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

Public Review Draft

Proposed Addendum u to Standard 90.1-2022, Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings

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

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ASHRAE, 180 Technology Parkway NW, Peachtree Corners, GA 30092

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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.

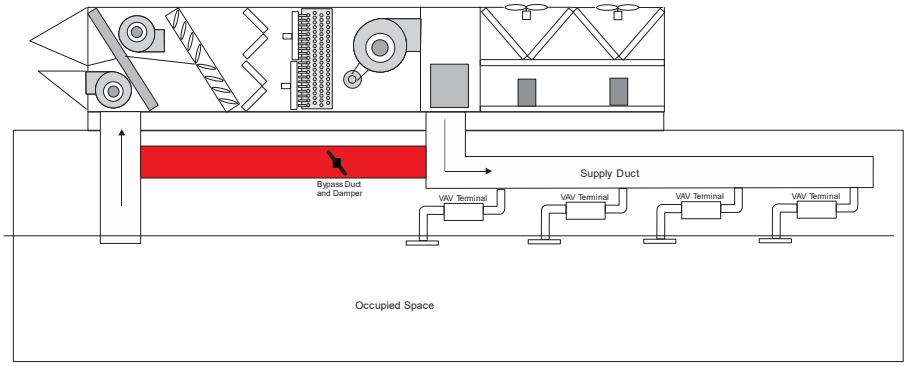
With the addition of occupied standby control as defined in 6.5.3.9, there have been issues with multi-zone VAV systems that control space temperature by modulating airflow to the space. Section 6.5.3.2 only requires turning down the fan speed to 50%. 50% speed is much higher than the minimum design 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.

Minimum ASHRAE 62.1 Design Ventilations Rates

Building Type	Average Design Ventilation Rate
Small Office	11.7%
Medium Office	19.2%
Large Office	19.9%
Outpatient	24.8%
Hospital	23.2%
Primary School	50.7%
Secondary School	54.4%

* 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.

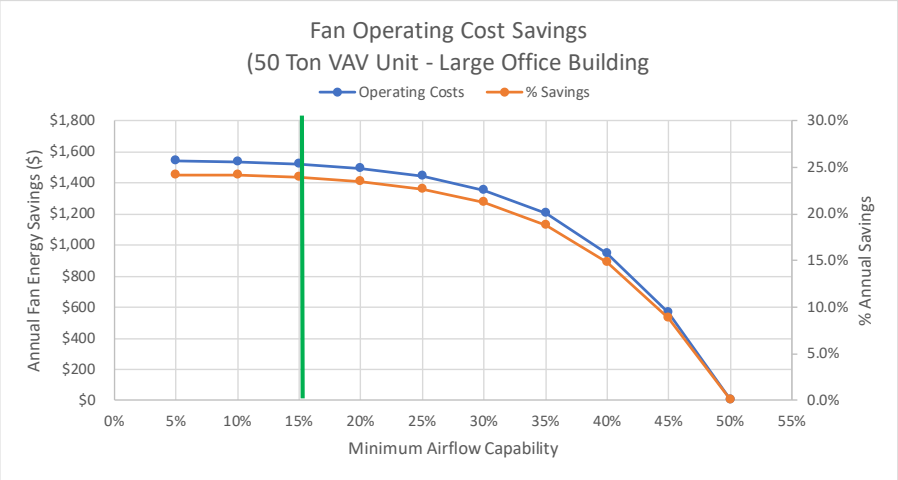
Note that this change only applies to multi-zone VAVs and does not apply to single-zone VAVs that control the capacity of mechanical cooling directly based on space temperature.

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.

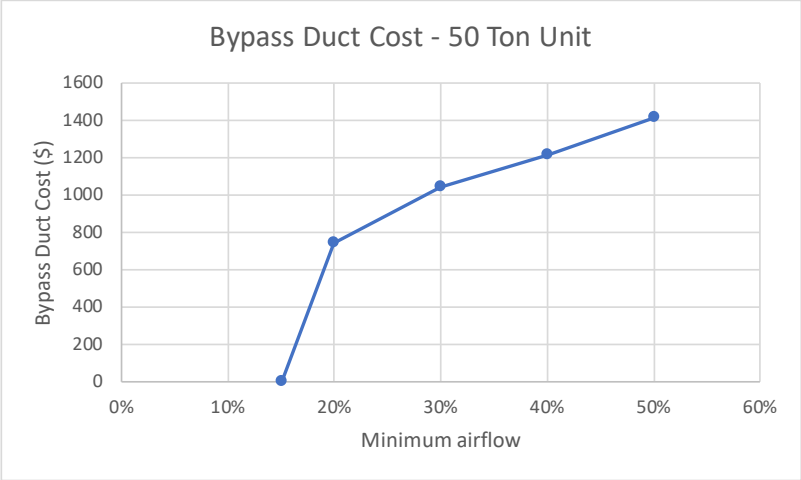
Note: This ISC incorporates a new definition, “design minimum outdoor air rate,” that was approved in addendum p and will likely be published before this draft ISC is published for public comment. To make it easier for reviewers, the definition and another related definition are shown below:

> **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.

Note to Reviewers: This public review draft makes proposed independent substantive changes to the previous public review draft. These changes are indicated in the text by underlining (for additions) and strikethrough (for deletions) except where the reviewer instructions specifically describe some other means of showing the changes. Only these changes to the previous draft are open for review and comment at this time. Additional material is provided for context only and is not open for comment except as it relates to the proposed substantive changes.]

Addendum u to 90.1-2022

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.