ASHRAE

ADDENDA

ASHRAE Addendum t to
ASHRAE Guideline 36-2021

High-Performance Sequences of Operation for HVAC Systems

Approved by ASHRAE and the American National Standards Institute on February 29, 2024.

This addendum was approved by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. Instructions for how to submit a change can be found on the ASHRAE® website (www.ashrae.org/continuous-maintenance).

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FOREWORD

This addendum revises the location of where requests are defined to recognize that they are used more broadly than indicated by their current definition as a subsection of Trim and Respond Set-point resets. Requests are a way for zones and other dependent equipment to indicate a need from source systems or plants. For example, when used with duct static pressure setpoint reset logic, requests are a way for zones to indicate demand for an increase in pressure. However, requests are also used within the guideline to enable equipment. For example, the hot water plant requests generated by hot water valves are prerequisites for a hot water plant to be enabled. Defining requests independently from the setpoint reset logic ensures that associated parameters including importance multipliers and cumulative request hours are applied to all forms of requests.

Note: In this addendum, changes to the current guideline are indicated in the text by underlining (for additions) and strikethrough (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum t to Guideline 36-2021

(IP and SI Units)

Revise Section 5.1.14 as follows:

5.1.14. Requests

5.1.14.1. A “request” is a call to reset a setpoint or enable equipment to run that is generated by downstream zones or air-handling systems. These requests are sent upstream to the plant or system that serves the zone or air handler that generated the request.

a. For each downstream zone or system, and for each type of request listed for the zone/system, provide the following software points:

1. Importance-Multiplier (default = 1)

Importance-Multiplier is used to scale the number of requests the zone/system is generating. A value of zero causes the requests from that zone or system to be ignored. A value greater than one can be used to effectively increase the number of requests from the zone/system based on the critical nature of the spaces served. Consider as an example, a hot water system serving dozens of reheat coils at terminal zones and a large preheat coil at the air handler. Setting the Importance-Multiplier for plant requests for the preheat coil to a value greater than one could help ensure that the plant can be enabled to serve that individual demand while still ignoring a certain number of reheat coils until there is a sufficiently large call for heat to support stable plant operation.

2. Request-Hours Accumulator. Provided SystemOK (see Section 5.1.19) is true for the zone/system and there is an active request, every x minutes (default 5 minutes), add x divided by 60 to this request-hours accumulator point.

3. System Run-Hours Total. This is the number of hours the zone/system has been operating in any mode other than Unoccupied Mode.

Request-Hours accumulates the total time when a request is generated to help identify zones/systems that are driving the reset logic or requesting system operation. Cumulative%-Request-Hours calculates the percentage of System

Run-Hours when there is an active request. Rogue zone identification is particularly critical in this context because a single rogue zone can keep the T&R loop at maximum and prevent it from saving any energy.

4. Cumulative%-Request-Hours. This is the zone/system Request-Hours divided by the zone/system run-hours (the hours in any mode other than Unoccupied Mode) since the last reset, expressed as a percentage.

5. The Request-Hours Accumulator and System Run-Hours Total are reset to zero as follows:

   i. Reset automatically for an individual zone/system when the System Run-Hours Total exceeds 400 hours.

   ii. Reset manually by a global operator command. This command will simultaneously reset the Request-Hours point for all zones served by the system.

6. A Level 4 alarm is generated if the zone Importance-Multiplier is greater than zero, the zone/system Cumulative% Request Hours exceeds 70% for 1 hour continuously, and the total number of zone/system run hours exceeds 40.

b. See zone and air-handling system control sequences for logic to generate requests.

c. Multiply the number of requests determined from zone/system logic times the Importance-Multiplier and send to the system/plant that serves the zone/system. See Section 5.1.15 for Trim & Respond set-point reset logic and system/plant logic to see how requests are used in the reset and enabling logic.

5.1.15. Trim & Respond Set-Point Reset Logic

Trim & Respond (T&R) logic resets a setpoint for pressure, temperature, or other variables at an air handler or plant. It reduces the setpoint at a fixed rate until a downstream zone is no longer satisfied and generates a request. When a sufficient number of requests are present, the setpoint is increased in response. The importance of each zone's requests can be adjusted to ensure that critical zones are always satisfied. When a sufficient number of requests no longer exist, the setpoint resumes decreasing at its fixed rate. A running total of the requests generated by each zone is kept to identify zones that are driving the reset logic.

T&R logic is optimal for controlling a single variable that is subject to the requirements of multiple downstream zones (such as the static pressure setpoint for a VAV air handler). In this application, it is easier to tune than a conventional control loop and provides for fast response without high-frequency chatter or loss of control of the downstream devices. It typically does generate low-frequency cyclic hunting, but this behavior is slow enough to be nondisruptive.

See Section 5.1.14.4 for an example of T&R implementation.

5.1.15.1. T&R set-point reset logic ~~and zone/system reset requests~~, where referenced in sequences, shall be implemented as described below.

~~5.1.15.2. A "request" is a call to reset a static pressure or temperature setpoint generated by downstream zones or air-handling systems. These requests are sent upstream to the plant or system that serves the zone or air handler that generated the request.~~

~~a. For each downstream zone or system, and for each type of set-point reset request listed for the zone/system, provide the following software points:~~

~~1. Importance-Multiplier (default = 1)~~

~~*Importance-Multiplier is used to scale the number of requests the zone/system is generating. A value of zero causes the requests from that zone or system to be ignored. A value greater than one can be used to effectively increase the number of requests from the zone/system based on the critical nature of the spaces served.*~~

~~2. Request-Hours Accumulator. Provided SystemOK (see Section 5.1.19) is TRUE for the zone/system, every *x* minutes (default 5 minutes), add *x* divided by 60 times the current number of requests to this request-hours accumulator point.~~

~~3. System Run-Hours Total. This is the number of hours the zone/system has been operating in any mode other than Unoccupied Mode.~~

~~*Request-Hours accumulates the integral of requests (prior to adjustment of Importance-Multiplier) to help identify zones/systems that are driving the reset logic. Rogue zone identification is particularly critical in this context, because a single rogue zone can keep the T&R loop at maximum and prevent it from saving any energy.*~~

~~4. Cumulative%-Request-Hours. This is the zone/system Request-Hours divided by the zone/system run-hours (the hours in any mode other than Unoccupied Mode) since the last reset, expressed as a percentage.~~

~~5. The Request-Hours Accumulator and System Run-Hours Total are reset to zero as follows:~~

~~i. Reset automatically for an individual zone/system when the System Run-Hours Total exceeds 400 hours.~~

~~ii. Reset manually by a global operator command. This command will simultaneously reset the Request-Hours point for all zones served by the system.~~

~~6. A Level 4 alarm is generated if the zone Importance-Multiplier is greater than zero, the zone/system Cumulative% Request Hours exceeds 70%, and the total number of zone/system run hours exceeds 40.~~

~~b. See zone and air-handling system control sequences for logic to generate requests.~~

~~c. Multiply the number of requests determined from zone/system logic times the Importance-Multiplier and send to the system/plant that serves the zone/system. See system/plant logic to see how requests are used in T&R logic.~~

5.1.15.2. For each upstream system or plant setpoint being controlled by a T&R loop, define the following variables. Initial values are defined in system/plant sequences below. Values for trim, respond, time step, etc. shall be tuned to provide stable control. See Table ~~5.1.14.3~~5.1.15.2.

Table ~~5.1.14.3~~5.1.15.2 Trim & Respond Variables

Variable	Definition
Device	Associated device (e.g., fan, pump)
SP0	Initial setpoint
SPmin	Minimum setpoint
SPmax	Maximum setpoint
Td	Delay timer
T	Time step

I	Number of ignored requests
R	Number of requests from zones/systems
SPtrim	Trim amount
SPres	Respond amount (must be opposite in sign to SPtrim)
SPres-max	Maximum response per time interval (must be same sign as SPres)

Informative Note: The number of ignored requests (I) should be set to zero for critical zones or air handlers.

5.1.15.3. Trim & Respond logic shall reset the setpoint within the range SPmin to SPmax. When the associated device is OFF, the setpoint shall be SP0. The reset logic shall be active while the associated device is proven ON, starting Td after initial device start command. When active, every time step T, if R≤I, trim the setpoint by SPtrim. If there are more than I requests, respond by changing the setpoint by SPres*(R – I), (i.e., the number of requests minus the number of ignored requests) but no more than SPres-max. In other words, every time step T.

If R≤I, change Setpoint by SPtrim
If R > I, change setpoint by (R – I)*SPres but no larger than SPres-max

The following is an example of a sequence that uses T&R to control the static pressure setpoint of a VAV AHU serving multiple downstream zones. This sequence defines the T&R variables as shown in Informative Table ~~5.1.14.4~~5.1.15.3.

Informative Table ~~5.1.14.4~~5.1.15.3 Example Sequence T&R Variables

Variable	Definition
Device	Supply fan
SP0	120 Pa (0.5 in. of water)
SPmin	37 Pa (0.15 in. of water)
SPmax	370 Pa (1.50 in. of water)
Td	5
T	2
I	2
SPtrim	–10 Pa (–0.04 in. of water)
SPres	15 Pa (0.06 in. of water)
SPres-max	37 Pa (0.15 in. of water)

Description of General Operation

Starting 5 minutes after the fan status indicates the supply fan is ON, the sequence will slowly reduce the AHUs static pressure setpoint by 10 Pa (0.04 in. of water) every 2 minutes if R≤I. As static pressure drops, downstream VAV box dampers will open further for a given load. When the combination of reduced static pressure and changes in load *drives more than two VAV boxes more than 95% open, the system will respond by increasing static pressure setpoint by 15 Pa (0.06 in. of water) for every request but no more than a maximum of 37 Pa (0.15 in. of water), regardless of the number of requests. The setpoint will continue to increase every 2 minutes until all but 2 VAV boxes (for Ignored Request value of 2) are satisfied (damper position < 85%). Subsequently, the setpoint will continue to decrease by 10 Pa (0.04 in. of water) every 2 minutes.*

Example

(Note: for the example below, the net result for each time step is separately calculated using the variables in Pascal units and in units of inches of water column, in order to facilitate following the example in either units. Thus, the unit conversion of the net result is not exact at each time step.)

System starts at 11:55. Initial setpoint is 120 Pa (0.5 in. of water). At 12:00 (Td after start time), the reset begins.

*At 12:02 (i.e., 1*T after reset begins), there is one request (i.e., R = 1). Since R<I, trim component reduces setpoint by SPtrim, which is 10 Pa (0.04 in. of water). Net result: setpoint is 110 Pa (0.46 in. of water).*

*At 12:04 (i.e., 2*T), there are two requests (i.e., R = 2). Since R=I, trim component reduces setpoint by 10 Pa (0.04 in. of water). Net result: setpoint is 100 Pa (0.42 in. of water).*

*At 12:06 (i.e., 3*T), there are three requests (i.e., R = 3). Since R – I = 1, response component increases setpoint by 15 Pa (0.06 in. of water) (i.e., 1*SPres). Net result: setpoint is 115 Pa (0.48 in. of water).*

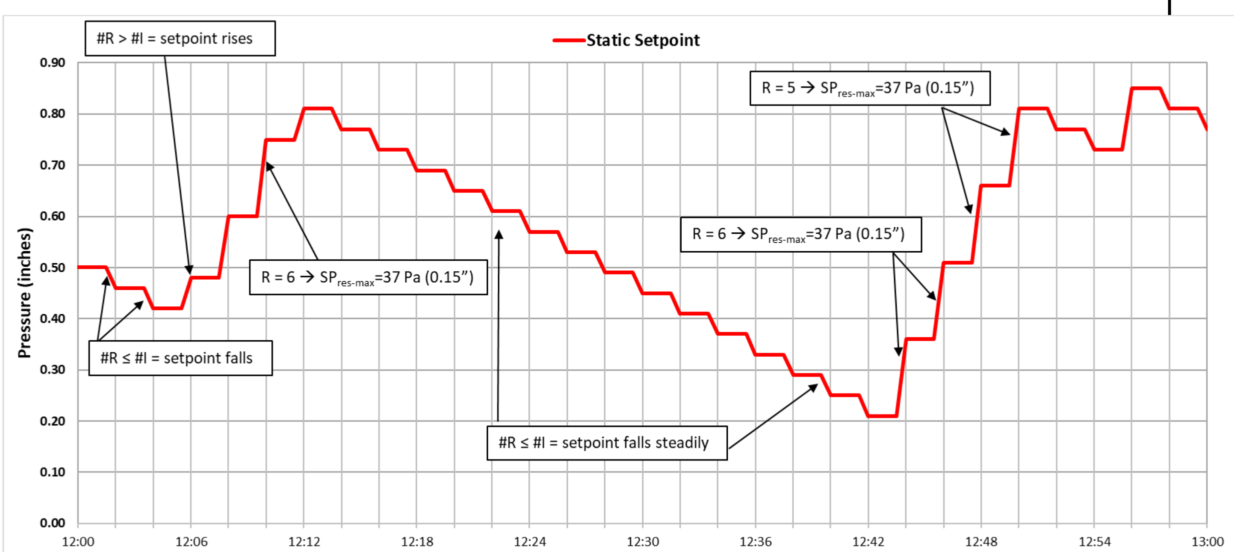
*At 12:08 (i.e., 4*T), there are four requests (i.e., R = 4). Because R – I = 2, response component increases setpoint by 30 Pa (0.12 in. of water) (i.e., 2*SPres). Net result: setpoint is 145 Pa (0.60 in. of water).*

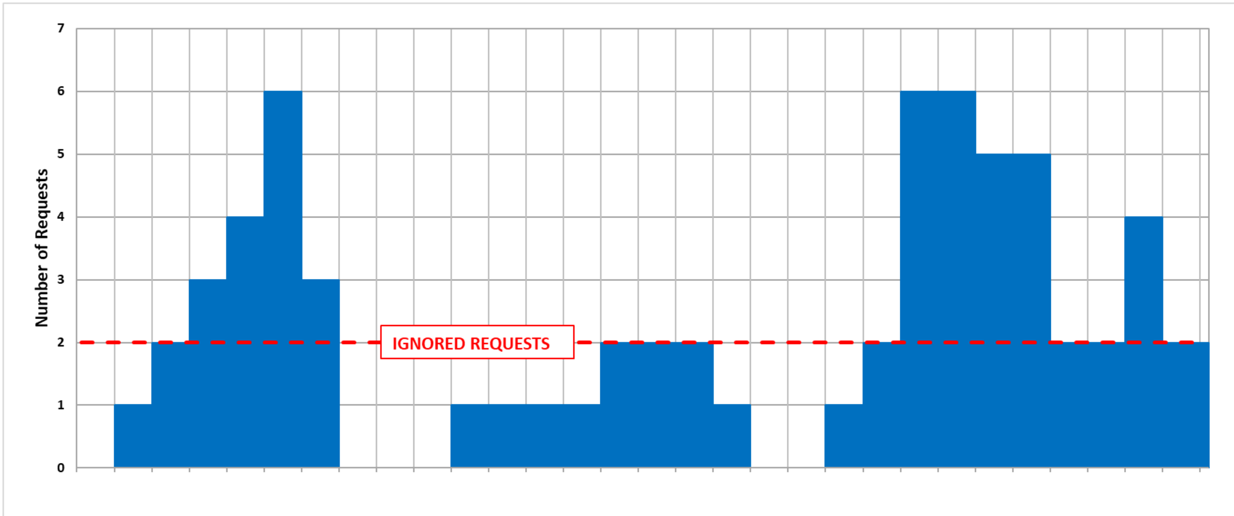
*At 12:10 (i.e., 5*T), there are six requests (i.e., R = 6). Because R – I = 4, but* $SPres_{max}$ *= 37 Pa (0.15 in. of water), response component increases setpoint by the maximum of 37 Pa (0.15 in. of water) (i.e., not 4*SPres = 60 Pa [0.24 in. of water]). Net result: setpoint is 182 Pa (0.75 in. of water).*

*At 12:12 (i.e., 6*T), there are three requests (i.e., R = 3). Because R – I = 1, response component increases setpoint by 15 Pa (0.06 in. of water) (i.e., 1*SPres). Net result: setpoint is 197 Pa (0.81 in. of water).*

*At 12:14 (i.e., 7*T), there are zero requests (i.e., R = 0). Because R<I, trim component reduces setpoint by 10 Pa (0.04 in. of water). Net result: setpoint is 187 Pa (0.77 in. of water).*

Informative Figure ~~5.1.14.4~~5.1.15.3 shows a trend graph of the example above, continued for a period of an hour.





Informative Figure ~~5.1.14.4~~5.1.15.3 Example sequence trend graph.

The system will tend toward minimum static pressure (thus saving energy) but respond rapidly to increasing demand from the terminal units. A cyclic pattern is characteristic of a robust T&R loop—the setpoint is not expected to remain static except at its minimum and maximum values. Note that Informative Figure ~~5.1.14.4~~5.1.15.3 was created to illustrate how requests are used to reset the setpoint and does not necessarily represent the expected behavior of an actual T&R loop, although the long, slow cycling of the setpoint value is typical of T&R control.

Update paragraph references for Importance Multipliers from Section 5.1.14.2.a.1 to 5.1.14.1.a.1 throughout.

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ASHRAE is concerned with the impact of its members' activities on both the indoor and outdoor environment. ASHRAE's members will strive to minimize any possible deleterious effect on the indoor and outdoor environment of the systems and components in their responsibility while maximizing the beneficial effects these systems provide, consistent with accepted Standards and the practical state of the art.

ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the Standards and Guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive Technical Committee structure, continue to generate up-to-date Standards and Guidelines where appropriate and adopt, recommend, and promote those new and revised Standards developed by other responsible organizations.

Through its *Handbook*, appropriate chapters will contain up-to-date Standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating Standards and Guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.

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