Control Strategies For HVAC Systems

Definition of control:

„to apply a regulating influence upon a device to make it perform as required”

where

the regulating influence is a force applied by a person, electric circuit, mechanical mechanism and the device (valve, damper, relay etc.) that changes the amount of mass (quantity of water, air, fuel, material, etc.) or energy (electric current, heat, etc.) that is delivered into a process.
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Drawings of an AHU

Dual Line

Single Line

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An AHU and its Control System
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**High Limit Humidity Control Strategy**

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**DDC**

*Direct Digital Control* or *Distributed Digital Control*

Terms *Direct* and *Distributed* differences between these control systems and analogue electronic or pneumatic control systems.

Term *Distributed* underscores ability to increase system reliability, speed, computing power by dividing the control functions of a facility among a number of smaller microprocessor based panels. Each of these panels can operate alone or as a part of larger system.
• **Direct Digital Control** is based on computer processor, with electronic or pneumatic actuators

• Nearly all current DDC products can be programmed with sophisticated control sequences

• DDC allows central delivery system setpoints to be optimized based on actual zone load conditions ensuring rational energy management or occupants comfort

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**SEQUENCE (DESCRIPTION) OF OPERATION**

It thoroughly describes the intended operation of the control system.

The sequence of operation is developed by the mechanical engineer together with the control system’s application engineer.

It is reference document used during installation, operation and commissioning of HVAC system.
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**ORGANIZATION OF A SEQUENCE OF OPERATION**

**1. System overview**
Briefly describes the mechanical equipment and processes being maintained by the control system.

**2. Energy management overview**
Briefly describes the energy management strategies that are incorporated into the system’s operation.

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**3. Pre-conditioning operation**
Describes how the equipment operates during the period preceding the building's occupied period.

**4. Occupancy operation**
Describes how the processes and their control loops operate during the period when building is occupied.

Is broken down into subsections for each process:
- Fan operation
- Static pressure control
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- Temperature control
  - Mixing air
  - Supply air
  - Zone
- Humidity control
- Zone pressurisation
- Lighting control
- Preliminary equipment control
  - Boilers
  - Chillers
  - Cooling towers

5. Unoccupied operation

Describes how the processes and their control loops operate during the period following occupied time and ending when the pre-conditioning mode begins.

Each subsections listed under the Occupancy operation mode are also described in this section.

6. Emergency strategies

Describes the response of the affected control loops in the event an emergency condition such as smoke, fire, freeze or fault occurs.
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7. Temperature setpoints and occupied schedules

It contains tables or schedules referenced in the other sections. Possible schedules are:
- Mixed Air Reset Schedule
- Supply Air Reset Schedule
- Hot Water Reset Schedule
- Occupancy Schedule
- Unoccupied Setpoint Tables
- Valves Sequencing Schedules

8. Other sections

Valuable operation information not described under any of the above section.

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Control Strategies

- Scheduling
- Optimum Start
- Optimum Stop
- Night Setback/ setup
- Load Based Control
- PID Loops
- Minimum Outside air control
- Discharge air reset
- Chilled water reset
- Free Cooling
- Heating resets
- Space setpoint reset
- Pressure resets
- Evening Purge
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Scheduling
1. Mixed Air Reset Schedule
2. Supply Air Reset Schedule
3. Hot Water Reset Schedule
4. Occupancy Schedule
5. Unoccupied Setpoint Tables
6. Valves Sequencing Schedules

eg.

<table>
<thead>
<tr>
<th>Outside Air Temperature</th>
<th>Supply Air Setpoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>-15°C</td>
<td>20°C</td>
</tr>
<tr>
<td>20°C</td>
<td>13°C</td>
</tr>
</tbody>
</table>

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Optimum Start

• One of the oldest EMS strategies
• Basically takes into account Outside Air Temperature, Zone Temp & recovery ability of HVAC equipment
• Starts the equipment just early enough to meet setpoint at the beginning of occupancy
• Decide if you want optimum start heating or cooling or both
• Keep outdoor air dampers closed during a morning warm-up optimum start period
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**Optimum Stop**

- Stops the facility systems prior to scheduled stop time to let the building “coast” to the end
- Use the mass of the building and comfort delivery systems to maintain comfort without heating or cooling
- Especially good for electric heat
- Optimum stop ~30 to 45 minutes early
- Don’t turn the air off!! (may depend on occupants)

**Night Setback/Setup**

- with resetable setpoint
- with fixed setpoint
- Winter & Summer
- Make sure you can recover from it
- Use Optimum Start to recover properly
- Be sure that Outside Air damper is closed
## Minimum Outside Air

- How much Outside Air is needed?
- What is 10%? And 10% of what?
- Variable air Volume challenges
- Does mixed air temp control satisfy need
- Outside Air need based on CO$_2$ concentration

## Occupancy Sensors

- Use occupancy sensors for lighting and zone-level HVAC control
- Can also use window sensors to turn off HVAC when windows are open
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**Free Cooling**

- Only valid if part of load is handled by AHU’s with Outside Air economizer and other loads that need chilled water all the time
- When AHU’s are running in cold weather, start CHWP’s and allow water thru AHU coils to cool down chilled water loop for loads needing chilled water in winter

**Evening Purge**

- If outdoor air temp is cool, and space is warm, flush the building
- Keeps the building from overheating at night
- Requires ~ 5°C difference between OAT and space temp (OAT <18°C)
- Monitor energy use with and without this