ASHRAE 90.1 CHANGING FROM 2007 VERSION TO 2010 VERSION

Jerry Sipes, Ph.D., P.E.
Price Industries
Vice President of Engineering

ASHRAE Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings is a document that is in a state of continuous maintenance. That means changes to the standard are ongoing and addendum are submitted for public review and approval frequently. Since the 2004 version, there have been three additional printed/complete versions (2007, 2010, 2013) where all the addendum that have gone through the public review process and been approved are added to the prior release. For example, between the 2007 version and the 2010 version there were over 100 approved addenda 52 of which affect mechanical systems.

Most state code authorities are using one of the complete versions of 90.1 and have differing speeds at which they adopt newer versions. Figure 1 shows the version of the 90.1 standard by state as code in the United States and territories as of March 2014. You can see that the majority of states are using the 2007 version of ASHRAE 90.1 or an equivalent of that version.

Statistics shown courtesy of the Department of Energy, Office of Energy Efficiency & Renewable Energy

Figure 1. Version of ASHRAE 90.1 by state as of March 2014
Figure 2 shows that a significant number of states are moving towards adopting the 2010 version of ASHRAE 90.1 or an equivalent of that version. This movement is being encouraged by United States government agencies such as the Department of Energy or by state adoption of energy standards required by green building initiatives such as LEED. Surprisingly, there will still be seven states and one territory without a statewide energy code.

As mentioned earlier, there were 52 addenda that affect mechanical systems. There were other significant changes to the overall scope, lighting, building envelope, and energy modeling sections of the ASHRAE 90.1 standard which need to be evaluated by the designer in the states adopting the 2010 version. The addenda can be grouped in several ways, but there are only two major groups: 1) equipment efficiency and 2) system design and control requirements.

When the updated addenda are evaluated by energy modeling such as performed by the Pacific Northwest National Laboratory, the simulations of 16 building types in 17 climate zones indicated that the buildings conforming to 90.1-2010 on average will consume between 25.6% (including plug loads) and 32.7% (not including plug loads) less energy than the same buildings conforming to the 90.1-2004 standard.

The scope of 90.1-2010 was expanded to include “new equipment or building systems specifically identified in the Standard that are part of industrial or manufacturing processes.” One process specifically identified as part of the scope of 90.1-2010 is computer rooms. In prior versions, they were exempt from the prescriptive economizer requirements but now must conform.

Please note that the information detailing the changes by addendum may not be complete and, due to the complexity of the 90.1 standard, should be evaluated as the changes pertain to the whole ASHRAE 90.1 document. The following information is presented in an effort to allow the reader to see the changes by topic and is not intended to be all encompassing as to the changes between the 2007 and 2010 versions of ASHRAE 90.1.
CHANGES IN EQUIPMENT EFFICIENCY REQUIREMENTS

Single Zone VAV

- **Addendum N:**
  - Air handling and fan coil units with chilled-water cooling coils and supply fans with motors greater than or equal to 5 hp shall have their supply fans supplied by two-speed motors or variable speed drives. At cooling demands at 50% or less, design load shall be able to reduce the airflow to the greater of either half full fan speed or the volume of air required to meet the ventilation requirements of ASHRAE 62.1.
  - Unitary equipment 110,000 Btu/h or larger that serve a single zone at cooling loads below 50% of design load must provide a means to reduce fan speed the greater of two-thirds full fan speed or to the volume of outdoor air required to meet the ventilation requirements of ASHRAE 62.1.
  - Discharge air temperature sensors may be required.

Variable-refrigerant-flow (VRF)

- **Addendum CP:** VRF (multi-split) now has efficiency requirements. VRF is defined as an engineered direct expansion (DX) multi-split system incorporating at least one variable capacity compressor distributing refrigerant through a piping network to multiple indoor fan coil units, each capable of individual zone temperature control, through integral zone temperature control devices and common communications networks. Variable refrigerant flow utilizes three or more steps of control on common, inter-connecting piping.
  - There is a special category for VRF systems that use heat recovery in a refrigerant-to-water heat exchanger.
  - Due to the large number of equipment sizes and minimum efficiencies, the reader is directed to ASHRAE 90.1-2010 Table 6.8.1 to find the minimum allowable efficiency by applicable VRF equipment size and type.

Chillers

- **Addendum M:**
  - There are now two paths for chiller compliance. The first has a more stringent Integrated Part Load Value (IPLV). The other has a more stringent full-load kW/ton. Both paths have a part-load and a full-load metric that must be satisfied.
  - Addendum M also combines all water-cooled positive displacement chillers into one category and adds a new size category for centrifugal chillers at or above 600 tons.
  - The air cooled chiller without condenser equipment category has been eliminated. They must now be rated with matching condensers.
  - **Addendum BL:** This addendum expanded the scope for chillers in ASHRAE 90.1.
    - Efficiency levels must take into account any glycol present in the water. It is not uncommon for designers to add glycol (or brine) to the water in cold climates without taking into account the degradation of performance for the chiller. Chillers are tested using only water in the AHRI 550/590 test standards. Efficiency for chillers must meet the values in Table 6.8.1C using water as the test fluid.
    - Centrifugal chillers are covered by 90.1 if they:
      - Have 20 to 80°F lift (condenser leaving minus evaporator leaving temperatures)
      - Have 36°F or higher leaving evaporator fluid temperature
      - Have 115°F or lower leaving condenser fluid temperature
    This means that the majority of centrifugal chillers will now be subject to 90.1 required levels of efficiency.
Cooling Towers

- **Addendum U: Heat rejection**
  
  There are now limits on the use of centrifugal fans in cooling towers once the tower handles more than 1,100 gpm. Towers with a combined rated capacity of 1,100 gpm or greater at 95°F condenser water return, 85°F condenser water supply, and 75°F outdoor air wet-bulb temperature will be required to use axial fan power levels of 38.2 gpm per horsepower.

  - Open-circuit cooling towers that are ducted or require external sound attenuation are exempted.

- **Addendum A, L:** An additional cooling tower category was added for closed-circuit cooling towers (fluid coolers). Minimum efficiency and certification requirements for both axial and closed-circuit centrifugal fan cooling towers were added to Table 6.8.1G.

Liquid-to-liquid heat exchangers

- **Addendum AD:** There is now a certification program (AHRI 400) referenced for liquid-to-liquid heat exchangers. In the 2010 version, no target efficiency levels were set.

Air conditioners and heat pumps

- **Addendum S:** Integrated energy efficiency ratio (IEER) was introduced for unitary products to replace the integrated part load value (IPLV). IEER is a measure that expresses cooling part-load EER for commercial unitary air conditioning and heat pump equipment on the basis of weighted operation at various load capabilities. IEER replaces the IPLV metric for all commercial unitary products rated above 65,000 Btu/hr.

- **Addendum CO:** Water-cooled and evaporative-cooled air conditioners and heat pumps have higher full-load efficiency requirements.

- **Addendum T and BW:** Packaged terminal air conditioners (PTAC) and packaged terminal heat pumps (PTHP) have new more stringent efficiency requirements. A definition of non-standard size was added to allow standard-size units in new construction to have a different efficiency level than replacement units fitting into existing wall openings.

- **Addendum BG:** Water-to-water heat pumps now fall into the scope of standard 90.1 and have varying efficiency requirements based on application such as water source, ground source, and ground water source to allow the rating temperatures to reflect the application.

Computer room air conditioners (CRAC)

- **Addendum AQ:** CRAC units were added to the scope of standard 90.1.

- **Addendum BU:** ASHRAE Standard 127 is the referenced test procedure. CRAC units will need to meet efficiencies as determined by the Sensible Coefficient of Performance (SCOP). SCOP-127 determines the efficiency for the CRAC that is reflective of the mostly sensible cooling that occurs in computer and data centers. See table 6.8.1H in ASHRAE Standard 90.1-2010.

Motors and transformers

- **Addendum AJ and BK:** There are now federal requirements for integral horsepower general purpose motors to have a premium efficiency as defined by National Electrical Manufacturers Association (NEMA) Standard MG1. Special purpose motors are exempt from the premium efficiency requirement. General purpose electric motors (subtype I and II) are now defined in section 3.2.

- **Addendum O:** Distribution transformers that are low-voltage dry-type are required by 90.1-2010 to meet the 2007 federal requirements.

**CHANGES IN SYSTEM CONTROL AND DESIGN REQUIREMENTS**

Outside Air

**Economizers**

- **Addendum CY (large scale change in standard):**
  
  This addendum adds the requirement for economizer mode for all zones except 1a and 1b. Zone 1a is very humid and hot and 1b is dry.

  - This includes these counties in the United States:
    - Broward, Miami-Dade, and Monroe Counties in Florida
- Hawaii, Kalawao, Kauai, and Maui counties in Hawaii

- An economizer is required for an individual fan coil, zone fan, and coil system or VRF that is 54,000 Btu/h (4.5 tons) or greater.

- The first state of cooling will be economizer until the high-limit cutoff point is reached and then followed by mechanical cooling. The high-limit cutoff point varies by climate zone.

- There are now twelve exemptions to the economizer mode. This is a brief summary of those exemptions. For a complete evaluation of the applicability to your design you should reference the 90.1-2010 standard.

1. Climate zone 1a and 1b (seven counties as listed above).

2. Individual fan coil, zone fan, and coil or VRF less than 54,000 Btu/h (4.5 ton).

3. Systems in cooling mode that have skin loads at 60°F outdoor temperature greater than the zone internal cooling load.

4. Low number of system operating hours (< 20 hours per week).

5. Residential spaces with cooling load < 270,000 Btu/h.

6. Open refrigeration cases that would be affected by outdoor air used for cooling.

7. Systems required by ASHRAE 62.1 to have non-particulate air treatment.

8. Percentage of design airflow that is humidified to over 35°F dew point.
   - 25% for process cooling – not applicable for computer rooms
   - 75% for healthcare spaces

9. Data centers’ loads meeting one of the four requirements:
   - Total design cooling for all computer rooms is less than 3 million Btu/h and the building is not serviced by a centralized chilled water plant.
   - The local code (or water) authority does not allow cooling towers.
   - Room total cooling load as designed is less than 600,000 Btu/h and the building is served by a centralized chilled water plant.
   - Computer room cooling equipment is being added to an existing building and the additional load is less than 600,000 Btu/h.

10. Data centers where 75 percent or greater of the design load is for an essential facility such as Critical Operations, Tier IV design, etc.

11. Economizer may be traded off with an improvement in equipment efficiency (see Table 1).

   - Systems with dedicated outdoor air such as water-source heat pumps and radiant cooling may have difficulty meeting the air economizer requirement as the ductwork is often not sized for the full space cooling load. As an alternative, these types of systems can include heat recovery through heat exchangers or water economizers.

**Addendum BU:** For data centers using water economizers when an outdoor air economizer is required, the expected cooling load at 40°F dry-bulb/35°F wet-bulb must be met with evaporative water economizers or the expected cooling load at 35°F dry-bulb must be met with dry water economizers.
Table 1. (ASHRAE 90.1-2010 Table 6.3.2) Eliminate Required Economizer for Comfort Cooling by Increasing Cooling Efficiency

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Efficiency Improvement*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2a</td>
<td>17%</td>
</tr>
<tr>
<td>2b</td>
<td>21%</td>
</tr>
<tr>
<td>3a</td>
<td>27%</td>
</tr>
<tr>
<td>3b</td>
<td>32%</td>
</tr>
<tr>
<td>3c</td>
<td>65%</td>
</tr>
<tr>
<td>4a</td>
<td>42%</td>
</tr>
<tr>
<td>4b</td>
<td>49%</td>
</tr>
<tr>
<td>4c</td>
<td>64%</td>
</tr>
<tr>
<td>5a</td>
<td>49%</td>
</tr>
<tr>
<td>5b</td>
<td>59%</td>
</tr>
<tr>
<td>5c</td>
<td>74%</td>
</tr>
<tr>
<td>6a</td>
<td>56%</td>
</tr>
<tr>
<td>6b</td>
<td>65%</td>
</tr>
<tr>
<td>7</td>
<td>72%</td>
</tr>
<tr>
<td>8</td>
<td>77%</td>
</tr>
</tbody>
</table>

* If a unit is rated with an IPLV, IEER or SEER then to eliminate the required air or water economizer the minimum cooling efficiency of the HVAC unit must be increased by the percentage shown. If the HVAC unit is only rated with a full load metric like EER or COP cooling then these must be increased by the percentage shown.

**Dampers**
- Addendum CB:
  1. Backdraft dampers are allowed only for exhaust and relief in buildings less than three stories in height.
  2. Backdraft dampers on outdoor air intakes must be protected from wind to limit windblown infiltration through the damper.
  3. Outside air dampers in climate zones 5a, 6, 7, and 8 are required to be low-leak dampers (AMCA Class 1) and motorized.
  4. In climate zones 1, 2 or 3, outside air dampers may be gravity or backdraft type.
  5. In climate zones 4, 5, 6, 7, and 8, for exhaust/relief dampers in one or two story buildings gravity or backdraft dampers are allowed.
  6. In climate zones 4, 5b, and 5c outside air dampers must be motorized.

**Demand Control Ventilation (DCV)**
- Addendum AP: Zones with more than 40 occupants per 1,000 square feet require demand control ventilation. In the 2004 version, the requirement for DCV was spaces with more than 100 occupants per 1,000 square feet.

**Ventilation Reset**
- Addendum CK: Ventilation Reset – Multiple-zone VAV systems using direct digital control (DDC) of individual VAV zone boxes under the control of a central control system shall reduce outdoor air intake in response to changes in system ventilation efficiency as defined by ASHRAE 62.1, Appendix A.
  1. Exemption: if the system requires exhaust air energy recovery (ERV) (Table 6.5.6.1, Standard 90.1).
  2. Exemption: if the total HVAC system motor nameplate hp < 5 hp.
  3. Systems with total design exhaust airflow greater than 70% of total design outdoor air intake.
  4. VAV systems with zonal transfer fans that recirculate air from other zones without directly mixing it with outdoor air, dual-duct dual-fan VAV systems, and VAV systems with fan-powered terminal units.
Exhaust Air Energy Recovery

- Addendum E: Energy Recovery Ventilators
  1. Each fan system shall have an energy recovery system when the system’s supply airflow rate exceeds the values shown in Table 2 (ASHRAE 90.1-2010 Table 6.5.6.1) based on the climate zone and outdoor airflow rate percentage at design conditions.
  2. Energy recovery systems shall have at least a 50% energy recovery effectiveness. 50% energy recovery effectiveness shall mean a change in the enthalpy of the outdoor air supply equal to 50% of the difference between the outdoor air and return air enthalpies at design conditions.
  3. Provision shall be made to bypass or control the energy recovery system to permit air economizer operation as required by ASHRAE 90.1 Section 6.5.1.1.

   a. Exemptions to Section 6.5.1.1
      1. Laboratory systems meeting 6.5.7.2.
      2. Systems serving spaces that are not cooled and are not heated to less than 60°F.
      3. Systems exhausting toxic, flammable paint or corrosive fumes or dust.
      4. Commercial kitchen hoods used for collecting and removing grease vapors and smoke.
      5. Where more than 60% of the outdoor air heating is provided by site-recovered or site solar energy.
      6. Heating energy recovery in climate zones 1 and 2.
      7. Cooling energy recovery in climate zones 3c, 4c, 5b, 6b, 7, and 8.
      8. Where the largest source of air exhausted at a single location at the building exterior is less than 75% of the design outdoor airflow rate.
      9. Systems requiring dehumidification that employ energy recovery in series with the cooling coil.
     10. Systems expected to operate less than 20 hours per week at the outdoor air percentage covered by Table 6.5.6.1.

Table 2. (ASHRAE 90.1 Table 6.5.6.1) Energy Recovery Requirement

<table>
<thead>
<tr>
<th>Zone</th>
<th>% Outdoor air at full design airflow rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≥ 30% and &lt; 40%</td>
</tr>
<tr>
<td>3b, 3c, 4b, 4c, 5b</td>
<td>NR</td>
</tr>
<tr>
<td>1b, 2b, 5c</td>
<td>NR</td>
</tr>
<tr>
<td>6b</td>
<td>≥ 11000</td>
</tr>
<tr>
<td>1a, 2a, 3a, 4a, 5a, 6a</td>
<td>≥ 5500</td>
</tr>
<tr>
<td>7, 8</td>
<td>≥ 2500</td>
</tr>
</tbody>
</table>

NR – Not Required

Airside

Supply Air Temperature Reset

- Addendum BH: Multi-zone HVAC systems must include controls that automatically reset the supply air temperature in response to the building loads or to the outdoor air temperature. The goal is to have the supply air temperature at full reset when most zones require minimal cooling. Outdoor air temperature reset begins at an outdoor air temperature of 70°F with 1°F of reset per 2°F reduction in the outdoor air temperature until the maximum supply air temperature reset is achieved.
  1. Supply air temperature shall be reset by the controls to at least 25% of the difference between the design supply air temperature and the design room air temperature.
  2. Controls that adjust the reset based on zone sensed humidity are allowed.
  3. Zones that are expected to have relatively constant loads such as equipment rooms or core spaces shall be designed for the fully reset supply temperature.
Exemptions:

4. Climate zones 1a, 2a, and 3a.
5. Systems that prevent re-heating, re-cooling or mixing of heated and cooled supply air.
6. Systems in which at least 75% of the energy for reheating (on an annual basis) is from site recovered or site solar sources.

**Overhead heating with supply air**

- Addendum BX: This change is intended to reduce short circuiting of warm supply air into ceiling air returns and to improve the air distribution effectiveness.
  1. Where reheating is permitted by 90.1, zones that have both the supply and return air openings greater than 6 feet above the floor shall not supply heating air more than 20°F above the space temperature set point.

Exemptions:

2. Laboratory exhaust systems that comply with 6.5.7.2.
3. During preoccupancy building warm-up and setback.

**Dual maximum control on VAV boxes**

- Addendum H: This addendum is geared toward zones with direct digital controls (DDC). It is intended to take advantage of the energy-saving potential of DDC when controlling the air volume and reheat. This addendum allows the reheat airflow to increase from 20% to 50% which will lower the discharge air temperature, provide better thermal comfort, and improve ventilation effectiveness.
  1. Adds exemptions to 6.5.2.1 Zone Controls (sub of Simultaneous Heating and Cooling).

Exemptions:

a. Zones for which the volume of air that is reheated, re-cooled, or mixed is less than the larger of the following:
   1. 30% of the zone design peak supply rate.
   2. The volume of outdoor air required to meet the ventilation requirements of section 6.2 of ASHRAE Standard 62.1 for the zone.
   3. Any higher rate that can be demonstrated, to the satisfaction of the authority having jurisdiction, to reduce overall system annual energy usage by offsetting reheat/re-cool energy losses through a reduction in outdoor air intake.

b. Zones that comply with all the following:
   1. The volume of air that is reheated, re-cooled, or mixed in dead band between heating and cooling does not exceed the larger of the following:
      a. 20% of the zone design peak supply rate.
      b. The volume of outdoor air required to meet the ventilation requirements of Section 6.2 of ASHRAE Standard 62.1 for the zone.
      c. Any higher rate that can be demonstrated, to the satisfaction of the authority having jurisdiction, to reduce overall system annual energy usage by offsetting reheat/re-cool energy losses through a reduction in outdoor air intake.
   2. The volume of air that is reheated, re-cooled, or mixed in peak heating demand shall be less than 50% of the zone design peak supply rate.
   3. Airflow between dead band and full heating or full cooling shall be modulated.

**VAV control on lab exhaust**

- Addendum AS: In 6.5.2, this addendum removes the exemption for spaces such as hospitals and laboratories where the pressure control requirements set the minimum flow from the VAV box. It establishes a new section on laboratory exhaust that specifies the effectiveness and control needed to allow the zones that aren’t required to be maintained at a constant flow to act as VAV. This is only for spaces that do not require pressure control.
**Fan power limitation**

- Addendum CA: This addendum closes a loophole in the fan powered allowances for VAV systems. Standard VAV systems that are multi-zone have single duct terminals (or other control valves) that vary airflow to the individual zones. Due to the pressure drop across these terminals, there is a higher fan power allowance. When a VAV system is not multi-zone (without volume control terminals) there is no need for the added fan power allotment due to the lack of pressure drop across the single ducts.
- Single zone VAV systems shall comply with the constant volume fan power limitation.

**Heat recovery pressure drop**

- Addendum DJ: There is now a pressure drop credit for energy recovery devices that compensates for effectiveness and is shown in Table 3 (ASHRAE 90.1 Table 6.5.3.1.1B).

**Table 3. (ASHRAE 90.1 Table 6.5.3.1.1B) Fan Power Limitation Pressure Drop Adjustment**

<table>
<thead>
<tr>
<th>Device</th>
<th>Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Recovery Device other than Coil Runaround Loop</td>
<td>((2.2 \times \text{Energy Recovery Effectiveness}) - 0.5\text{ in. w.c. for each airstream})</td>
</tr>
<tr>
<td>Coil Runaround Loop</td>
<td>0.6\text{ in. w.c. for each airstream}</td>
</tr>
</tbody>
</table>

**Elevator ventilation**

- Addendum DF: Elevators are now required to follow the requirements of 10.4.3.
  1. All cab lighting shall have efficacy of not less than 35 lumens per Watt.
  2. Cab ventilation fans for elevators without air conditioning shall not consume over 0.33 W/ft³ at maximum speed.
  3. When stopped and unoccupied with doors closed for over 15 minutes, cab lighting and fan ventilation shall be turned off until needed again.

**Garage Ventilation Control**

- Addendum DI: Ventilation in enclosed parking garages shall automatically detect contaminant levels and stage fans or modulate fans to 50% or less of design capacity provided acceptable contaminant levels are maintained.
- Exemptions:
  1. Garages less than 30,000 ft² with ventilation systems not using mechanical cooling or heating.
  2. Garages that have a ventilation system nameplate hp ratio that exceeds 1500 ft³/hp and do not use mechanical cooling or heating.
  3. Where not permitted by the authority having jurisdiction.

**Duct Leakage**

- Addendum A, CQ: The duct sealing and leakage had not been updated since 1999. In this addendum, an economic analysis showed that for almost all cases, the seal class A was justifiable. This allowed two tables to be removed and simplified this section. A definition of seal class A was added and all references to seal class B and seal class C were removed.
  1. **Seal Class A**: A ductwork sealing category that requires sealing all transverse joints, longitudinal seams, and duct wall penetrations. Duct wall penetrations are openings made by pipes, holes, conduit, tie rods, or wires. Longitudinal seams are joints oriented in the direction of airflow. Transverse joints are connections of two duct sections oriented perpendicular to airflow.
     a. Openings for rotating shafts shall be sealed with bushings or other devices that seal off air leakage.
     b. Pressure sensitive tape shall not be used as the primary sealant unless it is certified to comply with UL-181A or UL-181B, and the tape is used in accordance with that certification.
     c. All connections shall be sealed. Sealing that would void product listings is not required.
     d. Spiral lock seams need not be sealed.
     e. Duct work that is designed to operate at static pressures in excess of three in w.c. and all ductwork outdoors shall be leak tested according to industry-accepted procedures.
**Kitchen Exhaust**

- Addendum AX: Section 6.5.7.1 *Kitchen Hoods* was struck and replaced with 6.5.7.1 *Kitchen Exhaust Systems*.

  1. Short-circuit hoods are no longer allowed. A study by the American Gas Association Research and the California Energy Commission found that direct supply of make-up air, in excess of 10% of hood exhaust airflow, into the hood cavity significantly deteriorates the capture and containment performance of kitchen hoods. The research found that short-circuit hoods waste energy and degrade the kitchen performance and hygiene (6.5.7.1.1).

  2. Rather than allow make-up air systems in kitchens to provide make-up air volume equal to the exhaust flow rate, whenever possible, transfer air from adjacent spaces should be used (6.5.7.1.2).

  3. Exhaust hoods must have been subjected to a recognized performance test. The intent of this section (6.5.7.1.3) is to conserve energy through the use of validated performance. This was based on ASHRAE Research Project 1202. A 5,000 cfm threshold was maintained to exempt small restaurants but include larger restaurants and commercial/institutional kitchens.

  4. Make-up air can be fully conditioned with demand ventilation or energy recovery devices (6.5.7.1.4).

  5. Field verification shall be used to evaluate design airflow rates and demonstrate proper capture and containment performance (6.5.7.1.5).

**Waterside**

*Variable-flow and variable-speed pumps*

- Addendum AK: When individual pumps are 5 hp or larger and the total system pump power is equal to or greater than 10 hp, variable flow (or VFD-like performance) is required. This changed from 50 hp per pump and at least 100 ft head.

*Pump pressure optimization*

- Addendum AK: The differential pressure set point shall be no more than 110% of that required to achieve design flow through the heat exchanger. Where differential pressure control is used to comply with this section and DDC controls are used the set point shall be reset downward based on valve positions until one valve is nearly open.

- Exemptions
  1. Systems where the minimum flow is less than required by the equipment manufacturer for proper operation such as chillers and the total pump system power is 75 hp or less.

  2. Systems that have no more than three control valves.

*Water cooled unitary systems*

- Addendum AK: Condenser water flow for unitary equipment shall have a two-position automatic valve interlocked to shut off water flow when the compressor is off. The pumps 5 hp and larger with a total system pump power equal to or greater than 10 hp require variable flow (or VFD-like performance).

*Service water booster systems*

- Addendum CV: Service water booster systems have been noted to waste energy in three ways:

  1. The pressure is boosted beyond the pressure needed for most conditions and then reduced with one or more pressure reducing valves – this is no longer allowed – safety devices are exempted from this requirement.

  2. Variable speed drives may be controlled inefficiently when no service water flow is required; pumps must be shut off when no service water flow is needed.

  3. Fluid pressure must be measured, and pump operation must follow the load to prevent over pressurization.

*Nominal pipe sizes for maximum flow*

- Addendum AF, CC: Minimum efficiency for water systems did not exist in ASHRAE 90.1 until these addendum were added. To establish a minimum efficiency such as the fan power limitation on the air side would not be easily achieved. Instead, design guidance in tabular format as to pipe size for systems with and without variable speed pumping, with and without two position valves, and for three ranges of annual operating hours were developed.
This means that the impact of system design temperature delta will impact the pipe size since the pipe size is based on the volume of water and frictional losses that the system pumps must overcome.

The pipe sizes covered by Table 6.5.4.5 range from a minimum of 2.5 inches and upward. Once the pipe size exceeds 12 inches, the design water flow is limited to a maximum allowable velocity.

**Pump head**

**Addendum V:** Prior to this addendum, hydronic designers often used a conservative estimate and did not always adjust the initial estimated pump size and head to the actual operating conditions. Now, pump head calculations must be performed prior to sizing pumps.

**Pipe Insulation**

**Addendum B, BA:** Hot water and steam piping now have a more stringent insulation requirement. Credit is given for the use of non-metallic schedule 80 (or greater) pipe due to the self-insulating nature and external insulation thickness that can be reduced by an equivalent heat transfer by linear foot. Also, adjustments for buried piping have been made.

**Radiant Panels**

**Addendum AE:** Radiant panels transfer heat (cooling or heating) via radiation from the room-side face of the panel. The backside of the panel may be exposed to spaces that may be unconditioned. A study showed that increasing the insulation thickness beyond the R-3.5 (from 1” to 4” thickness) had a minimal impact on the life-cycle cost of the application. As a result, addendum AE requires the back of the panel to be insulated with a minimum of R-3.5.

**Heat pump pool heaters**

**Addendum Y:** Heat pump pool heaters are now required to have a minimum efficiency of 4.0 COP at 50°F and use the AHRI 1160 performance rating standard. The prior minimum efficiency of 40 COP was at 80°F.

**Furnaces and water heating**

**Addendum K, AO:** Table 6.8.1E and Table 7.8 were revised with the 2008 federal efficiency levels for water heating and furnaces.

All of the information related to the addendum changes was taken from the various published ASHRAE 90.1-2007 addendum which are available on the ASHRAE website.

For more information on the changes between the 2007 and 2010 versions of ASHRAE 90.1, see the standards page on www.ashrae.org.