providing insights for today's hvac system designer

Engineers Newsletter

volume 44–1

ASHRAE Standard 90.1-2013

HVAC and Power section highlights

This newsletter is intended to help readers interpret and apply the new requirements in Standard 90.1-2013. Unlike the 2010 version, the 2013 version has significant changes to the building envelope and energy modeling requirements, however for brevity, only the more significant changes to the HVAC and power requirements are discussed in this newsletter.

Scope

The scope of ASHRAE Standard 90.1 widened slightly in this 2013 version. It is still focused on commercial and high-rise (≥4 stories) residential buildings. It still applies to both new buildings and renovations of existing buildings. New requirements have been added to address refrigeration equipment, such as walk-in coolers and freezers, and refrigerated display cases.

Progress by version. The goal of the 2010 version was to create a cost justified path to 30 percent energy cost savings for the whole building, compared to its 2004 predecessor. *Whole building* meant that the savings calculation included energy uses not restricted by 90.1, effectively reducing the percent savings of the covered building components and equipment. The calculation was weight-averaged by climate zone and building type. On average, 90.1-2010 came close to achieving that goal, with 25 percent energy cost savings for the whole building.

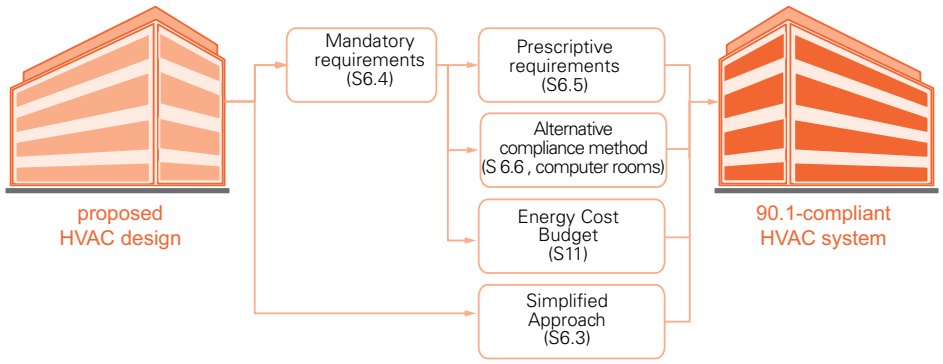
Recent modeling funded by ASHRAE and the U.S. Department of Energy estimated that buildings following the 2013 version will save, on average, 38 percent of their whole building energy cost compared to those complying with the 2004 version. The analysis also calculated energy use by building type and climate zone, in terms of kBtu/ft^2. (See sidebar for limitations of comparing this value for the same type of building constructed in different locations.)

Compliance paths. There are multiple paths to compliance with Standard 90.1 (Figure 1). All buildings must meet the mandatory requirements, which are located in Section "x.4" of each chapter. For example, the mandatory provisions in the HVAC chapter are in Section 6.4, and in Section 8.4 of the Power chapter.

Site Energy Use Intensity (EUI)

One of the challenges with using site EUI (kBtu/ft^2) as a measure of energy use is fuel selection. Different fuels have a different impact on site EUI, regardless of how efficiently the process or system uses the energy. This would be a problem if our energy codes were based on site EUI.

Figure 1. Compliance path for Section 6 of ASHRAE Standard 90.1-2013



Mandatory Requirements

Mandatory requirements are just that: mandatory. They cannot be traded off using any of the alternative compliance paths, such as the Energy Cost Budget (Chapter 11) or the new alternative compliance path for computer room systems (Section 6.6).

Many of the changes to the mandatory requirements in the HVAC chapter (Section 6.4) are summarized in the following section.

Equipment Efficiency Changes.
The mandatory minimum equipment efficiency levels were changed for several classes of equipment, including:

- **Air-cooled air-conditioners.** More stringent requirements for packaged units (Table 1).
- **Air-to-air heat pumps**. See Table 2.
- **Chillers**. Centrifugal chillers optimized for non-standard conditions use formulas to calculate requirements for kW/ton and IPLV (spreadsheet available from ASHRAE.org). See Tables 3 and 4.
- **Commercial refrigeration**. New requirements to cover this type of equipment.
- **Computer room units**. Efficiency requirements modified following a change to the test procedure.
- **Condensing units**. See Table 5.
- **Cooling towers**. The required efficiency for open-circuit towers increased by about 5 percent.
- **Escalators and moving walks**. New requirement to reduce speed when no passengers are present (Section 10.4.4).
- **Evaporative condensers**. New requirements to cover this type of equipment.
- **Motors**. More stringent requirements for integral hp motors and new requirements for fractional hp motors (Chapter 10). This affects general-purpose designs A and B up to 600 V, general-purpose subtypes 1 and 2 up to 600 V, and small motors down to ¼ hp.

Table 1. Air-cooled air conditioners

class	size	heat type	sub-category	efficiency-old	efficiency-new
Air conditioners, air-cooled	< 65,000 Btu/h (3-phase)	all	split system	13.0 SEER	13.0 SEER (no change)
		all	single package	~~13.0 SEER~~	14.0 SEER (1/1/2015)
	≥ 65,000 and < 135,000 Btu/h	none/electric	split and single package	11.2 EER ~~11.4 IEER~~	11.2 EER 12.9 IEER (1/1/2016)
		other	split and single package	11.0 EER ~~11.2 IEER~~	11.0 EER 12.7 IEER (1/1/2016)
	≥ 35,000 and < 240,000 Btu/h	none/electric	split and single package	11.0 EER ~~11.2 IEER~~	11.0 EER 12.4 IEER (1/1/2016)
		other	split and single package	10.8 EER ~~11.0 IEER~~	10.8 EER 12.2 IEER (1/1/2016)
	≥ 240,000 and < 760,000 Btu/h	none/electric	split and single package	10.0 EER ~~10.1 IEER~~	10.0 EER 11.6 IEER (1/1/2016)
		other	split and single package	9.8 EER ~~9.9 IEER~~	9.8 EER 11.4 IEER (1/1/2016)
	≥ 760,000 and	none/electric	split and single package	9.7 EER ~~9.8 IEER~~	9.7 EER 11.2 IEER (1/1/2016)
		other	split and single package	9.5 EER ~~9.6 IEER~~	9.5 EER 11.0 IEER (1/1/2016)

Table 2. Air-to-air heat pumps

class	size	heat type	sub-category	efficiency-old	efficiency-new
Heat pump, air-cooled	< 65,000 Btu/h	all	split system	~~13.0 SEER (clg)~~ ~~7.7 HSPF (htg)~~	14.0 SEER (clg) 8.2 HSPF (htg)
		all	single package	~~13.0 SEER (clg)~~ ~~7.7 HSPF (htg)~~	14.0 SEER (clg) 8.0 HSPF (htg)
	≥ 65,000 and < 135,000 Btu/h	none/electric	split and single package	11.0 EER ~~11.2 IEER~~	11.0 EER 12.2 IEER (1/1/2016)
		other	split and single package	10.8 EER ~~11.0 IEER~~	10.8 EER 12.0 IEER (1/1/2016)
	≥ 135,000 and < 240,000 Btu/h	none/electric	split and single package	10.6 EER ~~10.7 IEER~~	10.6 EER 11.6 IEER (1/1/2016)
		other	split and single package	10.4 EER ~~10.5 IEER~~	10.4 EER 11.4 IEER (1/1/2016)
	≥ 240,000 Btu/h	none/electric	split and single package	9.5 EER ~~9.6 IEER~~	9.5 EER 10.6 IEER (1/1/2016)
		other	split and single package	9.3 EER ~~9.4 IEER~~	9.3 EER 10.4 IEER (1/1/2016)

Table 3. Positive displacement chillers

class	size	efficiency-old		efficiency-new	
		Path A	Path B	Path A	Path B
Air-cooled chillers	< 150 tons	~~9.562 EER~~ ~~12.50 IPLV~~	N/A	10.10 EER 13.70 IPLV	9.70 EER 15.80 IPLV)
	≥ 150 tons	~~9.562 EER~~ ~~12.750 IPLV~~	N/A	10.10 EER 14.00 IPLV	9.70 EER 16.10 IPLV)
Water-cooled positive displacement	< 75 tons	~~0.780 kW/ton~~ ~~0.630 IPLV~~	~~0.800 kW/ton~~ ~~0.600 IPLV~~	0.750 kW/ton 0.600 IPLV	0.780 kW/ton 0.500 IPLV
	≥ 75 tons and < 150 tons	~~0.775 kW/ton~~ ~~0.615 IPLV~~	~~0.790 kW/ton~~ ~~0.586 IPLV~~	0.720 kW/ton 0.560 IPLV	0.750 kW/ton 0.490 IPLV)
	≥ 150 tons and < 300 tons	~~0.780 kW/ton~~ ~~0.630 IPLV~~	~~0.718 kW/ton~~ ~~0.540 IPLV~~	0.660 kW/ton 0.540 IPLV	0.680 kW/ton 0.440 IPLV
	≥ 300 tons and < 600 tons	~~0.620 kW/ton~~ ~~0.540 IPLV~~	~~0.639 kW/ton~~ ~~0.490 IPLV~~	0.610 kW/ton 0.520 IPLV	0.625 kW/ton 0.410 IPLV
	≥ 600 tons			0.560 kW/ton 0.500 IPLV	0.585 kW/ton 0.380 IPLV

- **Single-package vertical units (SPVUs).** In addition to Table 6, a new table was added for a special class of SPVUs, which can only be used in certain replacement situations (Table 7).
- **Water-cooled air-conditioners.** See Table 8.
- **Water-source heat pumps.** See Table 9.

Some of the minimum efficiency requirements have a future effective date, allowing manufacturers time to adjust product designs and production.

Direct digital control (DDC) requirement thresholds. One of the more significant changes in the 2013 standard is the requirement for direct digital controls (DDC), triggered by certain thresholds and situations. For new buildings with systems that serve more than three zones, DDC is required if 1) an air-handling fan system is 10 bhp or larger, 2) a chilled-water plant is 25 tons or larger, or 3) a hot-water plant is 300 MBh or larger. In existing buildings, the thresholds relate to how much of the building is being changed, and the type of system that is being altered (see Table 10).

Electric power monitoring and reporting (sub-metering). Section 8.4.3.1 is a new section of mandatory requirements for monitoring and reporting electrical data. Energy use of the following systems needs to be monitored separately: HVAC, interior and exterior lighting, and receptacles.

Important things to note:

- Up to 10 percent of the load for each of the subcategories may be miscategorized.
- Buildings with tenants must monitor each tenant area separately.
- Data must be recorded at least every 15 minutes, and reported hourly, daily, monthly, and annually.
- Maintain data for at least three years.
- Exceptions: buildings less than 25,000 ft^2, individual tenant spaces less than 10,000 ft^2, dwelling units, residential buildings with less than 10,000 ft^2 of common area, and critical and equipment branches of NEC Article 517.

Table 4. Centrifugal chillers

class	size	efficiency-old		efficiency-new	
Water-cooled centrifugal	< 150 tons	~~0.634 FL~~ ~~0.596 IPLV~~	~~0.639 FL~~ ~~0.450 IPLV~~	0.610 FL 0.550 IPLV	0.695 FL 0.440 IPLV
	≥ 150 tons and < 300 tons	~~0.634 FL~~ ~~0.596 IPLV~~	~~0.639 FL~~ ~~0.450 IPLV~~	0.610 FL 0.550 IPLV	0.635 FL 0.400 IPLV
	≥ 300 tons and < 400 tons	~~0.576 FL~~ ~~0.549 IPLV~~	~~0.600 FL~~ ~~0.400 IPLV~~	0.560 FL 0.520 IPLV	0.595 FL 0.390 IPLV
	≥ 400 tons and < 600 tons	~~0.576 FL~~ ~~0.549 IPLV~~	~~0.600 FL~~ ~~0.400 IPLV~~	0.560 FL 0.500 IPLV	0.585 FL 0.380 IPLV
	> 600 tons	~~0.570 FL~~ ~~0.539 IPLV~~	~~0.590 FL~~ ~~0.400 IPLV~~	0.560 FL 0.500 IPLV	0.585 FL 0.380 IPLV

Table 5. Condensing units

class	size	efficiency-old	efficiency-new
Air-cooled	≥ 135,000 Btu/h	~~10.1 EER~~ ~~11.4 IEER~~	10.5 EER 11.8 IEER
Water-cooled	≥ 135,000 Btu/h	~~13.1 EER~~ ~~13.6 IEER~~	13.5 EER 14.0 IEER
Evaporatively-cooled	≥ 135,000 Btu/h	~~13.1 EER~~ ~~13.6 IEER~~	13.5 EER 14.0 IEER

Table 6. Single-package vertical units (SPVUs)

class	size	outdoor air (db/wb)	efficiency-old	efficiency-new
Single-package vertical air-conditioner or heat pump (cooling mode)	< 65,000 Btu/h	95°F/ 75°F	~~9.0 EER~~	10.0 EER
	≥ 65,000 and < 135,000 Btu/h	95°F/ 75°F	~~8.9 EER~~	10.0 EER
	≥ 135,000 and < 240,000 Btu/h	95°F/ 75°F	~~8.6 EER~~	10.0 EER
Single-package vertical heat pump (heating mode)	< 135,000 Btu/h	47°F/ 43°F (htg)	3.0 COP (htg)	3.0 COP (no change)
	≥ 135,000 and < 240,000 Btu/h		~~2.9 COP (htg)~~	3.0 COP (htg)
New category added for replacement units (see Table 7)				

Table 7. Special* single-package vertical units (SPVUs)

class	size	outdoor air (db/wb)	efficiency - old	efficiency-new
Single-package vertical air-conditioner or heat pump (cooling mode) *non-weathered space constrained*	≤ 30,000Btu/h	95°F/ 75°F	~~9.0 EER~~	9.2 EER
	> 30,000 and ≤ 36,000 Btu/h	95°F/ 75°F	9.0 EER	9.0 EER (no change)
Single-package vertical air-conditioner or heat pump (heating mode) *non-weathered space constrained*	≤ 36,000 Btu/h	47°F/ 43°F (htg)	3.0 COP (htg)	3.0 COP (htg) (no change)

**"special" means indoor use, requires an opening in an exterior wall with existing sleeve that is space limited, and is for replacement applications only, duly marked on the equipment

Energy monitoring and reporting, all utilities. Building level energy use data must be collected and reported for electric and non-electric utilities also (Section 10.4.5.2). The energy data is to be recorded at least every 60 minutes, reported and retained for three years. Exceptions: buildings or additions less than 25,000 ft^2, individual tenant spaces less than 10,000 ft^2, dwelling units, residential buildings with less than 10,000 ft^2 of common area, and fuel used for on-site emergency equipment.

Humidity control. Section 6.4.3.6 now prohibits the use of fossil fuels and electricity for humidification above 30 percent RH and dehumidification to 60 percent RH, except in special circumstances. Recovered or site solar energy must be used instead. Exceptions are made for:

- Systems that use desiccants with direct evaporative cooling in series.
- Systems that serve space types with their own code requirements or accreditation standards for humidity control, such as museums, hospitals, vivariums, pharmacies, and supermarkets. For such systems, the deadband must be at least ±10 percent RH. In zones where tighter control is required by code or accreditation standard (±5 percent RH), new energy may be used.

This new section also prevents simultaneous humidification and dehumidification.

Demand-controlled ventilation (DCV). The occupancy threshold for DCV was reduced from greater than 40 people per 1000 ft^2 to 25 or more people per 1000 ft^2, with exemptions for certain occupancy classes. This change will expand the occupancies where DCV is required. Based on Standard 62.1 default densities, new spaces that would be required to have DCV include: classrooms, music/dance class, lobbies, office reception, museum, mall commons, gym and health club, daycare, computer labs, and break rooms.

Exempt occupancies include correctional cells, daycare sickrooms, science labs, barber, beauty & nail salons, and bowling alley seating.

Table 8. Water-cooled air conditioners

class	size	heat type	sub-category	efficiency-old	efficiency-new
Air conditioners, water cooled	< 65,000 Btu/h	all	split and single package	12.1 EER 12.3 IEER	12.1 EER 12.3 IEER (no change)
	≥ 65,000 and < 135,000 Btu/h	none/electric	split and single package	12.1 EER ~~12.3 IEER~~	12.1 EER 13.9 IEER (1/1/2016)
		other	split and single package	11.9 EER ~~12.1 IEER~~	11.9 EER 13.7 IEER (1/1/2016)
	≥ 135,000 and < 240,000 Btu/h	none/electric	split and single package	12.5 EER ~~12.5 IEER~~	12.5 EER 13.9 IEER (1/1/2016)
		other	split and single package	12.3 EER ~~12.5 IEER~~	12.3 EER 13.7 IEER (1/1/2016)
	≥ 240,000 and < 760,000 Btu/h	none/electric	split and single package	12.4 EER ~~12.6 IEER~~	12.4 EER 13.6 IEER (1/1/2016)
		other	split and single package	12.2 EER ~~12.4 IEER~~	12.2 EER 13.4 IEER (1/1/2016)
	≥ 760,000	none/electric	split and single package	12.2 EER ~~12.4 IEER~~	12.2 EER 13.5 IEER (1/1/2016)
		other	split and single package	12.0 EER ~~12.2 IEER~~	12.0 EER 13.3 IEER (1/1/2016)

Table 9. Water-to-air heat pumps

class	size	entering water	efficiency-old	efficiency-new
Water-air: water loop	< 17,000 Btu/h	86°F (clg) 68°F (htg)	~~11.2 EER (clg)~~ ~~4.2 COP (htg)~~	12.2 EER (clg) 4.3 COP (htg)
	> 17,000 and < 135,000 Btu/h	86°F (clg) 68°F (htg)	~~12.0 EER (clg)~~ ~~4.2 COP (htg)~~	13.0 EER (clg) 4.3 COP (htg)
Water-air: ground water	< 135,000 Btu/h	59°F (clg) 50°F (htg)	~~16.2 EER (clg)~~ ~~3.6 COP (htg)~~	18.0 EER (clg) 3.7 COP (htg)
Brine-air: ground loop	< 135,000 Btu/h	77°F (clg) 32°F (htg)	~~13.4 EER (clg)~~ ~~3.1 COP (htg)~~	14.1 EER (clg) 3.2 COP (htg)

Table 10. DDC applications and qualifications

Bldg. status	application	qualification
New building	air-handling system and all zones served by the system	individual systems supplying morethan three zones and with fan system bhp ≥ 10 hp
	chilled-water plant and all coils and terminal units served by the system	individual systems supplying more than three zones and with design cooling capacity ≥ 300,000 Btu/h
	hot-water plant and all coils and terminal units served by the system	individual systems supplying more than three zones and with heating capacity ≥ 300,000 Btu/h
Alteration or addition	zone terminal unit such as a VAV box	where existing zones served by the same air-handling, chilled-water, or hot-water system have DDC
	air-handling system or fan coil	where existing air-handling system(s) and fan-coil(s) served by the same chilled-or hot-water plant have DDC
	new air-handling system and all new zones served by the system	individual systems with fan system bhp ≥ 10 hp and supplying more than three zones and more than 75 percent of zones are new
	new or upgraded chilled-water plant	where all chillers are new and plant design cooling capacity is ≥ 300,000 Btu/h
	new or upgraded hot-water plant	where all boilers are new and plant design heating capacity is ≥ 300,000 Btu/h

The requirement can be met with whichever DCV method is appropriate, e.g. scheduling, occupancy sensing, CO_2 measurement.

Setback controls. This section now requires the system to maintain an adjustable space temperature at least 10°F below the occupied heating setpoint and at least 5°F above the occupied cooling setpoint. Radiant heating systems are treated slightly differently than in the past: they must setback at least 4°F below the occupied heating setpoint.

Optimum start. Previously this was only required for large systems. The 2013 version removed the 10,000 cfm threshold, and now requires optimum start on any system that must be equipped with both setback controls (not continually operated and 15,000 Btu/h or larger) and DDC (see page 4 for DDC threshold).

A provision was added to require that outdoor air temperature be used in the optimization sequence so that it's less likely to be disabled due to not responding quickly enough during extreme weather. Optimum start must consider, at a minimum, the difference between the current space temperature and occupied setpoint, outdoor air temperature, and time to scheduled occupancy.

This requirement was expanded beyond air-based systems so that convection and radiant systems are included. Mass radiant floor slabs must use floor temperature in the optimum start algorithm also.

Prescriptive Requirements

Meeting all the prescriptive requirements, in addition to the Mandatory requirements, is one of the compliance paths in the Standard (Figure 2). Some, or potentially all, of these prescriptive requirements can be avoided if the user elects to use either the Energy Cost Budget Method (Chapter 11) or the new alternative compliance path for computer room systems (Section 6.6).

Many of the changes to the prescriptive requirements in the HVAC chapter (Section 6.5) are summarized below:

Fan Efficiency Grade (FEG). FEG is a new designation introduced by AMCA that seeks to enable selection and application of more-efficient fans. Some fans are better suited than others for a given application. Fans included in equipment listed under Section 6.4.1.1 (such as packaged rooftops, cooling towers, condensers, water-source heat pumps, air-cooled chillers, PTACs, furnaces, and VRF systems) or equipment that bears a third-party seal for air or performance (such as cataloged air-handling units and blower-coils) are exempt from this requirement. FEG67 is the minimum requirement for covered fans, and the selection point must be within 15 percent of peak efficiency. Fan system power limits still apply at the system level.

For more information on fan metrics including FEG, read the 2014 Engineers Newsletter, "FANtastic! A Closer Look at Fan Efficiency Metrics," vol. 43-3 (2014). Visit trane.com/EN

Cooling towers. New requirements for cooling towers relate to how variable-speed fans must operate. Multiple cell heat rejection equipment with variable-speed drives must operate the maximum number of fans and control all fans to the same speed instead of staging them, subject to manufacturer limits for minimum speed.

Open-circuit cooling towers used on water-cooled chiller systems that have multiple or variable-speed condenser-water pumps must be designed so that all open-circuit tower cells can be run in parallel with the larger of:

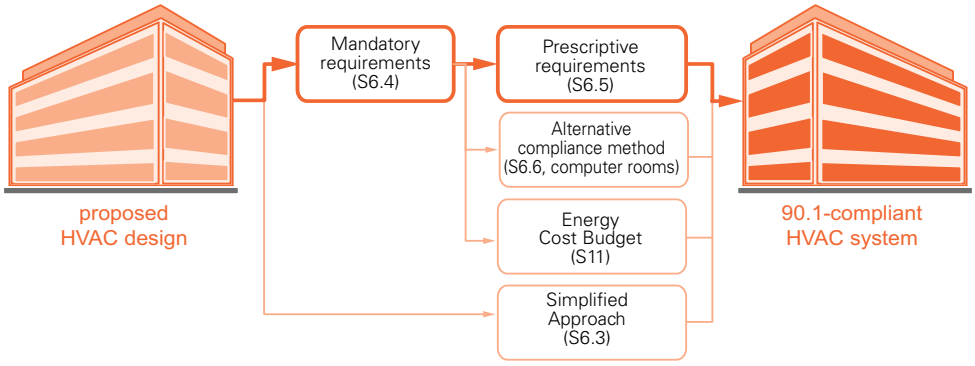
- the flow produced by the smallest pump at its minimum expected flow rate, or
- 50 percent of the design flow for the cell.

Boilers. Improved boiler heating turndown is required, depending on the capacity of the heating system.

This turndown may be achieved through multiple, single-input boilers, one or more modulating boilers, or a combination.

Though located under Section 6.5.3, which covers systems with total fan system motor nameplate of 5 hp and larger, fan airflow control was not intended to apply only to larger systems. Table 6.5.3.2.1 covers DX cooling system fan-motors of any size and chilled-water and evaporative-cooling system fan-motors down to ¼ hp. The error is currently in the process of being corrected by an addendum, though not yet published.

Figure 2. Mandatory plus prescriptive requirements



Fan airflow control (often referred to as "single-zone VAV control") was added as a mandatory requirement in the 2010 version. In the 2013 version, the former mandatory requirement was replaced by an expanded, prescriptive requirement that applies to DX, chilled-water, and evaporative cooling equipment.

If the cooling equipment controls capacity directly based on space temperature, it shall have at least two stages of fan airflow control, with low speed not exceeding 66 percent of full speed.

All other cooling equipment, including that which controls space temperature by modulating airflow to the space, shall have modulating fan control, with a minimum speed not exceeding 50 percent of full speed.

In addition, at least two fan speeds are required during air economizer operation.

Compressor stages for integrated economizer control. This was added in 2013, to limit "fighting" between the air economizer and the compressor once the economizer can no longer offset the entire cooling load. The effect of this change is far reaching, particularly for smaller units that haven't traditionally had as many stages of cooling capacity. Some manufacturers have elected to apply variable-speed or variable-capacity compressors in more products to meet this requirement. Table 11 shows the required minimum compressor displacement and number of stages based on the cooling capacity.

Fractional motors. This equipment entered Standard 90.1 in two ways this cycle: in the previously mentioned Chapter 10 mandatory section, and through Section 6.5.3.5 which requires that motors smaller than 1 hp (down to 1/12 hp) be either electronically-commutated or at least 70 percent efficient. Fans that only operate when providing heating are exempted, because the motor heat offsets other heat energy that would otherwise be necessary. Motors must be able to have their speed adjusted for either balancing or remote control. (Belt-driven fans may use sheave adjustments.) Motors installed in equipment that is certified per Section 6.4.1, and motors covered by Tables 10.8-4 or 10.8-5 (generally more stringent but skipping several sizes) are also exempted from this requirement.

Table 11. DX cooling stage requirements for units with air economizer

rated capacity	control type	minimum no. of cooling changes	minimum compressor displacement	effective date
≥ 75,000 Btu/h	capacity control based on space temp.	2 stages	no requirement	1/1/2014
≥ 65,000 Btu/h	capacity control based on space temp.	2 stages	no requirement	1/1/2016
≥ 65,000 Btu/h and < 240,000 Btu/h	modulating airflow to control space temp.	3 stages	≤ 35% of full load	1/1/2014
≥ 240,000 Btu/h	modulating airflow to control space temp.	4 stages	≤ 25% of full load	1/1/2014

Simultaneous heating and cooling (including humidification and dehumidification). The current wording of Standard 90.1 limits simultaneous heating and cooling within the sections on zone controls, hydronic systems, dehumidification systems, and humidification systems.

Zone level VAV reheating control is required to use "dual maximum" control sequence (Figure 3), if the system has DDC controls. (See DDC requirement thresholds on page 4.)

Preheat coils must be controlled so that they are turned off whenever mechanical cooling or economizer operation is occurring.

Automatic shut-off valves are required for humidifiers with preheating jackets, as is insulation (R-0-5) on dispersion tube hot surfaces located in the airstream.

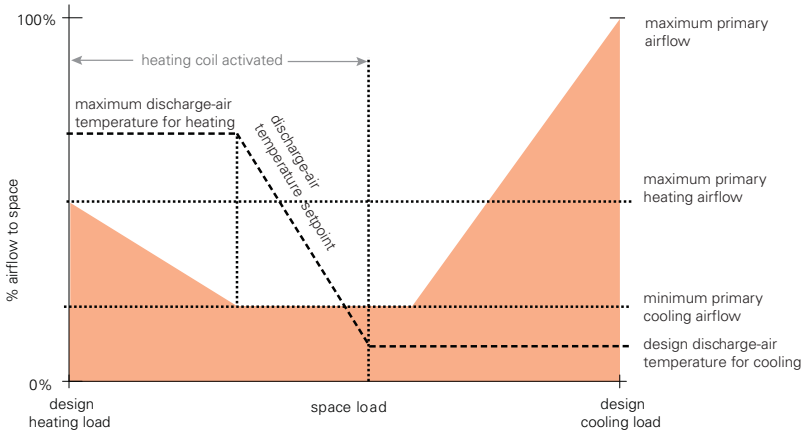
Fan system power limit. Single-zone variable-volume systems are now required to comply with the more stringent constant-volume fan power limit in Section 6.5.3.1, because they typically have much less ductwork and few or no pressure control devices. Other minor changes to the system fan power limit include:

- No sound attenuation credit is given unless the space NC is 35 or less.
- Deduction for systems that do not have a central cooling device.
- Deduction for systems that do not have a central heating device.

Door switches. The intent of the new requirements for interlocking door switches with heating and cooling operation is to reduce energy wasted when doors are left open and the outdoor temperature is too warm or too cold. This is typically accomplished with a mechanical switch that integrates the HVAC system operation.

This section requires turning off zone heating (or resetting the zone setpoint to 55°F) or the zone cooling (or resetting the setpoint to 90°F), if an exterior door in that zone is left open for 5 minutes.

Figure 3. Dual maximum VAV control sequence



Exceptions include:

- building entries with automatic closing devices,
- any space without a thermostat,
- alterations to existing buildings,
- loading docks, or
- if the outdoor temperature is below the space temperature during cooling mode.

Exhaust air energy recovery. The 2013 version has additional requirements for energy recovery on systems in climate zones 1A, 2A, 3A, 4A, 5A, 6A, 7 and 8 (Table 12). The requirements expand the requirement for exhaust air energy recovery to systems with as little as 10 percent outdoor air. Buildings with continuous operation of the ventilation system (8,000 hours per year) now follow a second table which further expands the requirements.

Economizers. The 2010 version significantly expanded the requirement for economizers to all climate zones except 1A. The 2013 version incorporates changes to the allowable economizer control types, and adds new requirements for sensor accuracy and integrated economizer control.

You may trade off an economizer by using higher performance equipment (Table 13).

We will be publishing a follow-up EN later this year that specifically addresses the economizer requirements.

Table 13. Eliminate required economizer for comfort cooling by increasing cooling efficiency

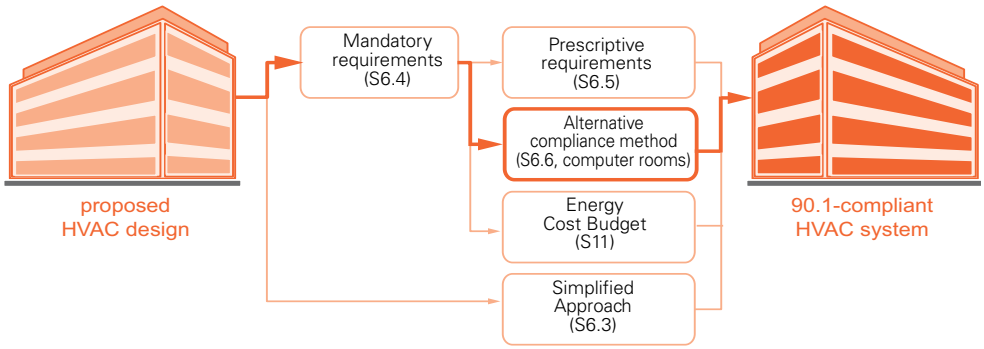
climate zone	efficiency improvement
2A	17%
2B	21%
3A	27%
3B	32%
3C	65%
4A	42%
4B	49%
4C	64%
5A	49%
5B	59%
5C	74%
6A	56%
6B	65%
7	72%
8	77%

Table 12. Exhaust air energy recovery

Ventilation system operating hours < 8000 hours per year								
	% outdoor air at full design airflow rate							
climate zone	≥ 10% and < 20%	≥ 20% and < 30%	≥ 30% and < 40%	≥ 40% and < 50%	≥ 50% and < 60%	≥ 60% and < 70%	≥ 70% and < 80%	≥ 80%
	design supply fan airflow rate (cfm)							
3B, 3C, 4B, 4C, 5B	NR	NR	NR	NR	NR	NR	NR	NR
1B, 2B, 5C	NR	NR	NR	NR	≥ 26000	≥ 12000	≥ 5000	≥ 4000
6B	≥ 28000	≥ 26500	≥ 11000	≥ 5500	≥ 4500	≥ 3500	≥ 2500	≥ 1500
1A, 2A, 3A, 4A, 5A, 6A	≥ 26000	≥ 16000	≥ 5500	≥ 4500	≥ 3500	≥ 2000	≥ 1000	≥ 0
7, 8	≥ 4500	≥ 4000	≥ 2500	≥ 1000	≥ 0	≥ 0	≥0	≥ 0
Ventilation system operating ≥ 8000 hours per year								
	% outdoor air at full design airflow rate							
climate zone	≥ 10% and < 20%	≥ 20% and < 30%	≥ 30% and < 40%	≥ 40% and < 50%	≥ 50% and < 60%	≥ 60% and < 70%	≥ 70% and < 80%	≥ 80%
	design supply fan airflow rate (cfm)							
3C	NR	NR	NR	NR	NR	NR	NR	NR
1B, 2B, 3B, 4C, 5C	NR	≥ 19500	≥ 9000	≥ 5000	≥ 4000	≥ 3000	≥ 1500	> 0
1A, 2A, 3A, 4B, 5B	≥ 2500	≥ 2000	≥ 1000	≥ 500	> 0	> 0	> 0	> 0
4A, 5A, 6A, 6B, 7, 8	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0

Economizer humidification system impact. While there has always been a section on the economizer's heating system impact, a new requirement related to humidification system impact was added in the 2013 version. The use of a water economizer is required if the systems uses hydronic cooling and includes a humidification system that is designed to maintain zone humidity higher than 35°F dewpoint.

Figure 4. Alternative compliance path (new)



Alternative Compliance Path

Computer rooms and data centers are included in the scope of Standard 90.1-2013, as they were in the 2010 version. But the 2013 version added an alternative compliance path (Section 6.6) for computer room systems, which includes data centers, based on power use effectiveness (PUE). This is an alternative to complying with the prescriptive requirements (Section 6.5). The mandatory requirements still apply (Figure 4).

The PUE compliance path:

- Is climate specific,
- Allows the use of full load PUE_0 or annualized PUE_1, and
- Was derived from full-year analysis of annualized energy use.

The maximum allowed PUE values were developed from energy simulations that use both water-cooled chillers with water economizers and air-cooled chillers with air economizers (no humidification); and setting the PUE to be equivalent to the less stringent of the two. The data centers were modeled to meet the prescriptive requirements in Section 6.5. The PUE values for all climate zones are achievable by either of these conventional system types, but any system design that does not exceed the maximum PUE is permitted.

Table 16. Maximun PUE for computer room systems

climate zone	PUE[a]	climate zone	PUE[a]	climate zone	PUE[a]
1A	1.51	1B	1.53		
2A	1.49	2B	1.45		
3A	1.41	3B	1.42	3C	1.39
4A	1.36	4B	1.38	4C	1.38
5A	1.36	5B	1.33	5C	1.36
6A	1.34	6B	1.33		
7	1.32				
8	1.30				

[a]PUE_0 and PUE_1 shall not include energy for battery charging

Closing

In the September 26, 2014 publication of the Federal Register, the U.S. Department of Energy published its final determination stating that it has found ASHRAE Standard 90.1-2013 to improve building energy efficiency compared to Standard 90.1-2010. As a result, states are "required to certify that they have reviewed the provisions of their commercial building code regarding energy efficiency, and, as necessary, updated their codes to meet or exceed Standard 90.1-2013."

In late 2014, the International Code Council published the 2015 International Energy Conservation Code (IECC), which specifically cites Standard 90.1-2013. As of this publication, the 2015 IECC has already been adopted as a model code by several jurisdictions.

Many changes to the HVAC and Power sections within Standard 90.1-2013 may cause system and equipment redesigns. The increasing focus on controls means that "business as usual" may not be adequate-or even in compliance with local energy codes.

There are numerous changes throughout the new version of 90.1. Standard and red-line (indicating specific changes) copies of the standard can be purchased from the ASHRAE Bookstore. The standard remains in continuous maintenance, which means that changes will continue to be made in an effort to reduce building energy cost. Visit the ASHRAE website to view Standard 90.1 addenda, addenda drafts up for public review, and errata.

By Susanna Hanson, Trane. You can find this and previous issues of the Engineers Newsletter at www.trane.com/engineersnewsletter. To comment, e-mail us at ENL@trane.com.

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References

[1] American Society of Heating, Refrigerating, and Air-Conditioning Engineers. 2010 ANSI/ASHRAE/IESNA Standard 90.1-2010: *Energy Standard for Buildings Except Low-Rise Residential Buildings*. Atlanta, GA: ASHRAE.

[2] American Society of Heating, Refrigerating, and Air-Conditioning Engineers. 2013. ANSI/ASHRAE/IESNA Standard 90.1-2013: *Energy Standard for Buildings Except Low-Rise Residential Buildings*. Atlanta, GA: ASHRAE.

[3] ASHRAE Standard 90.1-2013 User's Manual. Atlanta, GA: ASHRAE. Available at www.ashrae.org/bookstore.

[4] Energy Efficiency and Renewable Energy Office. *Notice of Determination: Determination Regarding Energy Efficiency Improvements in ANSI/ASHRAE/IES Standard 90.1-2013: Energy Standard for Buildings, Except Low-Rise Residential Buildings*. Federal Register. September 2014. Article available at https://www.federalregister.gov/articles/2014/09/26/2014-22882/determination-regarding-energy-efficiency-improvements-in-ansiashraeies-standard-901-2013-energy

[5] 2015 *International Energy Conservation Code*. International Code Council, Washington, D.C. ICC. 2014.

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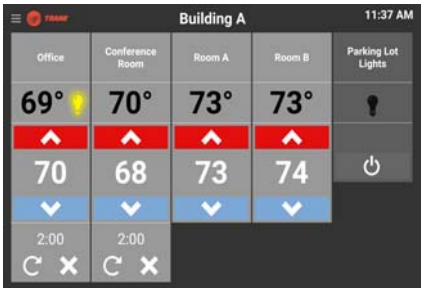

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Chilled-Water VAV Systems discusses the advantages and drawbacks of the system, reviews the various components that make up the system, proposes solutions to common design challenges, explores several system variations, and discusses system-level control.
(SYS-APM008-EN, updated May 2012)

Water-Source and Ground-Source Heat Pump Systems examines chilled-water-system components, configurations, options, and control strategies. The goal is to provide system designers with options they can use to satisfy the building owners' desires. (SYS-APM010-EN, updated November 2013)

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