

ASHRAE Guideline 36P: High Performance Sequences of Operation for HVAC Systems

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ASHRAE Distinguished Lecture Program
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Agenda

- ASHRAE G36: History, scope, goals
- Relationship to other standards and codes
- Vision for use
- Technical content: operation
- Technical content: optimization
- Technical content: fault detection
- Technical content: alarm suppression
- Interconnected applications
- Status of development

ASHRAE G36. History, scope, goals

- In the beginning ...
- Technical Committee 1.4, Control Theory and Applications ran a series of projects leading to:
- Guideline 36: High Performance Sequences of Operation for HVAC Systems

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ASHRAE G36. History, scope, goals

Sequences of Operation for Common HVAC Systems

RP 1547: CO2 Based Demand-Controlled Ventilation

RP 1455: Best of Class Sequences for Air Systems

Guideline 36P: High Performance Sequences of Operation ...

2000

2005

2010

2015

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ASHRAE G36. History, scope, goals

- Sequence of operation for hvac system. Initially limited to room air terminals and air handlers.
- Extends beyond operation of the equipment
- Includes embedded, on-line fault detection
- Includes 'calculated alarms' and alarm suppression
- Will include functional test procedures

GPC 36P - Proposed guideline

High Performance Sequences of Operation for HVAC Systems

1. PURPOSE:

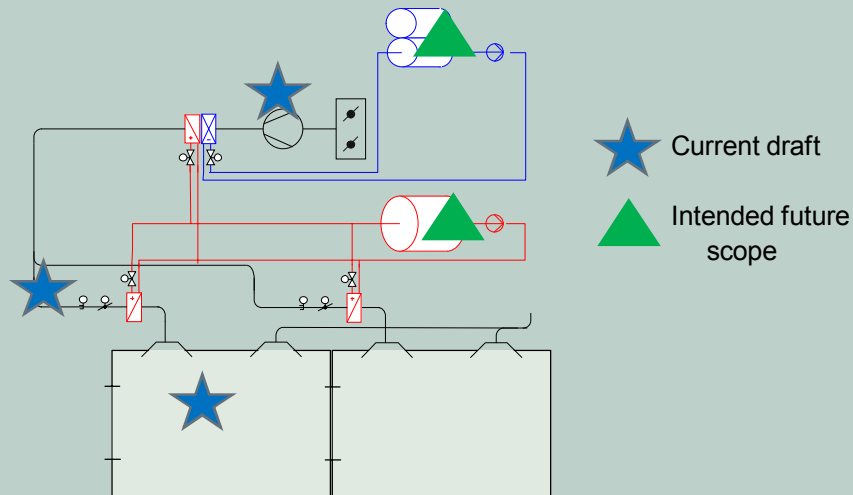
The purpose of this guideline is to provide uniform sequences of operation for heating, ventilating, and air-conditioning (HVAC) systems that are intended to maximize HVAC system energy efficiency and performance, provide control stability, and allow for real-time fault detection and diagnostics.

2. SCOPE:

2.1 This guideline provides detailed sequences of operation for HVAC systems.

2.2 This guideline describes functional tests that when performed will confirm implementation of the sequences of operation.

ASHRAE G36. History, scope, goals



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ASHRAE G36. History, scope, goals

- Room terminals: cooling only air terminal, air terminal with reheat, fan powered air terminal with reheat, dual-duct air terminal
- Air handlers to serve those terminals, OA, EA, RA dampers, cooling coil, heating coil, no heat recovery equipment
- Single-zone air handler
- No fan coils, radiators, chilled beams, ...

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ASHRAE G36. History, scope, goals

- Goal: improve quality of building automation by starting with a better specification
- Goal: improve quality of building automation by standardizing the functions
- Goal: solve technical challenges associated with building operational goals, especially energy efficiency, and indoor air quality
- Goal: improve building operation with smarter alarms and fault detection

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Relationship to other standards

- Seeks to comply with Standard 62.1
- Seeks to comply with Standard 90.1
- Seeks to comply with California Energy Code
- Seeks to mesh with Guideline 13



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Vision for use

- Engineers specify by reference to ASHRAE
- Maybe modify for the project
- Control manufacturers develop and test applications according to the guideline
- Contractors apply proven solutions
- Commissioning agents execute standard tests



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Operation: Generic thermal zone

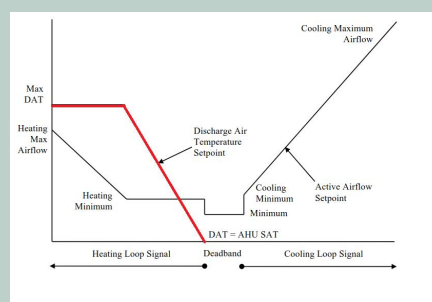
- Setpoints, setbacks, operating modes
- Independent of room HVAC equipment
- Opportunity to coordinate beyond HVAC
 - Not a goal of the project committee
 - Zone serves more than thermal needs
 - Unify control of room operating mode for comprehensive setback
 - Unify for coordinated demand response

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Operation: VAV terminal

- “Dual maximum sequence”.
- Also called “V sequence”
- Makes it possible to use lower flow levels at the minimum
- 2 ventilation functions
 - Minimum primary flow through the terminal
 - OA flow needed from the air handler



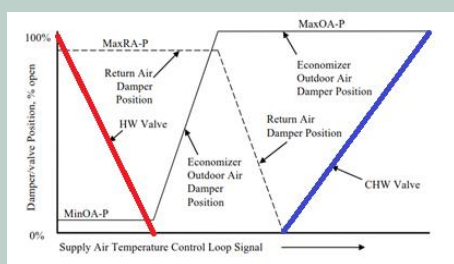
Sequence diagram from Public Review Draft, ASHRAE, June 2016

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Operation: VAV air handler

- Start/stop and speed control for supply fan
- Supply air temperature control with economizer
- Sequenced OA and RA dampers, not one signal
- Minimum OA control
- Relief fan or return fan



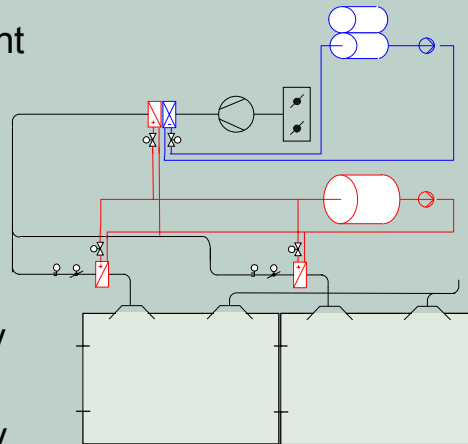
Sequence diagram from Public Review Draft, ASHRAE, June 2016

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Optimization

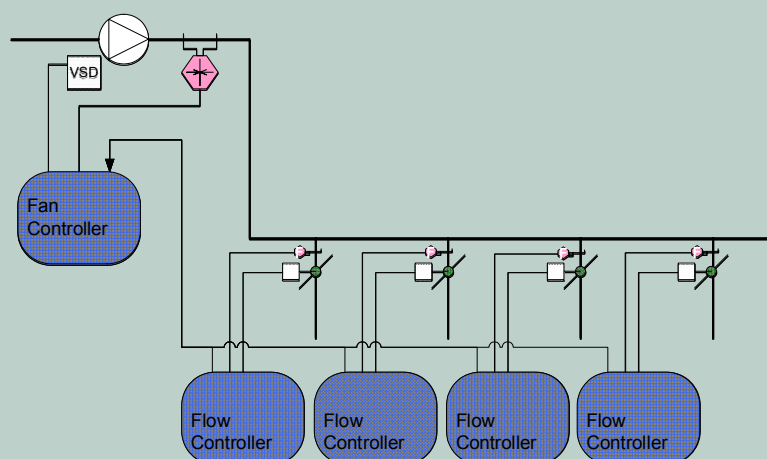
- Room hvac equipment is served by central systems that serve many other rooms
- Temperature and pressure of supplies affects overall energy consumption
- Actively adjust supply to minimize energy use



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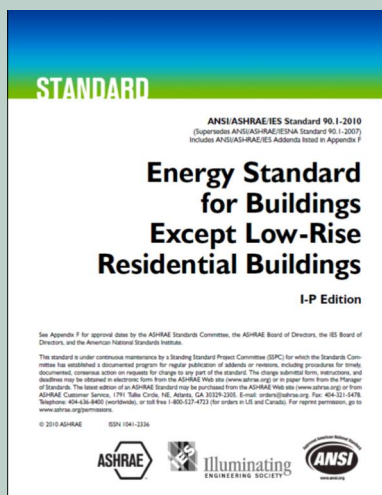
Optimization: Duct pressure



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ASHRAE Energy Standard



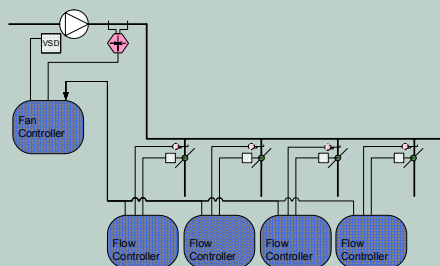
•**Setpoint Reset.** For systems with direct digital control of individual zone boxes reporting to the central control panel, static **pressure setpoint shall be reset** based on the **zone** requiring the most pressure; i.e., the setpoint is reset lower **until one zone damper is nearly wide open.**

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Optimization: Duct pressure

- “Trim and Respond” application
- Each terminal sets “System Request”: values from 0 to 3
- AHU program adds up request values
- Increase, decrease or maintain duct pressure based on summed request values

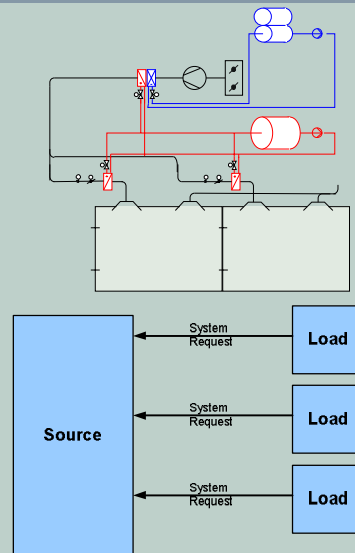


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Interacting control applications

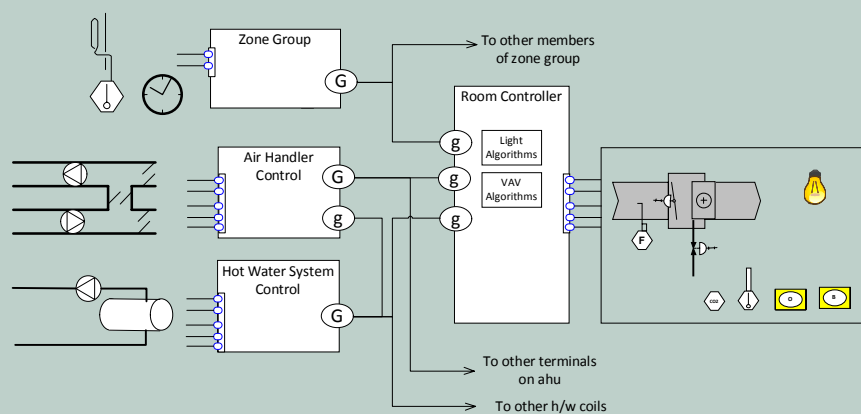
- HVAC system is interconnected sub-systems
- Zone to group
- Air terminal to AHU
- Air terminal to heating plant
- Control system is interconnected applications



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Resulting system



BAS diagram from Representing Building System Hierarchies with Corresponding BAS Data Structures, ASHRAE Conference 2015, CH-15-CO15

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Fault detection

- Applies rules from NIST research at air handler
- Use 'alarm points' to inform users

| | | | |
|------|---------------------------|---|-----------------------|
| FC#1 | Equation | $\text{DSP} < \text{DSPSP} - \text{DSP}$ <p style="text-align: center;">and</p> $\text{VF DSP} \geq 99\% - \text{VF DSP}$ | Applies to OS #1 – #5 |
| | Description | Duct static pressure is too low with fan at full speed | |
| | Possible Diagnosis | Problem with VFD Mechanical problem with fan Fan undersized SAT Setpoint too high (too much zone demand) | |
| FC#2 | Equation | $\text{MAT}_{\text{AVG}} + \text{MAT} < \min[(\text{RAT}_{\text{AVG}} - \text{RAT}), (\text{OAT}_{\text{AVG}} - \text{OAT})]$ | Applies to OS #1 – #5 |
| | Description | MAT too low; should be between OAT and RAT | |
| | Possible Diagnosis | RAT sensor error MAT sensor error OAT sensor error | |

Part of table from Public Review Draft,
ASHRAE, June 2016

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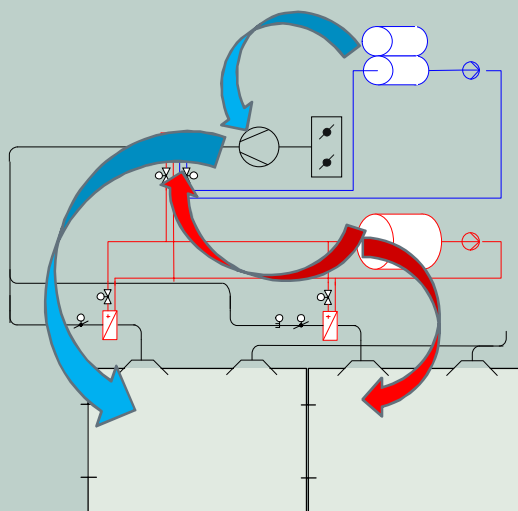
Fault detection

- Applies 'calculated alarms' at the room
 - Use 'alarm points' to inform users
- **Zone Alarms**
 - Zone temperature alarm
 - Zone CO2 alarm
 - **Air Terminal Alarms**
 - Low airflow alarm
 - Low discharge temp alarm
 - Airflow sensor calibration
 - Leaking damper
 - Leaking valve

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Alarm suppression



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Status of development

- GPC 36P formed in 2014
- Proceeding according to ANSI rules for consensus standards
- Conducted “Advisory Public Review” in 2015
- Conducted “Publication Public Review” in 2016, 2017 and 2018
- Hope to resolve and publish shortly

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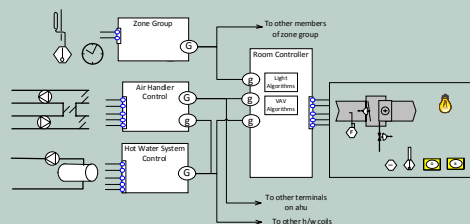
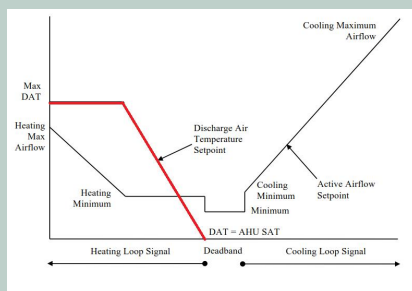
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Questions?



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