or cooling.**

> Note: Variable speed on constant volume fan systems may require advanced ventilation controls to meet ventilation requirements.

1317.11.3.2 Large volume fan systems. Single or multiple fan systems serving a zone or adjacent zones without separating walls with total air flow over 7,500 cfm (3,540 l/s) are required to reduce airflow based on space thermostat heating and cooling demand. A two-speed motor or variable **speed** drive shall reduce airflow to a maximum 60 percent of peak airflow or minimum ventilation air requirement as required by Chapter 12, whichever is greater.

Exceptions:

1. Systems where the function of the supply air is for purposes other than temperature control, such as maintaining specific humidity levels or supplying an exhaust system.
2. **Dedicated outdoor air supply unit(s) with heat recovery where airflow is equal to the minimum ventilation requirements and other fans cycle off unless heating or cooling is required.**
3. **An area served by multiple units where designated ventilation units have 50 percent or less of total area airflow and non-ventilation unit fans cycle off when heating or cooling is not required.**

1317.12 Kitchen hoods. Kitchen makeup air shall be provided as required by the *Oregon Mechanical Specialty Code*.

1317.12.1 Kitchen Makeup Air. For each kitchen ~~exhaust system~~ with a total exhaust capacity greater than ~~5,000~~ **2,000** cfm (~~2360~~ **944** L/s), 50 percent of the required makeup air shall be (a) unheated or heated to no more than 60°F (15.55°C); and (b) uncooled or evaporatively cooled.

Exceptions:

1. Where hoods are used to exhaust ventilation air that would otherwise be exhausted by other fan systems **and a detailed accounting of airflows is provided that considers the impact of demand controlled ventilation**. Air transferred from spaces served by other fan systems may not be used if those systems are required to meet either Sections ~~1203.2.12~~ **1317.3.2** or ~~1318.3~~ **1317.3.4**. Occupancy schedule of HVAC system supplying transfer air shall be similar to kitchen exhaust hood operating schedule.
2. **Kitchen exhaust systems that include exhaust air heat recovery complying with section 1317.3.4.**

1317.12.2 Kitchen Demand Ventilation. Each kitchen with a total exhaust capacity greater than 5,000 cfm shall be equipped with a demand ventilation system on at least 75 percent of the exhaust and makeup air. Such systems shall be equipped with automatic controls that reduce airflow in response to cooking appliance operation while maintaining full capture and containment of smoke effluent and combustion products.

1317.13 Permanently installed heating systems outside a building. Heating systems installed outside a building shall be radiant, gas-fired systems. Such heating systems shall be controlled by an occupancy sensing device or a timer switch, so that the system is automatically de-energized when no occupants are present.

1317.14 Vestibule and air curtain conditioning. Vestibules or air curtains shall not be equipped with separate heating or cooling systems. Vestibules may be pressurized with transfer air from the conditioned space that receives no additional heating or cooling. Any pressurization fan shall be equipped with controls to turn it off during unoccupied hours.

1317.15 Pipe sizing. All hydronic piping shall be designed such that the design flow rate in each pipe segment shall not exceed the values listed in Table 1317.15. Pipe size selections for systems that operate under variable flow conditions (e.g. modulating 2-way control valves at coils) and that contain variable speed pump motors are allowed to be made from the "Variable Flow" columns. All others shall be made from the "Other" columns.

Exception: Piping systems that have equivalent or lower total pressure drop than the same system constructed with standard weight steel pipe with piping and fittings sized per Table 1317.15.

Table 1317.15: Piping System Design Maximum Flow Rate[1]

IP Units - Maximum GPM			SI Units - Maximum L/s		
Nominal Pipe Size (in.)	Other (gpm)	Variable Flow (gpm)	DN Pipe Size (mm)	Other (L/s)	Variable Flow (L/s)
1/2	3	5	15	0.2	0.3
3/4	6	9	20	0.4	0.6
1	11	17	25	0.7	1.1
1-1/4	17	25	32	1.1	1.6
1-1/2	29	45	40	1.8	2.8
2	49	75	50	3.1	4.7
2-1/2	77	115	65	4.9	7.3
3	130	190	80	8.2	12
4	240	350	100	15	22
5	280	420	125	18	26
6	510	760	150	32	48
8	580	870	200	37	55
10	1200	1700	250	76	110
12	1700	2600	300	110	160
Maximum Velocity for >12	5.8 fps	8.5 fps	Maximum Velocity for >300	1.8 m/s	2.6 m/s

[1] Table values are maximum flows for energy cost effectiveness. Larger pipe may be recommended to reduce noise and pipe erosion.

1317.16 Refrigerated Warehouse Heating and Cooling. Heating and cooling systems that supply cold storage spaces and frozen storage spaces in refrigerated warehouses shall meet the requirements of this section.

1317.16.1 Underslab heating. Electric resistance heat shall not be used for the purposes of underslab heating.

Exception: Underslab heating systems controlled such that the electric resistance heat is thermostatically controlled and provided with a digital input or other interface approved by the local utility that allows heat to be disabled during on-peak periods defined by the local electric utility.

1317.16.2 Evaporators. Fan-powered evaporators used in coolers and freezers shall conform to the following:

(1) Single phase fan motors less than 1 horsepower and less than 460 Volts shall be electronically commutated motors.

(2) Evaporator fans shall be variable speed and the speed shall be controlled in response to space conditions.

Exception: Evaporators served by a single compressor without unloading capability.

1317.16.3 Condensers. Fan-powered condensers shall conform to the following:

(1) Condensers for systems utilizing ammonia shall be evaporatively cooled.

(2) Condensing temperatures for evaporative condensers under design conditions, including but not limited to condensers served by cooling towers shall be less than or equal to:

a. the design wetbulb temperature plus 20˚F in locations where the design wetbulb temperature is less than or equal to 76˚F,
b. the design wetbulb temperature plus 19˚F in locations where the design wetbulb temperature is between 76˚F and 78˚F, or
c. the design wetbulb temperature plus 18˚F in locations were the design wetbulb temperature is greater than or equal to 78 ˚F.

(3) Condensing temperatures for air-cooled condensers under design conditions shall be less than or equal to the design drybulb temperature plus 10˚F for systems serving frozen storage and shall be less than or equal to the design drybulb temperature plus 15˚F for systems serving cold storage.

Exception: Unitary condensing units.

(4) All condenser fans for evaporative condensers shall be continuously variable speed, and the condensing temperature control system shall control the speed of all condenser fans serving a common condenser loop in unison. The minimum condensing temperature setpoint shall be less than or equal to 70°F.

(5) All condenser fans for air-cooled condensers shall be continuously variable speed and the condensing temperature or pressure control system shall control the speed of all condenser fans serving a common condenser loop in unison. The minimum condensing temperature setpoint shall be less than or equal to 70°F, or reset in response to ambient drybulb temperature or refrigeration system load.

(6) All single phase condenser fan motors less than 1 horsepower and less than 460 V shall be either permanent split capacitor or electronically commutated motors.

1317.16.4 Compressors. Compressor systems utilized in refrigerated warehouses shall conform to the following:

(1) Compressors shall be designed to operate at a minimum condensing temperature of 70°F or less.

(2) The compressor speed of a screw compressor greater than 50 hp shall be controllable in response to the refrigeration load or the input power to the compressor shall be controlled to be less than or equal to 60 percent of full load input power when operated at 50 percent of full refrigeration capacity.

Exception: Refrigeration plants with more than one dedicated compressor per suction group.

PART II

DIVISION I — COMPLEX SYSTEMS DESIGN REQUIREMENTS

The requirements contained in Division I are fore the design and installations of complex HVAC controls and systems.
Division II contains requirements for the manufacture of fenestration products

SECTION 1318
GENERAL

1318.1 Purpose. The purpose of this section is to regulate the design and construction of the selection of heating, ventilating and air conditioning (HVAC) and equipment required for the purpose of effective conservation of energy within a building or structure governed by this code.

1318.2 Complex systems controls.

1318.2.1 Simultaneous heating and cooling. Zone thermostatic and humidistatic controls shall be capable of operating in sequence the supply of heating and cooling energy to the zone. Such controls shall prevent reheating, recooling, and mixing or simultaneous supply of air that has been previously mechanically heated with air that has been previously ~~mechanically~~ cooled **mechanically or with an outside air economizer**.

Exceptions:

1. Variable air volume (VAV) systems which, during periods of occupancy **are controlled**:
   - 1.1 ~~are designed~~ to reduce the **primary** air supply to each zone to a minimum **air volume when the zone temperature is in a 5°F (3°C) zone temperature dead band after cooling is no longer required** and before reheating, recooling or mixing takes place. This minimum volume shall be no greater than the larger of the following:
     - 1.1.1 ~~Thirty~~ **Twenty** percent of the peak supply volume; **or**
     - 1.1.2 The **volume of outdoor air** ~~minimum~~ required to meet **zone** ventilation requirements, unless increasing the volume to critical zones (zones with the highest ratio of outside air to total supply air) beyond the minimum ventilation requirements results in a decrease in overall outside air required by the HVAC system. An increase beyond minimum ventilation rates shall not be applied to more than 20 percent of the zones with reheat~~,~~ on any one system **excluding zones that include a means to automatically reduce outside air intake below design rates when spaces are partially occupied**; or
     - **1.1.3 The air flow rate required to comply with applicable codes or accreditation standards, such as pressure relationships or minimum air change rates in some areas of hospitals, vivariums and laboratories.**
   - ~~1.3 0.4 cfm/ft^2 (2 L/s per m^2) of zone conditioned floor area.~~
   - **1.2. so the volume of air that is reheated, recooled, or mixed in peak heating demand shall be less than 50% of the zone design peak supply rate.**
   - **1.3. so the airflow between dead band and full heating or full cooling shall be modulated.**

1.4 so the control logic of each system shall have means preventing changes in setpoint(s) from inducing simultaneous heating and cooling (including economizer cooling) except for humidity control or zone controls operating as described under exception 1.1.

2. **Laboratory systems that comply with 1317.3.6.**~~Zones where special pressurization relationships or cross contamination requirements are such that variable air volume systems are impractical, such as some areas of hospitals and laboratories. Systems which use this exception and supply heated or cooled air to multiple zones shall include controls which automatically reset supply air temperatures by representative building loads or by outside air temperature unless it can be shown that supply air temperature reset increases overall building annual energy costs.~~
3. At least 75 percent of the energy for reheating or for providing warm air in mixing systems comes from a site–recovered or site–solar energy source.
4. Zones where specified humidity levels are required to satisfy process needs, such as computer rooms, museums and areas of hospitals.
5. Zones with a peak supply air quantity of 300 cfm (142 L/s) or less.
6. **Three deck multizone systems that mix economizer-cooled (mixed) air with heated or cooled air where the temperature of the economizer-cooled air is reset based on weighted zone heating and cooling loads and zone airflow is reduced to a minimum of twenty percent design airflow or the volume of outdoor air required to meet zone ventilation requirements before mixing is allowed.**

1318.2.2 Humidity control. If a system is equipped with a means to add moisture to maintain specific humidity levels in a zone or zones, a ~~humidistat~~ **humidity control device** shall be provided.

1318.2.2.1 **The humidity control** ~~This~~ device shall be ~~capable of being~~ set to prevent the use of fossil fuel or electricity to produce relative ~~humidities~~ **humidity** in excess of 30 percent ~~for comfort purposes~~. Where a ~~humidistat~~ **humidity control device** is used for ~~comfort~~ dehumidification, it shall be ~~capable of being~~ set to prevent the use of fossil fuel or electricity to reduce relative ~~humidities~~ **humidity** below 60 percent. ~~Humidifiers with preheating devices mounted in the air stream shall be provided with an automatic valve to shut off preheat when humidification is not required.~~

Exception: Hospitals, process needs, archives, museums, critical equipment, and other non-comfort situations with specific humidity requirements outside this range.

1318.2.2.2 **Humidity controls shall maintain a deadband of at least 10% relative humidity where no active humidification or dehumidification takes place.**

Exception: Heating for dehumidification is provided with heat recovery or heat pumping and the mechanical cooling system efficiency shall be from the Optional Compliance Efficiency column in Tables 1317.6.1(1), 1317.6.1(2), and 1317.6.1(3). When the Optional Efficiency column is used for compliance, it shall not be used for compliance with 1311.2, Optional compliance approach.

1318.2.3 Variable air volume system static pressure reset controls. The system static pressure set point shall be reset to the lowest point possible while still providing the required air flow to the zones with the greatest demand. **Maximum setpoint shall be no more than one-third total fan design static pressure.**

Exception~~s~~: Systems where fan speed is reset directly based on zone airflows or other zone load indicators.

~~1. Systems that are not controlled by a static pressure sensor.~~

~~2. Systems without direct digital control of individual zone boxes.~~

1318.2.4 Chilled and hot water temperature reset controls. Chilled and hot water systems with a design capacity exceeding 300,000 Btu/hr. (88 kW) supplying chilled or heated water (or both) ~~to comfort conditioning systems~~ shall include controls that automatically reset supply water temperatures by representative building loads ~~(including return water temperature)~~ or by outside air temperature.

Exception~~s~~: ~~1.~~ Where the supply temperature reset controls cannot be implemented without causing improper operation of dehumidifying systems.

~~2. Hydronic systems that use variable flow to reduce pumping energy.~~

1318.2.5 Supply-air temperature reset controls. Multiple zone HVAC systems must include controls that automatically reset the supply-air temperature in response to representative ~~building~~ **zone** loads~~, or to outdoor air temperature~~. The controls must ~~be capable of~~ reset~~ting~~ the supply air temperature at least 25 percent of the difference between the design supply-air temperature and the design room air temperature. **Interior zones without an exterior wall load impact and high occupancy areas (per section 1317.3.2) shall have maximum airflow sized to meet typical cooling loads with the higher reset air temperature.**

Exceptions:

1. Systems that prevent re-heating, re-cooling, or mixing of heated and cooled supply air.
2. 75 percent of the energy for reheating is from site-recovered or site solar energy sources.
3. Zones with peak supply air quantities of 300 cfm or less.
4. **Dedicated outdoor air systems less than 5000 cfm with separate thermal controls.**

1318.2.6 Zone isolation controls. A system serving multiple occupancies or floors in the same building shall be independently zoned and equipped with isolation devices ~~**capable of**~~ **that** automatically shut~~ting~~ off the supply of conditioned air and outside air to and from each isolated area. Each isolated area shall be controlled independently and satisfy temperature setback (Section 1317.4.2) and optimum start control requirements. The central fan system air volume shall be reduced through fan speed reduction.

Exception: A cooling system less than 240,000 Btu/hr (70 kW) or a heating system with less than 300,000 Btu/hr (88 kW) total capacity.

1318.2.7 Separate air distribution systems. Zones with special process temperature requirements and/or humidity requirements shall be served by separate air distribution systems from those serving zones requiring only comfort conditions; or shall include supplementary control provisions so that the primary systems may be specifically controlled for comfort purposes only.

Exception~~s~~: Zones requiring only comfort heating or comfort cooling that are served by a system primarily used for process temperature and humidity control provided that~~:~~

~~1.The total supply air to those comfort zones is no more than 25 percent of the total~~

~~system supply air, or 2.~~ the total conditioned floor area of the zones is less than 1,000 square feet (90 m^2).

1318.2.8 Hydronic system controls. The heating of fluids in hydronic systems that have been previously mechanically cooled and the cooling of fluids that have been previously mechanically heated shall be limited in accordance with the following:

1318.2.8.1 Three-pipe system. Hydronic systems that use a common return system for both hot water and chilled water shall be prohibited.

1318.2.8.2 Two-pipe changeover system. Systems that use a common distribution system to supply both heated and chilled water shall meet the following:

(1) The system is designed to allow a deadband between changeover from one mode to the other of at least 15°F (-9°C) outside air temperature.

(2) The system is designed to operate and is provided with controls that will allow operation in one mode for at least four hours before changing over to the other mode.

(3) Reset controls are provided that allow heating and cooling supply temperatures at the changeover point to be no more than 30°F (-1°C) apart.

1318.2.8.3 Hydronic (water loop) heat pump systems. Hydronic heat pumps connected to a common heat pump water loop with central devices for heat rejection (e.g., cooling tower) and heat addition (e.g., boiler) shall meet the following requirements:

(1) Controls shall be installed that **~~are capable of providing~~** **provide** a heat pump water supply temperature dead band of at least 20°F (-7°C) between initiation of heat rejection and heat addition by the central devices (e.g., tower and boiler).

(2) Closed-circuit tower (fluid cooler) shall have either an automatic valve installed to bypass all but a minimal flow of water around the tower (for freeze protection) or low-leakage positive closure dampers.

(3) Open-circuit tower installed directly in the heat pump loop shall have an automatic valve installed to bypass all heat pump water flow around the tower. Open-circuit towers used in conjunction with a separate heat exchanger to isolate the tower from the heat pump loop shall be controlled by shutting down the circulation pump on the cooling tower loop.

(4) A two-position valve at each hydronic heat pump for hydronic systems having a total pump system power exceeding 10 hp.

1318.2.9 ~~8.4~~ **Hydronic variable flow systems** ~~**Variable flow controls.** Controls capable of varying pump flow shall be installed on hydronic pumping systems with motors of 10 hp and greater.~~ **HVAC chilled water, condenser water, 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 50 percent or less of the design flow rate; or the minimum flow required by the equipment manufacturer for proper operation of equipment served by the system.**

Exceptions:

1. Heating, chilled, and heat pump water systems that include three or fewer control valves and have a total pump system power less than or equal to 3 hp (2.2 kW).

2. Systems having a total pump system power less than or equal to 1-1/2 hp (1.1 kW).
3. Condenser water systems for chillers with capacities less than 780,000 Btu/hr (2,662 kW).

1318.2.9.1. 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.

~~Exception: Chillers that are piped in series for the purpose of increased temperature differential.~~

1318.2.9.2. 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).

1318.2.9.3. Variable flow controls. Individual pumps serving variable flow systems and having a motor horsepower exceeding 5 hp (3.7 kW) shall have control devices (such as variable speed control) that will result in pump motor demand of no more than 30 percent of design wattage at 50 percent of design water flow. The pump(s) speed shall be controlled in one of the following manners:

(1) For systems having a combined pump motor horsepower less than or equal to 20 hp (15 kW) and without direct digital control of individual coils, pump speed shall be a function of either:
a. required differential pressure, or
b. reset directly based on zone hydronic demand, or other zone load indicators, or
c reset directly based on pump power and pump differential pressure.

(2) For systems having a combined pump motor horsepower that exceeds 20 hp (15 kW) or smaller systems with direct digital control, pump speed shall be a function of either:
a. the static pressure set point as reset based on the valve requiring the most pressure, or
b. directly controlled based on zone hydronic demand.

1318.2.10 All hydronic heating or cooling coils with design flow exceeding 20 gpm (76 L/m) shall be equipped with dedicated pressure testing ports to enable testing of pressure drop through the coil. All hydronic heating or cooling systems served by pump(s) exceeding 5 HP (3.7 kW) shall be equipped with accessible pressure testing ports to enable testing supply and return pressure near the end of each major hydronic run.

1318.2.11 Direct Digital Control System Capabilities. All complex systems equipped with Direct Digital Control (DDC) systems and all buildings with total cooling capacity exceeding 780,000 Btu/hr (2,662 kW) shall have the following capability:

1318.2.11.1 Trending. All control system input and output points shall be accessible and programmed for trending, and a graphic trending package shall be provided with the control system.

1318.2.11.2 Demand Response Setpoint Adjustment. Control logic shall increase the cooling zone setpoints by at least 2°F (1°C) and reduce the heating zone setpoints by at least 2°F (1°C) when activated by a demand response signal. The demand response signal shall be a binary input to the control system or other interface approved by the serving electric utility.

Note: Exhaust air heat recovery relocated to 1317.3.4

~~**1318.3 Exhaust air heat recovery:** An exhaust air heat recovery system shall be installed for each HVAC fan system that has all of the following:~~

~~1. A design supply air capacity of 10,000 cfm (4720 L/s) or greater,~~

~~2. A minimum outside air supply of 70 percent or greater,~~

~~3. At least one exhaust fan rated at 75 percent of the minimum outside air supply.~~

~~The heat recovery system shall be capable of increasing the outside air supply temperature at design heating conditions by 20°F in Climate Zone 1 and 30°F (-1°C) in Climate Zone 2. A provision shall be made to bypass or control the heat recovery system to permit air economizer operation as required by Section 1317.3.~~

~~**Exceptions:**~~

~~1. HVAC systems with ventilation controls for high occupancy areas per Section 1317.2.2.~~

~~2. Laboratory systems meeting Section 1317.2.1.~~

~~3. Systems serving spaces which are not cooled and which are heated to less than 55°F (12.78°C).~~

~~4. Systems exhausting toxic, flammable, paint exhaust, corrosive fumes, or dust.~~

~~5. Type 1 kitchen exhaust hoods.~~

~~6. Where more than 60 percent of the outdoor heating energy is provided from site-recovered or site solar energy.~~

~~7. Systems that only provide cooling.~~

1318.4 Complex systems equipment performance

1318.4.1 Service water heating functions provided by space heating and cooling equipment. Space heating or cooling equipment used to provide additional functions (e.g., service water heating) as part of a combination (integrated) system shall comply with minimum performance requirements for the appropriate space heating or cooling equipment category. (See also Section 1315.2.)

~~**1318.4.2 Air transport energy.** The energy demand of each HVAC fan system shall be limited as specified in Sections 1318.4.2.1 and 1318.4.2.2. For the purposes of determining allowable fan motor horsepower, maximum combined fan motor horsepower is the sum of the motor brake horsepower of all fans operating at design conditions, including supply fans, return/exhaust fans and fan-powered terminal units.~~

~~**Exceptions:**~~

~~1. Individual HVAC fan systems with total nameplate fan system motor horsepower of 7.5 or less.~~

~~2. Individual exhaust fans with nameplate fan horsepower of 1 hp or less.~~

3. Induction/dilution exhaust fans used in hospitals and laboratories.
4. Fan-powered, parallel airflow terminal units where the fan does not operate in cooling mode.

1318.4.2.1 Constant volume fan systems. For fan systems which provide a constant air volume whenever the fans are operating, the power required by the motors for the combined fan system at design conditions shall not exceed Formula CV-1 shown below. This requirement includes 2-speed motors.

Formula CV-1 $BHP = \frac{\text{Design Airflow (CFM)} * 4.3}{4131}$

Fan systems with filtration systems that have a pressure drop at design air flow in excess of 1" water column when the filters are clean heat recovery, or direct evaporative humidifier/ cooler may use Formula CV-2:

Formula CV-2 $BHP = \frac{CFM * (P.D. + 4.3)}{4131}$

where:

BHP = the maximum combined fan brake motor horsepower.

CFM = the maximum design supply air flow in cubic feet per minute.

PD = the combined pressure drop at design air flow of all filtering systems in excess of 1" water column when the filters are clean plus the pressure drop of heat recovery and direct evaporative humidifier/cooler in inches water gauge.

Exception: Hospital and laboratory fan systems that incorporate flow control devices for maintaining precise pressurization control may use Section 1318.4.2.2.

1318.4.2.2 Variable air volume (VAV) fan systems. For fan systems which are able to vary system air volume automatically as a function of load, the power required by the motors for the combined fan system shall not exceed Formula VAV-1 shown below.

Formula VAV-1 $BHP = \frac{\text{Design Airflow (CFM)} * 6.0}{4131}$

Fan systems with filtration systems that have a pressure drop at design air flow in excess of 1" water column when the filters are clean heat recovery, or direct evaporative humidifier/ cooler may use Formula VAV-2:

Formula VAV-2 $BHP = \frac{CFM * (P.D. + 6.0)}{4131}$

where:

BHP = the maximum combined fan brake motor horsepower.

CFM = the maximum design supply air flow in cubic feet per minute.

PD = the combined pressure drop at design air flow of all filtering systems in excess of 1" water column when the filters are clean plus the pressure drop of heat recovery and direct evaporative humidifier/cooler in inches water gauge and additional pressure drops for hospitals and laboratories that have fully ducted return and/or exhaust systems or return and/or exhaust airflow control devices or high filtration as specified in the following Table 1318.4.2.2.

~~**Table 1318.4.2.2**~~
~~**Additional Pressure Drop (PD)**~~

~~ADDITIONAL PD FOR HOSPITALS AND LABORATORIES~~	
~~**Measure**~~	~~**Additional PD**~~
~~Fully ducted return and/or exhaust air systems~~	~~0.5 in w.c.~~
~~Return and/or exhaust air flow control devices~~	~~0.5 in w.c.~~
~~Filter systems of individual filter efficiency >85%~~	~~0.5 in w.c.~~

~~**1318.4.2.3 Selecting and sizing nameplate motor horsepower:** Selected fan motor shall be no larger than the first available motor size greater than the brake horsepower.~~

~~**Exceptions:**~~

~~1. Constant Volume Fans: Where the first available motor larger than the brake horsepower has a nameplate rating within 22% of the brake horsepower, the next larger nameplate motor size may be selected.~~
~~2. Fans with Variable Speed: Where the motor is controlled by a variable speed drive and where the first available motor larger than the brake horsepower has a nameplate rating within 50% of the brake horsepower, the next larger nameplate motor size may be selected.~~

1318.4.2 Fan system power limitation. Each HVAC system at fan system design conditions shall not exceed the allowable fan system motor nameplate horsepower (hp) (Option 1) or fan system brake horsepower (bhp) (Option 2) as shown in Table 1318.4.2.(1) This includes supply fans, return/relief fans, exhaust fans, and fan-powered terminal units associated with systems providing heating or cooling capability.

Exceptions:

1. **Hospital, vivarium and laboratory systems that utilize flow control devices on exhaust and/or return to maintain space pressure relationships necessary for occupant health and safety or environmental control may use variable-volume fan power limitation.**
2. **Individual exhaust fans with motor nameplate horsepower of 1 hp or less.**

TABLE 1318.4.2(1)
FAN POWER LIMITATION[1]

	Limit	Constant Volume	Variable Volume
Option 1 Motor Nameplate hp	Allowable Nameplate Motor hp	$hp \leq CFM_S \cdot 0.0011$	$hp \leq CFM_S \cdot 0.0015$
Option 2 Fan System Input bhp	Allowable Fan System Input bhp	$bhp \leq CFM_S \cdot 0.00094 + A$	$bhp \leq CFM_S \cdot 0.0013 + A$

[1] where:

CFM = the maximum design supply airflow rate to conditioned spaces served by the system in cubic feet per minute.
hp = the maximum combined motor nameplate horsepower.
bhp = the maximum combined fan brake horsepower
A = sum of (PD x CFM_D/4131)

where:

PD = each applicable pressure drop from Table 1318.4.2(2) in inches w.c.
CFM_D = the design airflow through each applicable device from Table 1318.4.2(2) in cubic feet per minute.

TABLE 1318.4.2(2)
FAN POWER LIMITATION PRESSURE DROP ADJUSTMENT

Device	Adjustment
Credits:	
Fully ducted return and/or exhaust air systems	0.5 in. w.c. (2.15 in w.c. for laboratory & vivarium systems)
Return and/or exhaust airflow control devices	0.5 in. w.c.
Exhaust filters, scrubbers, or other exhaust treatment	Pressure drop of device calculated at fan system design condition
Particulate Filtration Credit: MERV 9 through 12	0.5 in. w.c.
Particulate Filtration Credit: MERV 13 through 15	0.9 in. w.c.
Particulate Filtration Credit: MERV 16 & greater & electronically enhanced filters	Pressure drop calculated at 2x 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
Heat recovery device, biosafety cabinet	Pressure drop of device at fan system design condition
Evaporative humidifier/cooler in series with another cooling coil	Pressure drop of device at fan system design condition
Sound attenuation section	0.15 in. w.c.
Exhaust system serving fume hoods	0.35 in. w.c.
Laboratory and vivarium exhaust systems in high-rise buildings	0.25 in. w.c./100 ft of vertical duct exceeding 75 feet

1318.4.2.1 Motor nameplate horsepower. For each fan, the selected fan motor shall be no larger than the first available motor size greater than the bhp. The fan bhp must be indicated on the design documents to allow for compliance verification by the building official.

Exceptions:

1. For fans less than 6 bhp, where the first available motor larger than the bhp has a nameplate rating within 50 percent of the bhp, the next larger nameplate motor size may be selected.
2. For fans 6 bhp and larger, where the first available motor larger than the bhp has a nameplate rating within 30 percent of the bhp, the next larger nameplate motor size may be selected.

Note: Large volume fan systems moved to 1317.11.3.2

~~**1318.4.2.4 Large volume fan systems.** Fan systems over 15,000 (7 m^3/s) cfm that serve single zone areas including but not limited to gymnasiums, cafeterias, auditoriums or warehouses, are required to reduce airflow based on space thermostat heating and cooling demand. A two-speed motor or variable frequency drive shall reduce airflow to a maximum 60 percent of peak airflow or minimum ventilation air requirement as required by Chapter 12, whichever is greater.~~

~~**Exception:** Systems where the function of the supply air is for purposes other than temperature control, such as maintaining specific humidity levels or supplying an exhaust system.~~

1318.4.3 Series fan-powered terminal unit fan motors. Fan motors for series fan-powered terminal units one horsepower or less shall be electronically-commutated motors or shall have a minimum motor efficiency of 70 percent when rated in accordance with NEMA Standard MG 1-2006 at full load rating conditions.

SECTION 1319
RESERVED