BSR/ASHRAE/IES Addendum u to ANSI/ASHRAE/IES Standard 90.1-2022

Proposed Addendum u to

Second Public Review (April 2024)
(Draft Shows Proposed Independent Substantive Changes to Previous Public Review Draft)

This draft has been recommended for public review by the responsible project committee. To submit a comment on this proposed standard, go to the ASHRAE website at www.ashrae.org/standards-research–technology/public-review-drafts and access the online comment database. The draft is subject to modification until it is approved for publication by the Board of Directors and ANSI. Until this time, the current edition of the standard (as modified by any published addenda on the ASHRAE website) remains in effect. The current edition of any standard may be purchased from the ASHRAE Online Store at www.ashrae.org/bookstore or by calling 404-636-8400 or 1-800-727-4723 (for orders in the U.S. or Canada).

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FOREWORD

This addendum is a second public review ISC to make some changes are a result of the first public review. Only the changes are open for comment.

The following is the original foreword from the first public review.

This addendum addresses issues that have been reported with the minimum 50% turndown airflow defined in section 6.5.3.2 b, which states the following:

> 6.5.3.2 b. All other units, including DX cooling units and chilled-water units that control the space temperature by modulating the airflow to space, shall have modulating fan control. Minimum speed shall not exceed 50% of full speed. At minimum speed, the fan system shall draw no more than 30% of the power at full fan speed. Low or minimum speed shall be used during periods of low cooling load and ventilation-only operation.

With the addition of occupied standby control as defined in 6.5.3.9, there have been issues with multi-zone VAV systems that control space temperature by modulating airflow to the space. Section 6.5.3.2 only requires turning down the fan speed to 50%. 50% speed is much higher than the minimum design ventilation rates for typical multi-zone VAV buildings. With occupied standby, the ventilation rates are even lower when operating in the ventilation-only mode. The following table shows minimum design ventilation rates for typical multi-zone VAV building applications.

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Average Design Ventilation Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Office</td>
<td>11.7%</td>
</tr>
<tr>
<td>Medium Office</td>
<td>19.2%</td>
</tr>
<tr>
<td>Large Office</td>
<td>19.9%</td>
</tr>
<tr>
<td>Outpatient</td>
<td>24.8%</td>
</tr>
<tr>
<td>Hospital</td>
<td>23.2%</td>
</tr>
<tr>
<td>Primary School</td>
<td>50.7%</td>
</tr>
<tr>
<td>Secondary School</td>
<td>54.4%</td>
</tr>
</tbody>
</table>

* Values based on ASHRAE 90.1 reference building models

These systems with only a minimum 50% airflow turndown rate can result in equipment cycling, poor control of the building VAV system, and, in some cases, tripping the unit’s safety devices. To solve this problem, some applications have been forced to add a bypass duct, as shown in the figure, to allow air to recirculate and keep the unit from tripping on safety devices. However, this increases annualized fan power and product installation costs.
Multi-zone VAV systems today are equipped with inverter fan speed control and are capable of much lower speeds and turndown than the 50%. This addendum proposes to reduce the minimum airflow for Multi-zone VAV systems where the space temperature is controlled by modulating airflow from 50% to 15%. Also, the current power reduction requirement of 30% at 50% airflow is much higher than what is achieved by variable-speed inverter driver fan systems. Based on this, the fan system power requirements will be changed from 30% at 50% airflow to 16% at 15% airflow.

Note that this change only applies to multi-zone VAVs and does not apply to single-zone VAVs that control the capacity of mechanical cooling directly based on space temperature.

We checked the capabilities of variable speed drives and ECM motors and confirmed that the 15% minimum turndown is not a problem and can be done. Some qualifications for minimum airflow sensors and ensuring compressor capacity control will function may be required. It should be noted that this condition occurs at lower loads and ambient, and often, the unit is operating in integrated or economizer-only operation or just ventilation. Compressor cycling will likely occur, but units should be checked for operation without tripping. Also, the units should use supply air temperature reset control per section 6.5.3.5 and VAV setpoint reset per 6.5.3.2.3, which can help with building turndown requirements.

Note: This ISC incorporates a new definition, “design minimum outdoor air rate,” that was approved in addendum p and will likely be published before this draft ISC is published for public comment. To make it easier for reviewers, the definition and another related definition are shown below:

**Outdoor air rate, required minimum:** the larger of the minimum outdoor air rate required for ventilation; the required minimum exhaust air rate; or the outdoor air rate required to meet pressurization requirements as defined by one or more of the following as applicable to the HVAC zone or HVAC system:
- ASHRAE Standard 62.1 using the Ventilation Rate Procedure for all spaces and systems and the Simplified Procedure for multiple zone recirculating HVAC systems
- ASHRAE Standard 62.2
- ASHRAE Standard 170
- Other codes or accreditation standards approved by the authority having jurisdiction

**Outdoor air rate, design minimum:** the lowest quantity of outdoor air an HVAC system is designed to supply to the space(s) it serves when these space(s) are occupied at design occupancy levels.

*Cost justification:* Most multi-zone VAV units sold today can have much lower turndown rates. Lower turndown rates will result in significant fan savings vs a unit that uses a bypass duct to meet the required minimum building airflow deliver rates. The following curve shows the annual fan energy savings relative to a unit that only turns down to 50% airflow for a typical 50-ton multi-zone VAV unit applied to the large office building. The curve is the average of a detailed study of all 19 climate zones. As you can see the fan energy is reduced 24% relative to the current required minimum turndown of 50%
It is likely that there will not be any cost impact on a properly designed true multi-zone VAV system. However, some designers are using single-zone VAV equipment and trying to use full VAV using hot gas bypass and limited airflow modulation that a true multizone VAV system requires and are forced in the field to use bypass ducts. Considering the cost of increases for use of the bypass duct, there is actually a cost reduction at the system level by elimination of a bypass duct to allow for proper system operation. The following curve shows an estimate of the cost for the bypass duct and controls for a 50-ton unit as a function of the minimum turndown.

Also, for limited VAV turn down there is significant energy savings for fans systems that can turn down below the current 50% requirement.

Some added costs may be needed for units with very limited capacity control that meet the minimum requirements of table 6.5.1.3. Still, the significant fan energy savings and elimination of the bypass duct will easily cover this.

Considering the significant energy savings and the potential elimination of the bypass duct, this change essentially has first-cost savings and, therefore, less than a zero-payback period. Even if some units have to add some cost for fan turndown, that proposed change is easily cost-justified.
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Make the following changes to 6.5.3.2.1 Supply Fan Airflow Control for both IP and SI

6.5.3.2 Fan Control
6.5.3.2.1 Supply Fan Airflow Control. Each cooling system listed in Table 6.5.3.2.1 shall be designed to vary the supply fan airflow as a function of load and shall comply with the following requirements:

a. Single-zone VAV DX and chilled-water cooling units that control the capacity of the mechanical cooling directly based on space temperature shall have a minimum of two stages of fan control. Low or minimum airflow shall not exceed 66% of design airflow. At low or minimum airflow, the fan system shall draw no more than 40% of the fan power at design airflow. Low or minimum airflow shall be used during periods of low cooling load and ventilation-only operation.

b. All other units, including multiple-zone VAV DX cooling units and chilled-water units that control the space temperature by modulating the airflow to the space, shall have modulating fan control. Minimum supply fan airflow shall not exceed the greater of 15% of design airflow or the design minimum outdoor air rate. Low or minimum airflow shall be used during periods of low cooling load and ventilation-only operation. Mechanical cooling, economizer, and ventilation shall operate at not less than 15% not limit the unit from operating at minimum supply fan design airflow.

c. Units that include an air economizer to meet the requirements of Section 6.5.1 shall have a minimum of two speeds of fan control during economizer operation.

Exceptions to 6.5.3.2.1:

1. Modulating fan control is not required for chilled-water and evaporative cooling units with <1 hp (0.75 kW) fan motors if the units are not used to provide ventilation air and if the indoor fan cycles with the load.

2. If the volume of outdoor air required to meet the ventilation requirements of Standard 62.1 at low airflow exceeds the air that would be delivered at the airflow defined in Section 6.5.3.2.1(a) or 6.5.3.2.1(b) then the minimum airflow shall be selected to provide the required ventilation air.