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# Silencing HVAC Equipment **at the** Source



John Finnegan, Product manager  
Industrial Acoustics Company  
Bronx, NY





# Source Noise Control

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## 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.

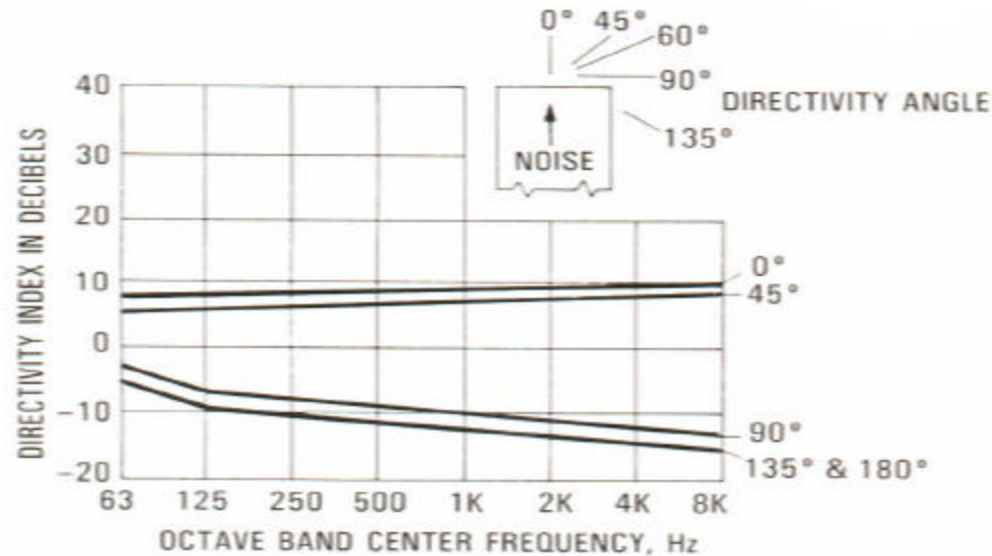


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## NOISE REDUCTION CRITERIA:

- 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
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## 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





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## 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

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## SOLUTION EVALUATION:

### Typical 4" Panel Selection:

OCTAVE BAND, Hz.	63	125	250	500	1K	2K	4K	8K	STC	Wt <sup>3</sup> /lb/ft <sup>2</sup>
Noishield Septum	21	19	23	35	50	60	68	72	37	9
Noishield Regular	20	21	27	38	48	58	67	66	40	8
Mill Duty Regular	28	27	28	41	50	57	57	64	43	10.5
Noise-Lock I	25	27	31	41	51	60	65	66	44	9.5
Noise-Lock II and Fire Noise-Lock	27	30	32	41	50	59	67	71	45	10.5
Trackwall Regular	18	25	35	45	52	51	56	57	46	10
Noise-Lock Door	22	27	41	46	50	52	54	56	49	7.3
Super-Noise-Lock	31	34	35	44	54	63	62	68	48	15
Trackwall Hard	31	38	43	48	53	53	58	59	51	10
Noishield Hard	22	33	45	52	58	68	75	65	56	9.5
Vault	34	39	46	56	62	59	60	64	57	15.5
Noise-Lock III	20	36	51	68	75	83	84	73	59	11
Noise-Lock II Hard	24	40	50	57	65	73	80	78	61	12
Noise-Lock IV Hard	21	30	50	60	73	79	80	71	62	11.3
Gemini Regular	34	48	58	69	75	82	86	76	70	21





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## SOLUTION EVALUATION:

### Absorption Characteristics:

- Regular Construction Includes Absorption
- Absorption GREATLY Increases Insertion Loss While providing Equal Noise Reduction

OCTAVE BAND, Hz.	125	250	500	1K	2K	4K	8K	NRC
Regular Panel	0.89	1.2	1.16	1.1	1	1	0.9	(1.10)0.95



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## SOLUTION EVALUATION:

### Typical Construction Systems:

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



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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 RECCOMENDATIONS:

- 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 RECCOMENDATIONS:

- 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
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## 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

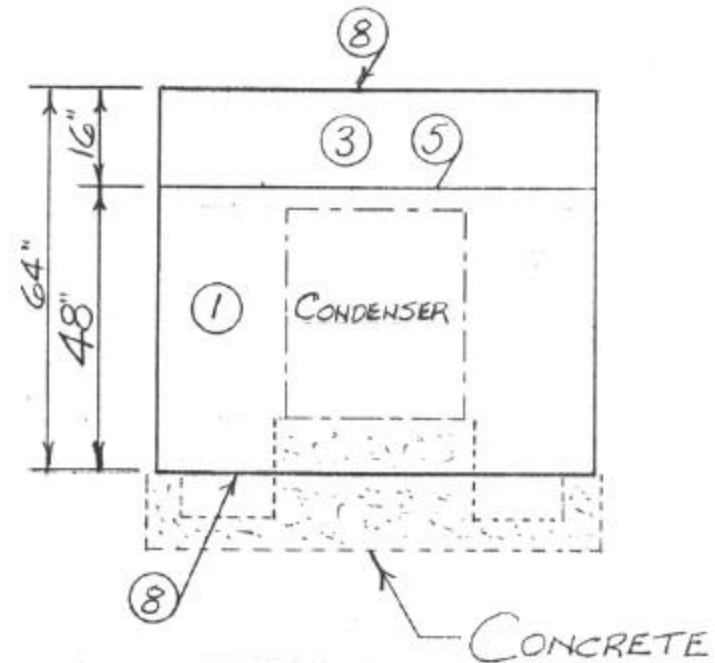
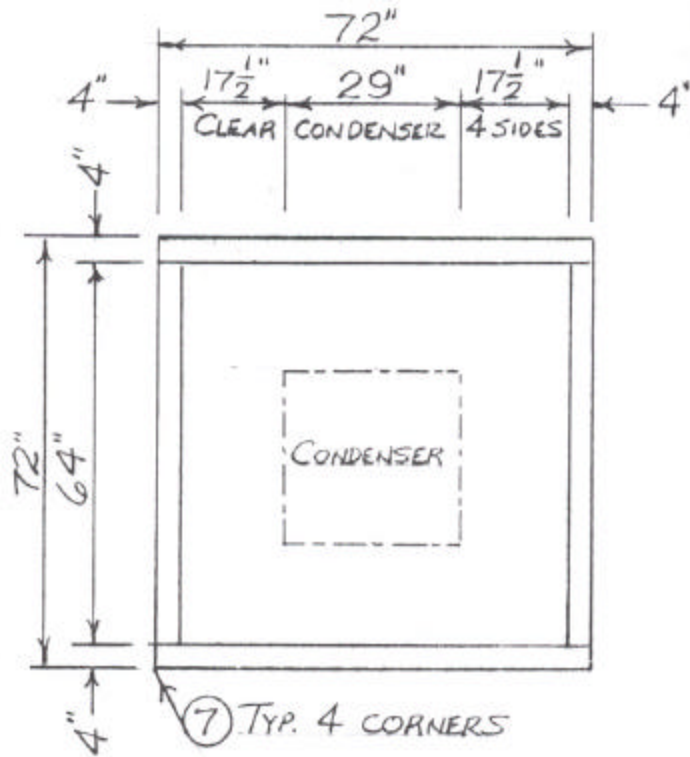




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## CASE HISTORIES:

- 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





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## CASE HISTORIES:

- DIRECT MOUNT SILENCER





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## CASE HISTORIES:

- DIRECT MOUNT SILENCER





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## 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

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## 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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