Basic Selection & Proper Application of Overhead Air Distribution Devices
GRD Selection & Application

- Terms
- Selection
  - Throw
  - Sound
- Installation Variations affect Performance
- Inlet Effects
Basics

- Return Air
- Coanda
- Total Air
- Primary Air
- Induced Room Air
- Entrained Room Air
Basics

• ASHRAE Standard 70-2006
  – Standard Defines Testing Procedures, Spaces, and Equipment
  – Isothermal Testing
  – Non-Turbulent, Smooth Inlet Conditions
  – Obtain Catalog Data
Selection – Throw

1) Throw – Distance to a specified $V_t$
2) Terminal Velocity ($V_t$) – Maximum airstream velocity at the end of a throw.
Selection – Throw

- Outlet Patterns – 150 cfm – 6” Inlet
Selection – Throw

- 380 cfm, 10” Neck, 700 fpm, $T_{50}$
  - 10’ Square Cone
  - 9’ Round Cone
  - 14’ 4 Way - Perf Curved Vane
  - 33’ 1 Way - Perf Curved Vane
  - 24’ 4 Way - Louver Face
Selection – Throw

- Deflection and Spread
Selection – Throw

• Throw Boundaries – Mapping

\[ V_t \text{ Maximum of } 75 \text{ fpm} \]

Occupied Zone
Selection – Throw

• Occupied Zone
Selection – Throw

- Generally:

\[ \text{Throw} (V_t \text{ at 50 fpm}) = \text{Distance to Boundary} \]
Selection – Throw

Tested in accordance with ASHRAE Standard 70-2006 “Method of Testing for Performance of Air Outlets and Inlets.”

Radii of diffusion are given in feet to terminal velocities of 150 fpm (minimum), 100 fpm (middle) and 50 fpm (maximum).

Throw data is based on supply air and room air being at isothermal conditions.
Selection – Throw

- Non-Isothermal Effects

Adjust Throw at $V_t = 50$ fpm
1% Per °F of Differential

<table>
<thead>
<tr>
<th></th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal</td>
<td>−</td>
<td>+</td>
</tr>
<tr>
<td>Vertical</td>
<td>+</td>
<td>−</td>
</tr>
</tbody>
</table>
Selection – Throw

- Exposed Mount vs. Surface Mount

Exposed Mount
Reduce Throw

30%
Selection – Throw

**Heating & Cooling** w/ OHAD

- Locate in from wall
- Discharge to perimeter
- Generally slot diffusers
- Cooling Airflow – 50 fpm at floor
- Heating Airflow – 50 fpm at 2/3 down the wall
Selection – Throw

• Obstructions
  – Air jet will typically remain on surface, if angle created by the ceiling, diffuser, and bottom of obstruction is $<10^\circ$.
  – From testing, angle can be as great as $15^\circ$. 
Selection – Sound

• Catalog Data
  – NC Rating
    • Average Room Size
    • Distance from Source
  – Assumes 10 dB Room Absorption
  – Single Diffuser or Standard Length
Selection – Sound

Approximate threshold of hearing for continuous noise.

(Band Center Frequencies, \(H^2O\))

(American Standard S 1.6 1990)
Selection – Sound

Table A. Throw Correction Multiplier for Length

<table>
<thead>
<tr>
<th>Length, Feet</th>
<th>2</th>
<th>4</th>
<th>8</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throw</td>
<td>0.9</td>
<td>1.0</td>
<td>1.1</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Table B. NC Correction for Length

<table>
<thead>
<tr>
<th>Length, Feet</th>
<th>2</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply</td>
<td>-2</td>
<td>0</td>
<td>+2</td>
<td>+3</td>
<td>+5</td>
</tr>
<tr>
<td>Return</td>
<td>0</td>
<td>+3</td>
<td>+5</td>
<td>+6</td>
<td>+8</td>
</tr>
</tbody>
</table>
## Selection – Sound

<table>
<thead>
<tr>
<th>Room Types</th>
<th>Recommended Level[^ab]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private residences</td>
<td>25-35</td>
</tr>
<tr>
<td>Hotels/Motels</td>
<td></td>
</tr>
<tr>
<td>Individual rooms or suites</td>
<td>25-35</td>
</tr>
<tr>
<td>Meeting/banquet rooms</td>
<td>25-35</td>
</tr>
<tr>
<td>Corridors, lobbies</td>
<td>35-45</td>
</tr>
<tr>
<td>Service/support areas</td>
<td>35-45</td>
</tr>
<tr>
<td>Office Buildings</td>
<td></td>
</tr>
<tr>
<td>Executive and private offices</td>
<td>25-35</td>
</tr>
<tr>
<td>Conference rooms</td>
<td>25-35</td>
</tr>
<tr>
<td>Tele-conference rooms</td>
<td>25 (max)</td>
</tr>
<tr>
<td>Open-plan offices</td>
<td>30-40</td>
</tr>
<tr>
<td>Corridors and lobbies</td>
<td>40-45</td>
</tr>
</tbody>
</table>

[^ab]: References and notes for recommended levels.
Selection – Sound

24” x 24” Diffuser, 380cfm, 700 fpm Neck Velocity

NC 17
NC 18
NC 22
NC 21/31
NC 28-33
Selection – Sound

1 - 1” Slot, 4’, 270 cfm, 800 fpm Neck Velocity

NC 31
NC 36
NC 37
NC 45
Installation – Sound

Proper and Improper Airflow Conditions to an Outlet

- Basis of Manufacturer’s Rating
- Sound Levels same as Manufacturer’s Rating with Equalizing Grid
- Sound Levels up to 12 dB Higher with NO Equalizing Grid
Installation – Sound

Effect of Proper and Improper Alignment of Flexible Duct Connector

- Sound Levels same as Manufacturer’s Rating
- Sound Levels up to 12 to 15 dB higher than Manufacturer’s Rating
Balancing Dampers

- Some outlets cataloged with damper in open position
- Sound Increase depends on:
  - damper design
  - ratio of throttled pressure over cataloged pressure drop

<table>
<thead>
<tr>
<th>Pressure Ratio</th>
<th>1.5</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>dB/NC Increase</td>
<td>4</td>
<td>6</td>
<td>13</td>
<td>18</td>
</tr>
</tbody>
</table>
Installation – Sound

Damper Location
Pressure Ratio = 2
(normal pressure drop X 2)
Inlet Effects
ASHRAE Standard 70 – Throw Room

- Measurements taken in a ‘Standard Test Room’
  - Height => 9’
  - Minimum Length = 24’
  - Minimum Width = 18’
  - All lights and windows shall be flush to the surface they are attached.
  - Air exhausted away from supply path.
ASHRAE Standard 70 – Inlet Conditions

• 2 Different Types of Test Ducts
  – Large Pressurized plenum
  – 3 Diameters Straight duct

• Air outlet device is to receive uniformly distributed air from the supply duct.
Effect of Inlet Conditions on Throw

• Test Standard Installation
  – Repeatable, uniform throw distances
  – Repeatable, drop
  – Repeatable, discharge pattern

• Hard 90 Degree Elbow
• Flex Duct 90 Degree Elbow
• Radial Opposed Blade Damper
• Butterfly Damper
• Bowtie Damper
A “Special” Field Installation
New Style Adapter
More Poor Workmanship Examples
Louver Face Ceiling Diffuser
Louver Face Ceiling Diffuser

9x9 to 8" Long

Isothermal 350 CFM
Louver Face Ceiling Diffuser
Louver Face Ceiling Diffuser
- Test Standard Installation

350 CFM
Louver Face Ceiling Diffuser
- Hard 90 Degree Elbow

350 CFM
Louver Face Ceiling Diffuser
- Flex Duct 90 Degree Elbow

350 CFM
AHHHH!! FLEX MONSTER!!
Louver Face Ceiling Diffuser
- Radial Opposed Blade Damper

350 CFM – Damper set for 0.25 inches of water
Louver Face Ceiling Diffuser - Butterfly Damper

350 CFM – Damper set for 0.25 inches of water
Louver Face Ceiling Diffuser - Bowtie Damper

350 CFM – Damper set for 0.25 inches of water
More Poor Workmanship Examples
Plaque Ceiling Diffuser
Plaque Ceiling Diffuser
Plaque Ceiling Diffuser
Plaque Ceiling Diffuser
- Test Standard Installation

350 CFM
Plaque Ceiling Diffuser
- Hard 90 Degree Elbow

350 CFM
Plaque Ceiling Diffuser
- Flex Duct 90 Degree Elbow

350 CFM
Plaque Ceiling Diffuser
- Radial Opposed Blade Damper

350 CFM – Damper set for 0.25 inches of water
Plaque Ceiling Diffuser
- Butterfly Damper

350 CFM – Damper set for 0.25 inches of water
Plaque Ceiling Diffuser

- Bowtie Damper

350 CFM – Damper set for 0.25 inches of water
Ceiling Slot Diffuser

Square Plenum

Sloped Plenum
Ceiling Slot Diffuser
Ceiling Slot Diffuser
- Test Standard Installation

350 CFM with straight plenum

350 CFM with sloped plenum
Ceiling Slot Diffuser
- Hard 90 Degree Elbow

350 CFM with straight plenum

350 CFM with sloped plenum
Ceiling Slot Diffuser
- Flex Duct 90 Degree Elbow

350 CFM with straight plenum

350 CFM with sloped plenum
Ceiling Slot Diffuser
- Radial Opposed Blade Damper

350 CFM with straight plenum (dpr set to .25inWC)

350 CFM with sloped plenum (dpr set to .25inWC)
Ceiling Slot Diffuser - Butterfly Damper

350 CFM with straight plenum (dpr set to .25inWC)

350 CFM with sloped plenum (dpr set to .25inWC)
Ceiling Slot Diffuser
- Bowtie Damper

350 CFM with straight plenum (dpr set to 0.25inWC)

350 CFM with sloped plenum (dpr set to 0.25inWC)
Workmanship Counts!
Inlet Effects on Sidewall Grilles (12X6)

0 Dia

1 Dia

2 Dia

3 Dia
Sidewall Grille Video (12X6)
GRD Selection & Application

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• Inlet Effects