Silencing HVAC Equipment at the Source

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Source Noise Control

Source Noise Control for HVAC Equipment:

• Often Challenging Solutions
• Typically Retrofitting Existing Installations
• Requires Knowledge of Construction Methods and Pre-Engineered Products
• Creativity A Plus
• Must Understand The Entire Situation
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Outline For This Morning:

• Review Required Noise Reduction Criteria
• “Solution” Evaluation
  • Noise Source, Products, Equipment Layout
• Noise Control Recommendations/Options
  • Enclosures, Direct Mount Equip., Barriers
• Case Histories
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NOISE REDUCTION CRITERIA:

• Level of Attenuation Required
  - “Take the Edge Off” or “Make it Quiet”
• Location and Proximity to the Receiver
  - Directivity (Any Benefits?), Propagation
• Signature of Noise
  - Pure Tone, Spectrum Noise, Pulsation
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NOISE REDUCTION CRITERIA:

• Level of Attenuation Required
  • Less than 12 dB(A)
  • Between 12 dB(A) and 20 dB(A)
  • Greater than 20 dB(A)
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NOISE REDUCTION CRITERIA:

• Location and Proximity to the Receiver
  • Directivity - Vertical Discharge Possible?
  • Proximity - Is the Problem in one direction?
• Site Configuration
  • Design Attenuation Only for the Need.
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**NOISE REDUCTION CRITERIA:**

- **Directivity “Angle”**

  Used in determining the Directivity Index in Outdoor Sound Propagation under free field conditions. Very helpful tool.
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NOISE REDUCTION CRITERIA:

• Proximity

  Very important in the initial design to account for the advantage of the Divergence

  - **Near Field**, Large sound pressure level variations with small changes in position from the source

  - **Far Field**, Sound pressure decreases inversely with distance (6dB reduction for each doubling of distance)

  - **Free Field**, Sound propagates in all directions without obstructions or reflections
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NOISE REDUCTION CRITERIA:

• Site Configuration

Questions to ask:

- Is there an adjacent wall(s) that could be reflective
- Is there an adjacent wall(s) that could be utilized for solution
- Is the receiver at a different elevation than the source
- What is the integrity of roof (roof mounted application)

-This could limit your choice of solutions-
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NOISE REDUCTION CRITERIA:

• Signature of the Noise Source
  • Pure Tone - Most complaints, care required in solution
  • Broad Spectrum - Typically easier to attenuate
  • Pulsation - Specific designs
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SOLUTION EVALUATION:

• Is Noise Radiating or is it being Discharged?

• Pressure Drop Allowances:
  • Total Pressure Drop
  • Intake vs. Exhaust
  • DIL vs. $\Delta P$

• Air Flow and Circulation Requirements

• Pre-Engineered Product Selection
SOLUTION EVALUATION:

Is Noise Radiating or is it being Discharged?

- Radiating or Casing Noise
- Noise Emitted Predominately Thru-Exhaust
- Noise Emitted Predominately Thru-Intake
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SOLUTION EVALUATION:

Pressure Drop Allowances:

• Total Pressure Drop
• Intake vs. Exhaust
• DIL vs. $\Delta P$
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SOLUTION EVALUATION:

Air Flow and Circulation

- Avoid Re-circulation
- Maintain Laminar Flow
- “Clean” Layouts
SOLUTION EVALUATION:

SOURCE Noise Control Product Selection Utilizing Pre-Engineered Products

- Rectangular Silencers (aka Sound Traps, Attenuators)
- Round Silencers
- Acoustic Louvers
- Acoustic Panel Systems
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SOLUTION EVALUATION:

Silencers
- Dynamic Insertion Loss (DIL)
- Configurations
- Pressure drop
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SOLUTION EVALUATION:

Silencer Selection Procedure

• What is the allowable noise level Exiting the Unit?
• Where in the spectrum do I need attenuation?
  - Low, middle, high frequency noise concern
• What pressure drop is acceptable?
  - Low, medium, high velocity system
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SOLUTION EVALUATION:

Silencer Selection Procedure

• What silencer fits my application?
  - Low Frequency, Mid Frequency.

• What silencer fits the physical space?
  - Cataloged sizes.
  - Q-Duct Modules or Custom Baffles.
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SOLUTION EVALUATION:

Typical Silencer Design Parameters

• Face Velocity Below 1,000 FPM
• Allowable Pressure Drop for the Entire System
• IL Typically Required in the Low to Mid Frequency Range. (Varies Due to the Equipment)
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SOLUTION EVALUATION:

Silencers “Three Banks”
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SOLUTION EVALUATION:

Acoustic Louvers

• 12”, 6”, 4” thickness
• Broad band attenuation, Limited DIL
• Great aesthetics
• Galvanized, stainless, aluminum materials
• Baked enamel available
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SOLUTION EVALUATION:

Acoustic Louver - 12”
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SOLUTION EVALUATION:

Standard Pre-Engineered Panel Systems

Typical 4” Thickness

Perforated “Absorptive” Liner

Solid Exterior

Standard Joiners, Fast Installation
## SOLUTION EVALUATION:

**Typical 4” Panel Selection:**

<table>
<thead>
<tr>
<th>OCTAVE BAND, Hz.</th>
<th>63</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1K</th>
<th>2K</th>
<th>4K</th>
<th>8K</th>
<th>STC</th>
<th>Wt^3/lb/ft^2</th>
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<tr>
<td>Noishield Septum</td>
<td>21</td>
<td>19</td>
<td>23</td>
<td>35</td>
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<td>21</td>
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<td>58</td>
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<td>27</td>
<td>28</td>
<td>41</td>
<td>50</td>
<td>57</td>
<td>57</td>
<td>64</td>
<td>43</td>
<td>10.5</td>
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<tr>
<td>Noise-Lock I</td>
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<td>27</td>
<td>31</td>
<td>41</td>
<td>51</td>
<td>60</td>
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<td>Noise-Lock II and Fire Noise-Lock</td>
<td>27</td>
<td>30</td>
<td>32</td>
<td>41</td>
<td>50</td>
<td>59</td>
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<td>71</td>
<td>45</td>
<td>10.5</td>
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<td>45</td>
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<td>10</td>
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<td>41</td>
<td>46</td>
<td>50</td>
<td>52</td>
<td>54</td>
<td>56</td>
<td>49</td>
<td>7.3</td>
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<tr>
<td>Super-Noise-Lock</td>
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<td>34</td>
<td>35</td>
<td>44</td>
<td>54</td>
<td>63</td>
<td>62</td>
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<td>48</td>
<td>15</td>
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<tr>
<td>Trackwall Hard</td>
<td>31</td>
<td>38</td>
<td>43</td>
<td>48</td>
<td>53</td>
<td>53</td>
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<td>Noishield Hard</td>
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<td>57</td>
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<td>78</td>
<td>61</td>
<td>12</td>
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<td>Noise-Lock IV Hard</td>
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<td>60</td>
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<td>79</td>
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<td>62</td>
<td>11.3</td>
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<td>Gemini Regular</td>
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<td>48</td>
<td>58</td>
<td>69</td>
<td>75</td>
<td>82</td>
<td>86</td>
<td>76</td>
<td>70</td>
<td>21</td>
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</tbody>
</table>
SOLUTION EVALUATION:

Absorption Characteristics:

• Regular Construction Includes Absorption

• Absorption GREATLY Increases Insertion Loss While providing Equal Noise Reduction

<table>
<thead>
<tr>
<th>OCTAVE BAND, Hz.</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1K</th>
<th>2K</th>
<th>4K</th>
<th>8K</th>
<th>NRC</th>
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<tbody>
<tr>
<td>Regular Panel</td>
<td>0.89</td>
<td>1.2</td>
<td>1.16</td>
<td>1.1</td>
<td>1</td>
<td>1</td>
<td>0.9</td>
<td>(1.10)0.95</td>
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</tbody>
</table>
# Solution Evaluation:

## Typical Construction Systems:

<table>
<thead>
<tr>
<th>CONSTRUCTION</th>
<th>THICK In. (mm)</th>
<th>Weight lb/ft² (kg/m²)</th>
<th>STC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plaster/Gypsum</td>
<td>4 (102)</td>
<td>14.4 (70)</td>
<td>39</td>
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<tr>
<td><strong>STANDARD PANEL</strong></td>
<td>4 (102)</td>
<td>8.0 (39)</td>
<td>40</td>
</tr>
<tr>
<td>Hollow Masonry Block, Plastered Both Sides</td>
<td>6.9 (175)</td>
<td>32.0 (156)</td>
<td>45</td>
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<tr>
<td><strong>UL FIRE-RATED PANEL</strong></td>
<td>4 (102)</td>
<td>10.5 (51)</td>
<td>45</td>
</tr>
<tr>
<td>Solid Concrete, Painted</td>
<td>4 (102)</td>
<td>37.0 (181)</td>
<td>47</td>
</tr>
<tr>
<td>Acoustic Block, Painted</td>
<td>6 (152)</td>
<td>30.0 (146)</td>
<td>48</td>
</tr>
<tr>
<td>Solid Concrete</td>
<td>12 (305)</td>
<td>150.0 (732)</td>
<td>53</td>
</tr>
<tr>
<td>Solid Concrete, Painted 1/2in. Shpsum Board, 1Side</td>
<td>6.5 (165)</td>
<td>55.0 (269)</td>
<td>55</td>
</tr>
<tr>
<td><strong>HARD PANEL</strong></td>
<td>4 (102)</td>
<td>9.5 (46)</td>
<td>56</td>
</tr>
</tbody>
</table>
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SOLUTION EVALUATION:

Pre-engineered Panel Systems Provide:

- Reliable and CONSISTANT Performance
- Lighter Weight to Performance Ratio (Critical for roof-mount apps.)
- Built-in Absorption, (Therefore, Increased Insertion Loss Performance)
- Fast On-site Installation (reduced Labor)
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SOLUTION EVALUATION:

Air-Cooled Chillers:
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SOLUTION EVALUATION:

Air-Cooled Chillers & Condensers:

- Open Top Enclosures
- Partial Panelized Enclosures
- Exhaust (Discharge) Silencers
- Barrier Walls
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SOLUTION EVALUATION:

Air Handling Units:
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SOLUTION EVALUATION:

Air Handling Units:

• Barrier Walls
• Open Top Enclosures
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SOLUTION EVALUATION:

Air Cooled Condensers:
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SOLUTION EVALUATION:

Air Cooled Condensers:

- Full Enclosures
  - Intake and Exhaust Silencers
  - Pre-Engineered Panel Enclosures
- Open Top Enclosures
- Direct Mount Discharge Silencers
- Barrier Walls
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NOISE CONTROL RECOMMENDATIONS:

• Enclosures (20dB and Greater)
  - Complete

• Direct Mount Equipment (12dB - 20dB)
  - Typically Silencers or Partial Enclosure

• Barriers (12 dB and Less)
  - Wall Systems
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NOISE CONTROL RECOMMENDATIONS:

• Enclosures (20dB and Greater)
  • Complete, 4 sided with roof
    • Ventilation and Access Doors
    • Utilizing Pre-Engineered Systems
  • Partial, Any side open or elevated
    • No Attenuated Ventilation Systems
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NOISE CONTROL RECOMMENDATIONS:

- Direct Mount Equipment (12dB - 20dB)
- Partial Enclosures coupled with:
  - Silencers
  - Louvers
  - Access Doors and Windows
- Attached Plenums with Silencers
- Direct mounted Louvers/ Silencers
NOISE CONTROL RECOMMENDATIONS:

• Barriers (12 dB and Less)
  • Performance is Dependent on Proximity To Noise Source and Wall Height
  • Typical Height Ranges From 8 ft to 30 ft
  • Walls Run Parallel to the Noise Source
  • Absorptive; Stops Noise Reflections Towards Previously Unaffected Areas
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CASE HISTORIES:

• Open Top & Open Bottom Enclosure
  “Air Cooled Condenser”

• Direct Mounted Silencer System
  “Air-Cooled Chiller”
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CASE HISTORIES:

• CONDENSER ENCLOSURE
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CASE HISTORIES:

• CONDENSER ENCLOSURE
Source Noise Control

CASE HISTORIES:

• CONDENSER ENCLOSURE
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CASE HISTORIES:

• CONDENSER ENCLOSURE
  • 4” Regular Panel
    Perforated Interior, Solid Exterior Skin
  • 9” Below Bottom of Condenser
  • 19” Above the Top of Condenser
  • Materials Delivered for under $1,000.00
  • 17 dB(A) reduction at 10’
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CASE HISTORIES:

• DIRECT MOUNT SILENCER
Source Noise Control

CASE HISTORIES:

• DIRECT MOUNT SILENCER
Source Noise Control

CASE HISTORIES:

• DIRECT MOUNT SILENCER
CASE HISTORIES:

• DIRECT MOUNT SILENCER

• One Piece “Module”
• Design Based on 3’-0”, low pressure silencer
• Bolt-On Design
• 8’ High Discharge Stack, silencers in top 3’
• 4” Regular Panel Casing

Perforated Interior, Solid Exterior Skin
CASE HISTORIES:

• DIRECT MOUNT SILENCER
  • Existing Barrier gave limited performance
  • Treat the Discharge with combination of Products
  • Panels for Stack, Sound Traps for Attenuation
  • Fast On-site attenuation
  • Materials delivered for under $3,500.00
  • 18 dB(A) reduction at 15’

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