The Taming of the Screw:
Screw Chiller Noise Sources and Their Mitigation

ASHRAE Seminar 07

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TECHNICAL COMMITTEE
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SOUND & VIBRATION

Screw Chiller Noise Sources and Their Mitigation

- Review of Screw Compression Technology
- Types of Screw Chillers
- Screw Compressor Noise Generation Mechanisms
- Chiller Noise Sources
- Component Level Mitigation
- System Level Mitigation

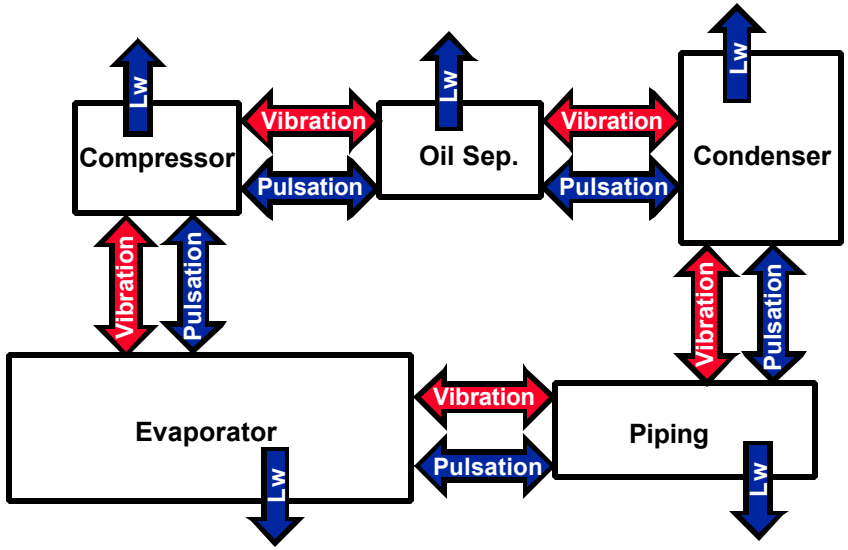
Screw Compression Technology

- **Advantages of Screw Compression:**
  - ➡ Positive Displacement
  - ➡ Few Moving Parts
  - ➡ Efficient

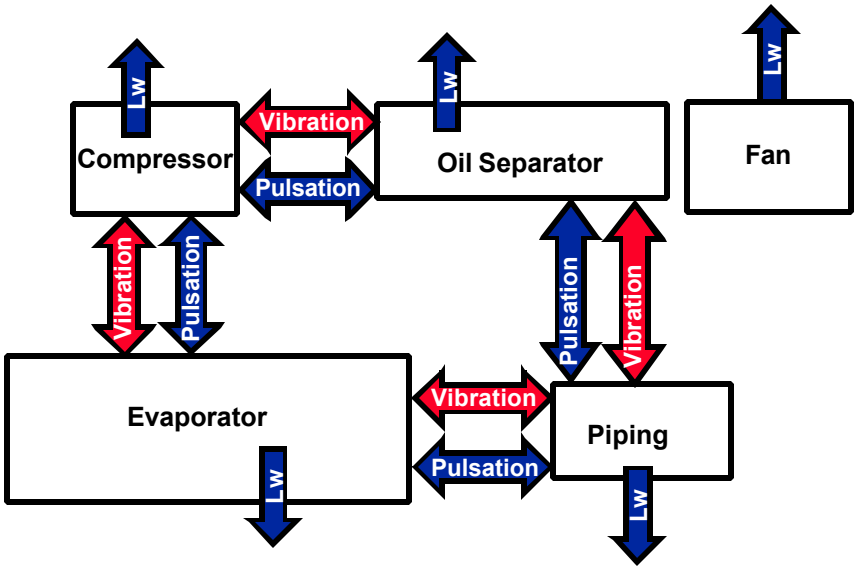
- **Disadvantages of Screw Compression:**
  - ➡ Complex Machining Requirements (Tight Tolerances)
  - ➡ Oil Seals
  - ➡ Noise - Pure Tones at Relatively High Frequencies (Sound Quality)

Screw Chiller Types & Noise Sources

- **Water-Cooled**
  - Compressor(s)
  - Heat Exchangers
  - Piping
  - Oil Separator(s)

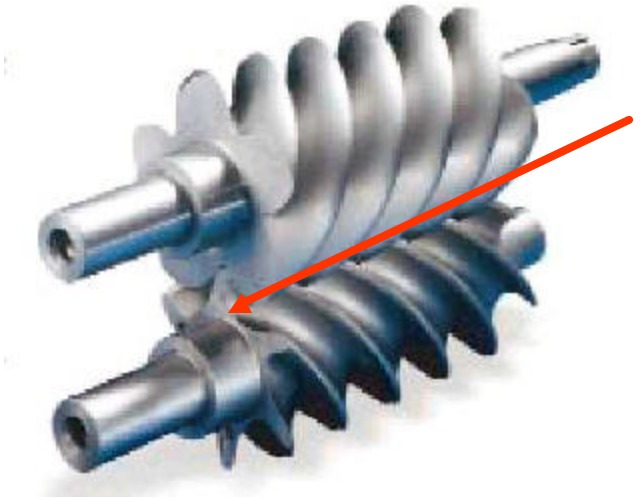


- **Air-Cooled**
  - Compressor(s)
  - Evaporator
  - Piping
  - Oil Separator(s)
  - Fans



Screw Compression Noise

- **Pressure Pulsations (Unsteady Mass Flow)**
- **Unsteady Forces**
- **Tonal - Lobe Passage Frequency (LPF)**
- **Two Paths:**
  - ➡ Gas-Borne
    - ❍ Compressor Shell
    - ❍ Piping
    - ❍ Heat Exchangers
  - ➡ Structure-Borne
    - ❍ Heat Exchangers / Piping



- **At Typical Screw Compressor LPF's, Shell and Tube Heat Exchangers are Very Responsive.**

Gas-Borne Excitation

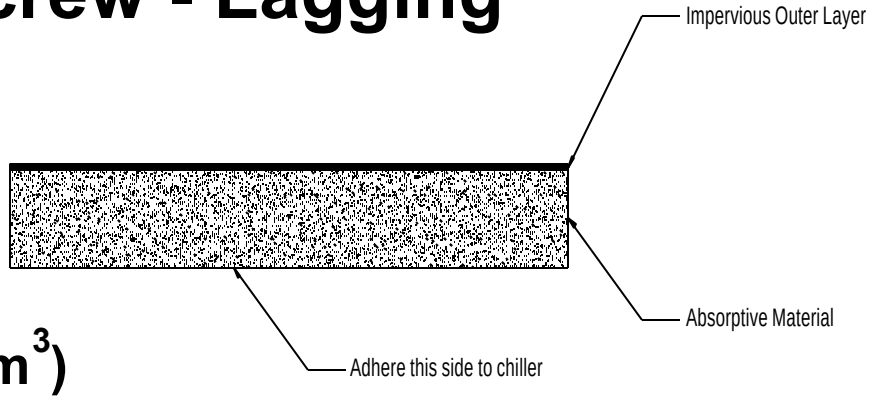
- **Pressure Pulsations in Refrigerant**
  - ➡ Discharge Side Symptoms:
    - Oil Separator(s)
    - Compressor Discharge Plenum
    - Discharge Piping
    - Condenser
  - ➡ Suction Side Symptoms:
    - Evaporator
    - Suction Piping
  - ➡ “Taming” Procedure:
    - Muffling (Usually difficult for an installed problem, more of a design fix)
    - Lagging - Mass and Decoupling Layer

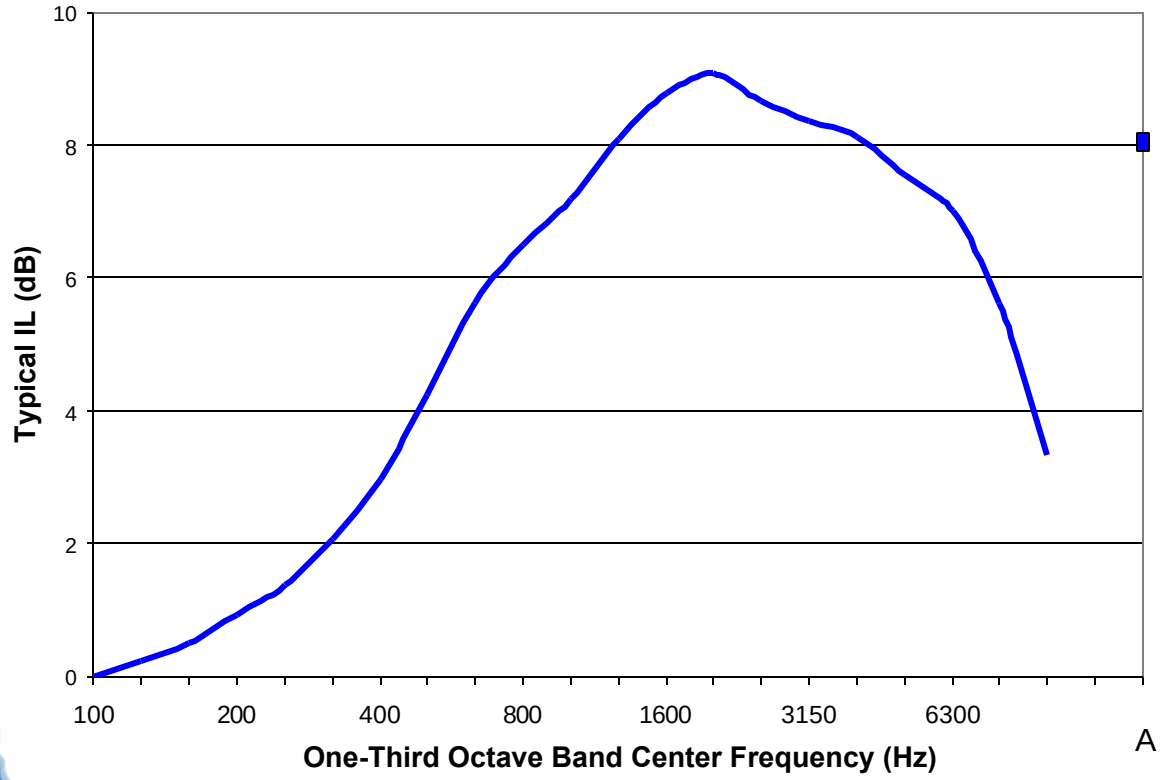
Structure-Borne Excitation

- **Compressor Vibration Transmitted to Other Components**
  - ➡ Symptoms:
    - Components Directly Connected to the Compressor
    - Heat Exchangers
    - Stiff Piping
  - ➡ “Taming” Procedure:
    - Component Structural Modification (OEM fix only - must be qualified)
    - Lagging - Mass and Decoupling Layer (Radiating Component)

Taming of the Screw - Lagging

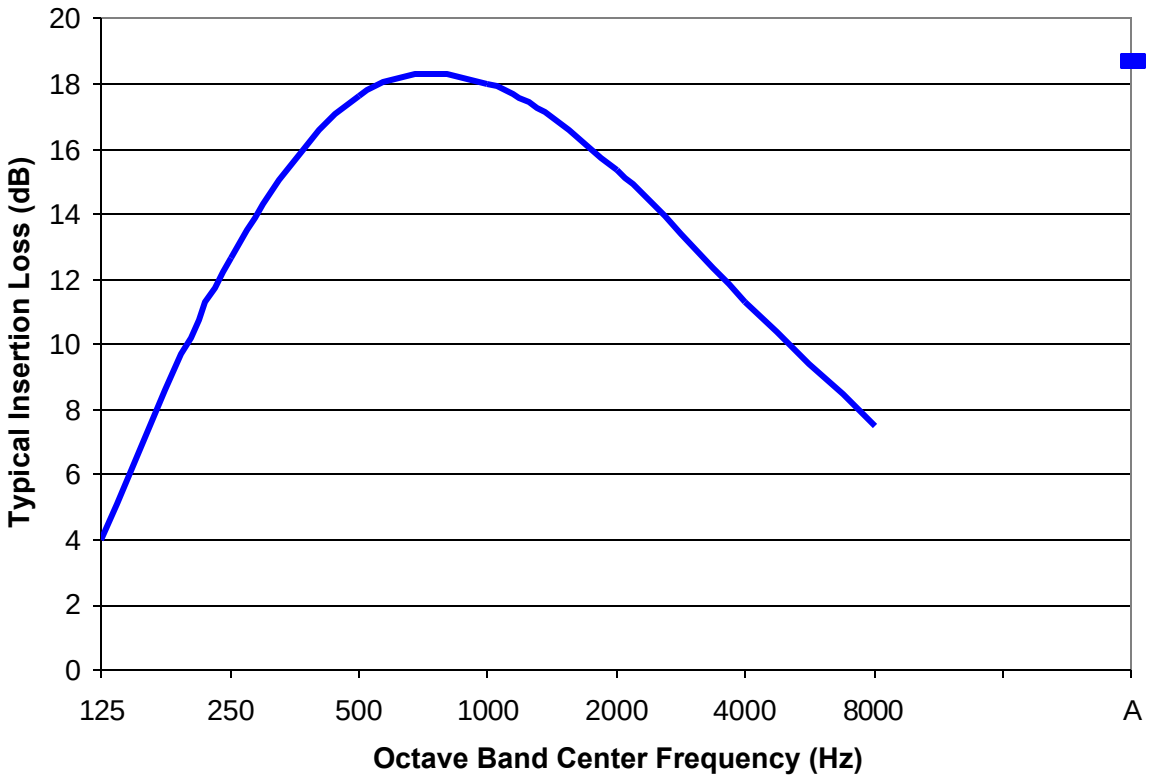
- Limp Mass with Absorption
- f > 250 Hz
- Mass > 1.0 lb./ft^2 (4 kg/m^2)
- 0.5 < r < 2.0 lb./ft^3 (8 to 32 kg/m^3)





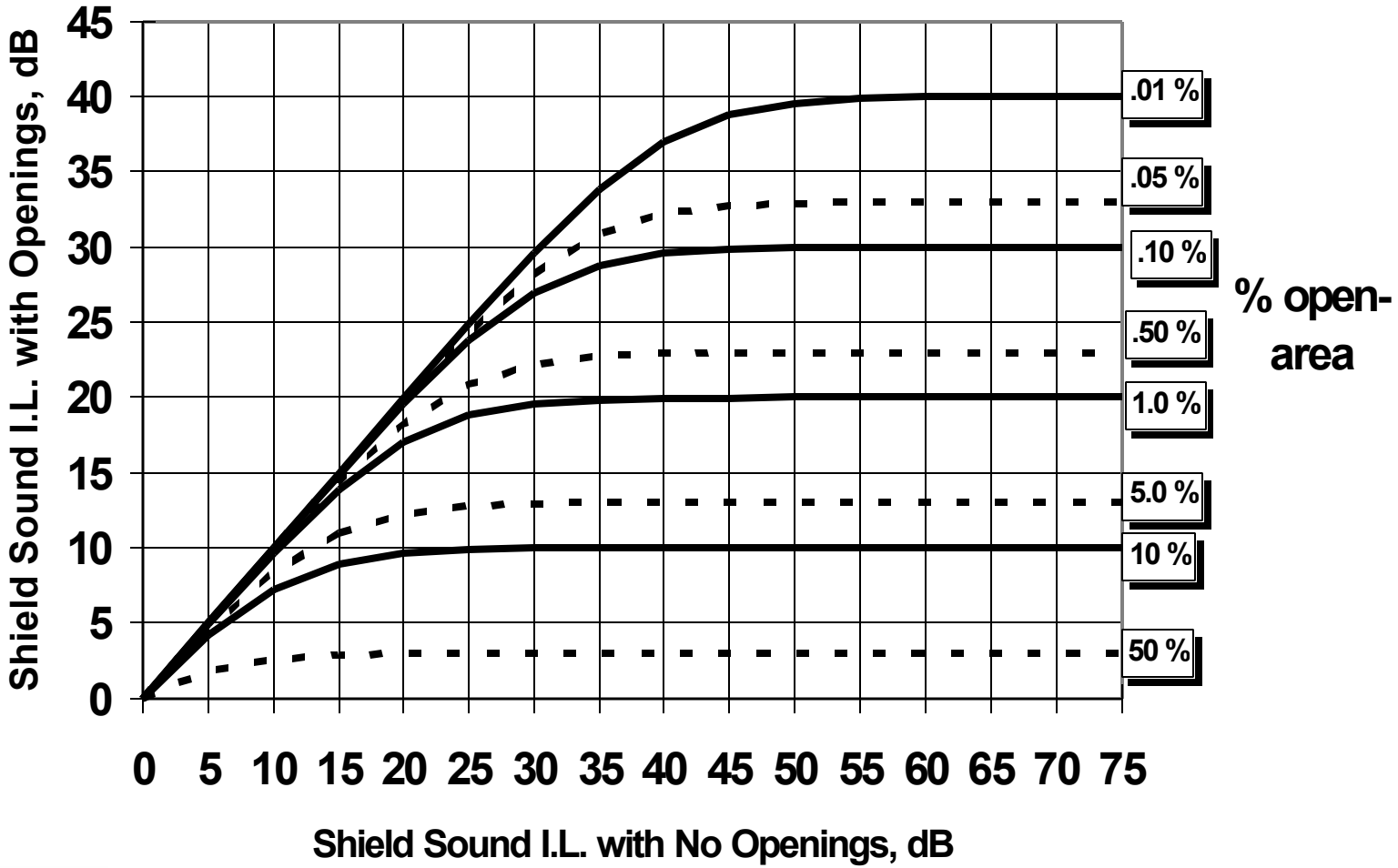
Water Cooled - System Level Noise Control

- **Enclosures**
  - ➡ Rigid
    - Panels
    - Absorption
  - ➡ "Flexible"
    - Quilted Barrier
    - Absorption and TL Combined



Water Cooled - System Level Noise Control

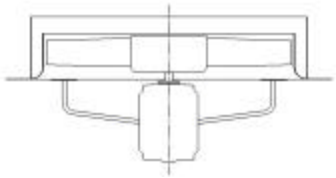
- Sealing of Leaks is Critical

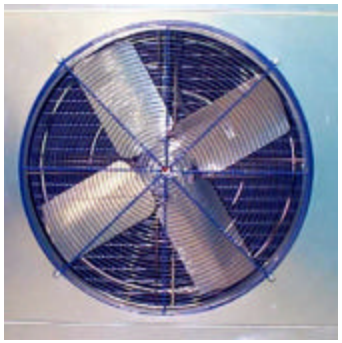


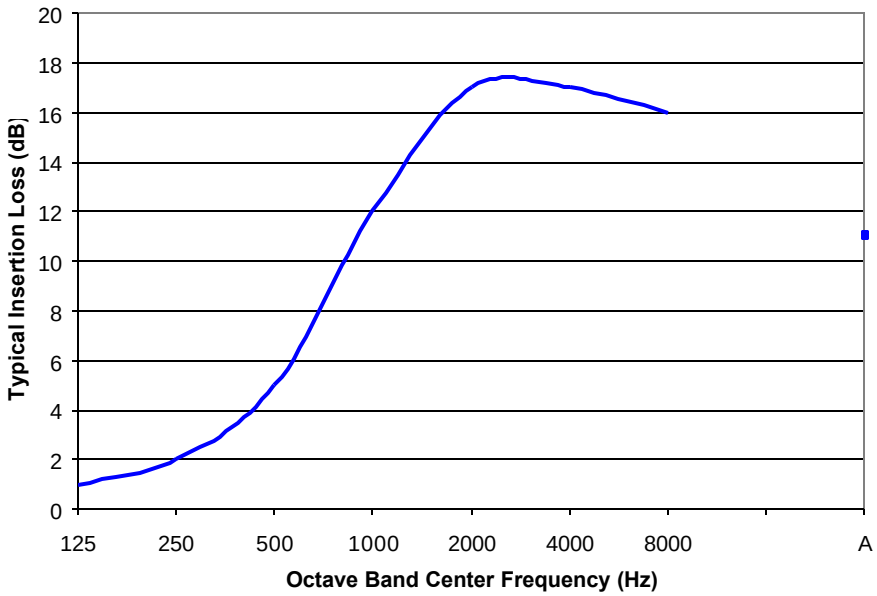
Air Cooled Chiller Noise Mitigation

- **Fan Noise Control**
  - ➡ Reduce Fan Speed
  - ➡ Reduce System Losses
  - ➡ Swept Blades
  - ➡ Reduce Inflow Distortion

- **Partial Enclosure (Fans and Refrigerant System Noise)**
  - ➡ Louvers
  - ➡ Sound Traps above Fan Deck
  - ➡ Barriers







The Taming of the Screw - Summary

- **Screw Chillers Produce Predominantly Tonal Noise**
- **Two Paths:**
  - ➡ Structure-borne
  - ➡ Gas-borne
- **Taming:**
  - ➡ Components - Lagging
  - ➡ Water-Cooled System - Enclosure
  - ➡ Air-Cooled System - Partial Enclosure