HIGH PERFORMANCE AIR SYSTEMS
THERMA-FUSER™ VARIABLE AIR VOLUME DIFFUSERS
High Performance Air Systems

High performance air systems demand modern design approaches with leading-edge products and technology in order to optimize comfort and reduce energy consumption. A comfortable environment is achieved by providing the smallest possible zones of temperature control, allowing for individual temperature distribution and better air movement. Reduction in energy is realized by designing a low-pressure HVAC system that allows for maximum turn-down while maintaining temperatures.

Levels of Control

A comfortable environment can be provided with many different strategies. The zones shown are generalized examples of typical configurations you will find in many of today’s built environments.

Typical Zones

These examples demonstrate some of the many products and options available, and how Acutherm can fit into each particular zone.

1. Large Meeting Room
2. Open Office with Perimeter
3. Small Office
4. Open Office
5. Small Meeting Room
Comfort

Occupant comfort and system efficiency stem from appropriately sized zones of control. Creating many small zones will provide exceptional levels of control, leading to outstanding occupant comfort. VAV diffusers are a cost-effective and practical way to provide this level of personalized control. Each VAV diffuser is supplied with an integrated thermostat and damper, allowing it to act as an individual VAV zone of control. The damper is continuously adjusted to vary the volume of airflow (warm or cold) into the room in response to room temperature and setpoint.

In addition to small zones of control, VAV diffusers enhance occupant comfort with excellent throw, room air movement, and temperature distribution. VAV diffusers use an adjustable damper to provide a variable discharge area that maintains a constant, high discharge velocity even at low supply air volumes. High discharge velocity maintains Coanda, the ability of dense, cold supply air to cling to the ceiling, preventing dumping even at low flow rates. High velocity supply also promotes room air movement by causing large amounts of induced (or secondary) air to be drawn up and entrained into the primary air, mixing rapidly and reaching room temperature within a few feet of the diffuser and only a few inches of drop. Meanwhile, the occupied area is filled with gently moving air and no pockets of stagnation.

Comfort is maintained over full VAV range of operation from full flow through low flow turndown.
Energy Savings

VAV Diffusers allow for low-pressure, low-energy consumption systems. The energy savings of systems designed using VAV diffusers can be broken down into three main sources:

- Small zones
- Low turndown and pressure drop
- Low system pressure

Many small zones provide individual temperature control to prevent over cooling or over heating when spaces are unoccupied. VAV diffuser systems do not have a velocity limitation because pressure independence is achieved by measuring only static pressure. The static pressure damper in a VAV diffuser system may be oversized to minimize pressure drop without the penalty of increasing minimum flow.

VAV diffuser systems require low duct pressure, which reduces the required fan horsepower, and in turn, the energy required to operate the system.

Sustainability

AcuTherm VAV diffusers have a long lifespan and offer simple maintenance. Thermally powered units do not require any wiring and, aside from setpoint adjustment, are virtually maintenance free with 30+ years of proven operation. Motorized diffusers make use of long-life brushless motors to reduce maintenance requirements and provide near silent operation. VAV diffuser systems are exceptionally adaptable to office changes. The modular concept and flexibility provided by a VAV diffuser system means that any changes to the floor plan need not trigger expensive and disruptive changes to the HVAC system.
High Performance Engineering

Each VAV diffuser is a ceiling diffuser with an integrated thermostat and damper, allowing it to act as an individual VAV zone of control. The damper is continuously adjusted to vary the volume of airflow (warm or cold) into the room in response to room temperature and setpoint. When supply air is warm, the VAV diffuser operates in heating mode and the damper opens in response to a drop in room temperature. When the supply air is cold, the VAV diffuser operates in cooling mode and the damper opens in response to a rise in room temperature.

Separate room temperature setpoints for heating and cooling are individually adjustable and average temperature is maintained within 1½°F/0.9°C.

As with all diffusers, air circulates around the room in a circular motion. Secondary air rises under the diffuser, passes beneath the diffuser plaque and entrains with the primary air at the outside edge of the diffuser. This secondary air best represents average room temperature.

To monitor average room temperature, a continuous sample of secondary air is drawn around the plaque past the room thermostat(s). This is accomplished by feeding primary air through venturi nozzle(s). Primary air blowing through the nozzle(s) creates just enough vacuum to draw some secondary air around the plaque, over the thermostat(s) and out the other side.

Performance Requirements

- Cooling supply air temperature between 50°F/10°C and 68°F/20°C.
- Heating supply air temperature between 80°F/26.5°C and 120°F/49°C.
- Duct static pressure between 0.05 in. w.g./12 Pa and 0.25 in. w.g./62 Pa.

Example: If VAV diffusers are to deliver nominal volume at inlet static pressure of 0.15 in. w.g./37 Pa and if a maximum static pressure of 0.25 in. w.g./62 Pa is to be held for quiet operation, size the duct for a maximum pressure drop of 0.1 in. w.g./25 Pa between the first and last takeoff.

Installation

VAV diffusers control room temperature by sensing room air induced up under the diffuser. VAV diffusers will allow you to design for the lowest possible static pressure while providing ample air to each space.

- Care should be taken not to disturb room air induction and entrainment.
- Location next to obstructions like walls or dropped lights results in the reflection of primary air back at the VAV diffuser. Relocate either the VAV diffuser or use directional blow baffles.
- Manual balancing dampers should be used at the takeoff for each diffuser.

Positive Induction Mechanism - a continuous sample of room air drawn over the built-in thermostat.
**Thermal VAV Diffusers**

**Therma-Fuser™ Series**
This series of stand-alone diffusers are simple to install, thermally powered, require no maintenance or wiring, and come with a 10 year warranty while offering the lowest cost per zone of control.

**Electric VAV Diffusers**

**Advantage Series**
This series of electric motorized diffusers provide a greater range of operation and increased speed of response that is required on some projects.

**Interoperable Series**
This series of electric motorized diffusers are specifically designed for use with multi-vendor DDC building control networks that use the BACnet open communication protocol.

### VAV Diffuser System Options

As energy costs continue to rise, the management of energy while balancing tenant comfort and operational costs is a significant challenge for commercial building owners and managers. A Building Automation System (BAS) is an option that provides monitoring of entire building systems with single source control and troubleshooting. Acutherm's VAV diffuser system is designed to work cooperatively with a wide range of BAS options. Whether you're looking for simple individual temperature control, with no energy required for operation, or full-scale networking for system scheduling, monitoring, reporting, troubleshooting and more, this guide will help you determine what is best for your building needs and budget.

### System Options

<table>
<thead>
<tr>
<th>Features</th>
<th>Thermal VAV Diffusers</th>
<th>Electric VAV Diffusers</th>
<th>Interoperable Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual/temperature control, superior air distribution, energy saving adaptable system</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>No diffuser wiring</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>No diffuser setting</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>BAS only monitors parts of system requiring periodic maintenance</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Monitors room air temperature</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Monitors supply/return air temperature</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Monitors diffuser supply air temperature</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Monitors diffuser supply air volume</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Network Protocol</td>
<td>Analog</td>
<td>BACnet™</td>
<td>BACnet™</td>
</tr>
<tr>
<td>Other Network Functions</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Diffuser power</td>
<td>Thermal</td>
<td>Thermal</td>
<td>Electric Motor</td>
</tr>
<tr>
<td>Installed cost</td>
<td>$</td>
<td>$</td>
<td>$</td>
</tr>
<tr>
<td>Warranty*</td>
<td>10 Year</td>
<td>10 Year</td>
<td>2 Year</td>
</tr>
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</table>

*Not applicable to options and accessories.

### System Options Table

<table>
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<tr>
<th>System Options</th>
<th>Thermal</th>
<th>Electric</th>
<th>Hybrid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Therma-Fuser stand-alone thermally powered VAV Diffusers</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Advanced series electric motor VAV Diffusers</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Interoperable BACnet building control network VAV diffusers</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Therma-Fuser diffusers + Interoperable diffusers</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
VAV Diffuser System Options

The example below demonstrates some of the many product options available. Selections should be based on individual project requirements.

1. **STATIC PRESSURE CONTROL**
   - PIM Pressure Independence Module
   + Provides static pressure control as diffusers open and close
   + Systems with a constant volume fan may use the PIM as a bypass

2. **DUCT HEAT**
   - Aqua-Zone Hot Water or Electric Duct Heaters
   + Provides constant supply air temperature at design and low airflow ratios

3. **TYPICAL ZONE – STAND-ALONE**
   - TF or ST Square Flinger Diffusers
   + Provides comfort and energy savings of individual temperature control
   + Easy adaptability to office changes
   + Maintenance free operation

4. **ARCHITECTURAL EXPOSED DUCT CEILING**
   - STB Round Diffuser
   + Round shape blends with architectural features or exposed round duct work

5. **ELEGANT LINEAR DESIGN**
   - TL Linear Slot Diffuser
   + Ideal for ceiling or sidewall applications
   + Streamlined aluminum extrusions provide continuous, slim architectural appeal

6. **SETPOINT CONTROL OPTION**
   - ADJ-D Digital & ADJ-W Wireless Wall Adjuster
   + Allow the occupant to easily adjust the temperature setpoint
   + Available on all Therma-Fuser Series diffusers

7. **SPECIAL ZONE – INTERMITTENT USE**
   - Advantage with Occupancy Sensor
   + Balances comfort and energy
   + Changes temperature and minimum flow setpoint when space is unoccupied

8. **SPECIAL ZONE – HIGH MAX CAPACITY AND INTERMITTENT USE**
   - Advantage with CO₂ Sensor and Drone
   + Balances ventilation and energy
   + Reduces minimum flow rate when high occupancy areas are unoccupied

9. **TYPICAL ZONE – NETWORKED**
   - TF and CL Interoperable Diffusers
   + BACnet Interoperability available for most models of diffusers and accessories

10. **SPECIAL ZONE – INTERMITTENT USE**
    - Advantage with Occupancy Sensor
    + Balances comfort and energy
    + Changes temperature and minimum flow setpoint when space is unoccupied

11. **SPECIAL ZONE – HIGH MAX CAPACITY AND INTERMITTENT USE**
    - Advantage with CO₂ Sensor and Drone
    + Balances ventilation and energy
    + Reduces minimum flow rate when high occupancy areas are unoccupied

12. **ELEGANT LINEAR DESIGN**
    - TL Linear Slot Diffuser
    + Ideal for ceiling or sidewall applications
    + Streamlined aluminum extrusions provide continuous, slim architectural appeal

13. **SETPOINT CONTROL OPTION**
    - ADJ-D Digital & ADJ-W Wireless Wall Adjuster
    + Allow the occupant to easily adjust the temperature setpoint
    + Available on all Therma-Fuser Series diffusers

14. **TYPICAL ZONE – NETWORKED**
    - TF and CL Interoperable Diffusers
    + BACnet Interoperability available for most models of diffusers and accessories
2 x 2 ft. Square Diffuser with Blade Damper
(24 in. / 600 mm square)
Therma-Fuser™ Series - TK
Four blade dampers provide superior throw with 80 linear inches of
variable discharge area.

<table>
<thead>
<tr>
<th>Detail</th>
<th>6 in. / 150 mm</th>
<th>8 in. / 200 mm</th>
<th>10 in. / 250 mm</th>
<th>12 in. / 300 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>24 x 24 in.</td>
<td>32 x 32 in.</td>
<td>40 x 40 in.</td>
<td>48 x 48 in.</td>
</tr>
<tr>
<td>Pressure ranges</td>
<td>0.05 to 0.25 in. wg</td>
<td>0.05 to 0.25 in. wg</td>
<td>0.05 to 0.25 in. wg</td>
<td>0.05 to 0.25 in. wg</td>
</tr>
<tr>
<td>Air volumes</td>
<td>115 to 265 CFM</td>
<td>260 to 640 CFM</td>
<td>535 to 1000 CFM</td>
<td>730 to 1500 CFM</td>
</tr>
<tr>
<td>Throw</td>
<td>8/6/4 to 13/10/8 ft.</td>
<td>13/10/8 to 18/15/12 ft.</td>
<td>18/15/12 to 23/19/16 ft.</td>
<td>23/19/16 to 28/24/21 ft.</td>
</tr>
<tr>
<td>Noise</td>
<td>&lt;15 to 37 NC</td>
<td>&lt;15 to 37 NC</td>
<td>&lt;15 to 37 NC</td>
<td>&lt;15 to 37 NC</td>
</tr>
</tbody>
</table>

1Throw for Δ 20ºF / 11ºC at v t= 50 / 100 / 150 FPM / 0.25 / 0.50 / 0.75 m/s
2Noise based on L w(10-12 watts reference)-10db

1 x 1 ft. Square Diffuser with Blade Damper
(12 5/8 in. / 320 mm square)
Therma-Fuser™ Series - TK
Specially designed for small task conditioning. Four blade damper
provides superior throw.

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<tr>
<th>Detail</th>
<th>6 in. / 150 mm</th>
</tr>
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<tbody>
<tr>
<td>Diameter</td>
<td>12 5/8 x 12 5/8 in.</td>
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<tr>
<td>Pressure ranges</td>
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<td>Air volumes</td>
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1Throw for Δ 20ºF / 11ºC at v t= 50 / 100 / 150 FPM / 0.25 / 0.50 / 0.75 m/s
2Noise based on L w(10-12 watts reference)-10db
Wall Adjusters and Thermostats

**Advantage Series - ADJ**

Acu-Zone Electric Zone Heater

Thera-Fuser™ Series - AZON-I-E & AZON-II-E

The Acu-Zone™ electric zone heaters use a patented airflow sensor and the most advanced modulating SCR (Silicon Controlled Rectifier) proportional heat controller to vary the electrical power through the coil. Electric heating units available in round, square and rectangular sizes.

Control
- SCR
- PID

Valve
- PICCV or CCV

Coil inlet diameter
- 6/8/10/12/14/16 in. 150/200/250/300/350/400 mm

Coil heating
- 5 1 to 111.6 MBH 17.4 to 380.9 kW

Coil air volumes
- 200 to 3300 cfm 94 to 1557 l/s

Power
- Varies by size

Additional Options:
- Optional one or two row coil

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**Options & Accessories**

Acu-Zone Hot Water Zone Heater

Thera-Fuser™ Series - AZON-II-W

The Acu-Zone hot water zone heaters use a modulating PI (proportional/ integral) heat controller to vary the hot water through the coil and prevent excessive valve cycling.

Control
- PID

Valve
- PICCV or CCV

Coil inlet diameter
- 6/8/10/12/14/16 in. 150/200/250/300/350/400 mm

Coil heating
- 5 1 to 111.6 MBH 17.4 to 380.9 kW

Coil air volumes
- 200 to 3300 cfm 94 to 1557 l/s

Pressure
- Varies by size

Additional Options:
- Optional two or four way valve

---

VAV Diffuser Blow Patterns

- Custom air patterns are available for most models.
- Contact Acu-Therm for additional information.

**Square Therma-Fuser Diffuser**

- 4-Row Blow
- 3-Row Blow
- 2-Row Blow
- 1-Row Blow

**Linear Therma-Fuser Diffuser**

- 1-Row 1-Way
- 2-Row 1-Way
- 2-Row 2-Way

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Linear Diffuser – Ceiling, Wall, Individual, or Continuous

**Advantage Series - ADJ**

Advanced linear design for individual units or continuous linear runs. VAV diffusers with streamlined aluminum extrusions to provide a slim architectural shape.

Length
- 24 / 36 / 48 / 60 in. 600 / 900 / 1200 / 1500 mm

Slots
- multiple slots and blow patterns available

Pressure ranges
- 0.05 to 0.25 in. wg 12 to 62 Pa

Air volumes
- 45 to 960 CFM 20 to 455 l/s

Throw
- 4/3/2 to 40/33/25 ft. 1.2/0.9/0.6 to 12.2/10.0/7.6 m

Noise
- <15 to 42 NC <15 to 42 NC

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VAV Diffuser Products

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Acu-Therm Pressure Relief Collar and Relief Ring

Thera-Fuser™ Series / Advantage Series / Interoperable Series

The Acu-Therm Pressure Relief Collar and Relief Ring are both inexpensive solutions when duct pressures are higher than desired. When the diffuser reduces the air flow into the room these devices bypass the excess air into the plenum return system. Relief Rings are smaller but limited to 6, 8 and 10 in. inlets. Pressure Relief Collars are available up to 14 in. inlets.

<table>
<thead>
<tr>
<th>Size</th>
<th>Height</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 / 8 / 10 in.</td>
<td>150 / 200 / 250 mm</td>
<td>Steel</td>
</tr>
<tr>
<td>3 1/4 in.</td>
<td>121 mm</td>
<td>Brass</td>
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Acu-Zone Hot Water Zone Heater

Thera-Fuser™ Series - AZON-II-W

The Acu-Zone hot water zone heaters use a modulating PI (proportional/integral) heat controller to vary the hot water through the coil and prevent excessive valve cycling.

Control
- PID

Valve
- PICCV or CCV

Coil inlet diameter
- 6/8/10/12/14/16 in. 150/200/250/300/350/400 mm

Coil heating
- 5 1 to 111.6 MBH 17.4 to 380.9 kW

Coil air volumes
- 200 to 3300 cfm 94 to 1557 l/s

Power
- Varies by size

Additional Options:
- Optional two or four way valve

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VAV Diffuser Blow Patterns

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Acu-Zone Electric Zone Heater

Thera-Fuser™ Series - AZON-I-E & AZON-II-E

The Acu-Zone™ electric zone heaters use a patented airflow sensor and the most advanced modulating SCR (Silicon Controlled Rectifier) proportional heat controller to vary the electrical power through the coil. Electric heating units available in round, square and rectangular sizes.

Control
- SCR
- PID

Valve
- PICCV or CCV

Coil inlet diameter
- 6/8/10/12/14/16 in. 150/200/250/300/350/400 mm

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Coil air volumes
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Power
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Additional Options:
- Optional one or two row coil

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Linear Therma-Fuser Diffuser

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Acu-Therm Pressure Relief Collar and Relief Ring

Thera-Fuser™ Series / Advantage Series / Interoperable Series

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Control
- PID

Valve
- PICCV or CCV

Coil inlet diameter
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Coil heating
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VAV Diffuser Blow Patterns

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Therma-Fuser System Design

The Therma-Fuser diffuser is a simple stand-alone or networked device that provides VAV control when supplied with air in a suitable range of temperature and pressure.

Supply Air Temperature
When supplied with cool air, the Therma-Fuser dampers modulate open on a rise in room temperature. When supplied with warm air, the dampers open on a room temperature drop.

Cool air should be a constant temperature not less than 50°F/10°C for standard models and warm air at a constant temperature of not more than 120°F/49°C. The constant discharge velocity of Therma-Fuser diffusers at varying air flow provides good room circulation which reduces stratification. Keeping heating supply air temperature as low as possible will further reduce room air stratification to a negligible level.

Static Pressure
Noise level at any air diffuser is influenced by air velocity through the diffuser which is, in turn, a function of static pressure in the neck of the diffuser. Noise level at a Therma-Fuser diffuser will not increase as it closes if the static pressure in the neck is held constant. As static pressure in the neck increases, sound level increases. Changeover from cooling to heating occurs as the supply air drops from 72°F/22°C to 68°F/20°C. Because Therma-Fuser diffusers control room temperature by sensing room air induced up the center of the space, care should be taken not to disturb room air induction and entrainment. For example, location near to walls or dropped lights results in the reflection of primary induction and entrainment.

Location
Because Therma-Fuser diffusers control room temperature by sensing room air induced up the center of the space, care should be taken not to disturb room air induction and entrainment. For example, location near to walls or dropped lights results in the reflection of primary induction and entrainment. Therma-Fuser diffusers should be located so that the supply air reaches the required air volume for room air induction. Static pressure above 0.25"wg/62 Pa may cause the sound level to become noticeable (NC25).

Duct Design
The goal of a high performance duct design is to design for lowest possible static pressure while providing ample air to each space. Duct design example: If Therma-Fuser diffusers are to deliver nominal volume at inlet SP of 0.15"wg/37 Pa and if a maximum SP of 0.25"wg/62 Pa is to be held for quiet operation, size the duct for a maximum pressure drop of 0.1"wg/25 Pa between the first and last takeoff. Manual balancing dampers should be used at the takeoff for each diffuser. Manual balancing dampers may not be required with ducts designed to Acutherm specifications.

System Design Checklist

Note: This is a general checklist. For detailed recommendations about specific systems visit www.acutherm.com

1. THERMA-FUSER DIFFUSER SIZE AND LOCATION
- Air volume sufficient for room needs. Correct inlet sizing for available static pressure.
- All Therma-Fuser diffusers within two feet of wall equipped with three-way blow away from wall.
- Multiple Therma-Fuser diffusers in same room—space no less than two times the 150 fpm/.76 m/s throw, use three-way blow if closer.
- Zone Control damper
- Fan Control
- Static pressure sensor located

2. SUPPLY AIR TEMPERATURE — Cooling Min. 50°F /10°C
- Heating Max. 120°F /49°C
- Changeover To Cooling 60°F /26°C
- To Cooling 68°F /20°C
- Source of cooling:
  - Chilled water AHU
  - DX
- Source of heating:
  - AHU: Heat Pump
  - Gas
  - Hot Water
  - Electric
  - Steam
- Separate perimeter heat —
  - Baseboard
  - Radiant panels
  - Separate duct
- Portions of building in one master zone:
  - One exterior
  - Separate master zones are preferred for the interior and each exposure
  - More than one exterior
  - Interior
  - Other

3. STATIC PRESSURE
- Inlet Min. 0.05"wg/12 Pa
- High Enough For Required Air Volume
- Inlet Max. 0.25"wg/62 Pa For NC 25 Or Less
- Control
- Less than 50% turndown of system air—static pressure control usually not necessary
- Over 50% turndown of system air—static pressure control necessary
- Fan Control
- Zone Control damper
- Supply
- Damper
- Acutherm PIM
- R-Bags—use only with ceiling plenum return
- Both fan and zone control

4. Duct Design
- Supply
- Static pressure no higher than 0.25"wg/62 Pa at the first takeoff (ceiling plenum from the static pressure control)
- Sufficient static pressure at the last Therma-Fuser diffuser to obtain the required airflow. Size last Therma-Fuser diffuser larger to achieve required flow at lower static pressures.
- Zone dampers are necessary when pressure losses in ducts are too high
- Manual balancing dampers should be used at the takeoff for each diffuser. Manual balancing dampers may not be required with ducts designed to Acutherm specifications.

Note: Do not use a return air thermostat (sensor) in return plenum.

Job Name _________________________________________________________________________

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- Supply air fan:
  - Fan runs continuously
  - Location of thermostat (or BMS sensor) used to control the AHU water valves or DX compressor.
- Water: do not use a return air thermostat (sensor)
- Supply air temperature controlled by discharge air temperature sensor
- Note: Separate master zones are preferred for the interior and each exposure

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