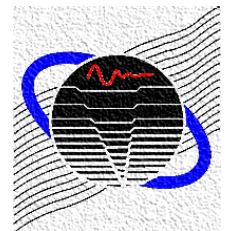# Noise Diagnostics on a Mobile Refrigeration Unit

David Herrin
University of Kentucky
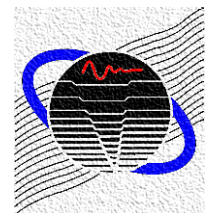
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Objectives

Refrigeration Unit NVH

- VAC team cooperated with Trane Technologies to better understand a product.
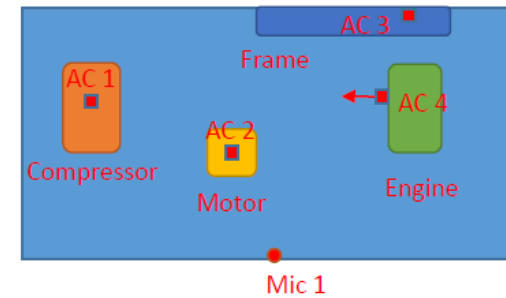- Student development.
- VAC team ranked the noise sources.

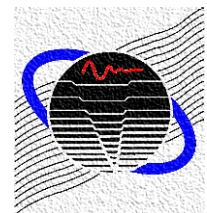**Vibro-Acoustics Consortium**

Measurement Setup

Refrigeration Unit NVH

Mic 1   5 ft above
Mics 2-4 9 ft away

Note: Tests allow for quick changes to the unit.
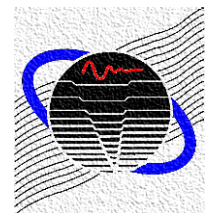
Vibro-Acoustics Consortium
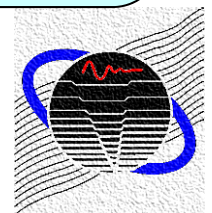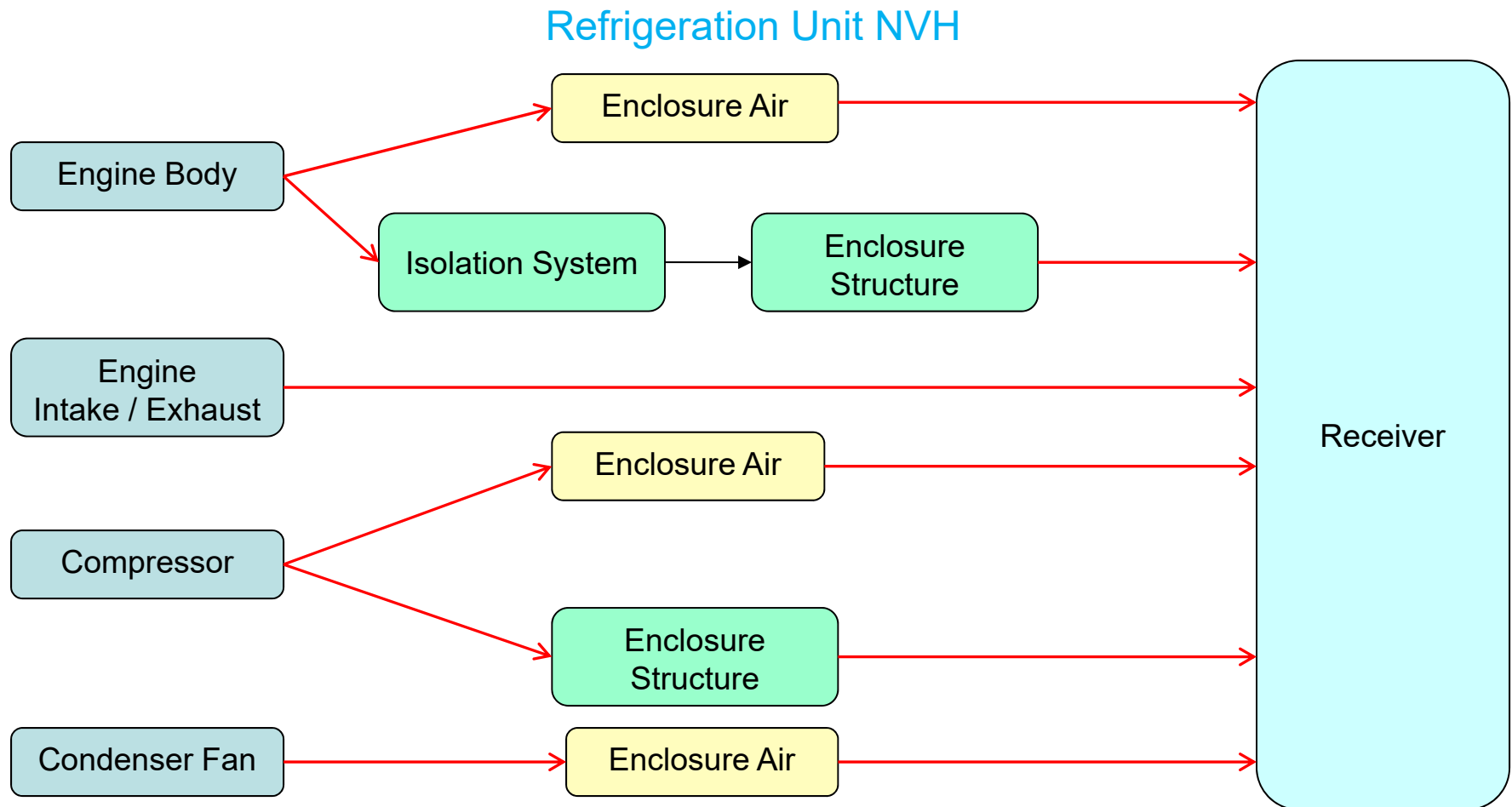
Important Sources

Refrigeration Unit NVH
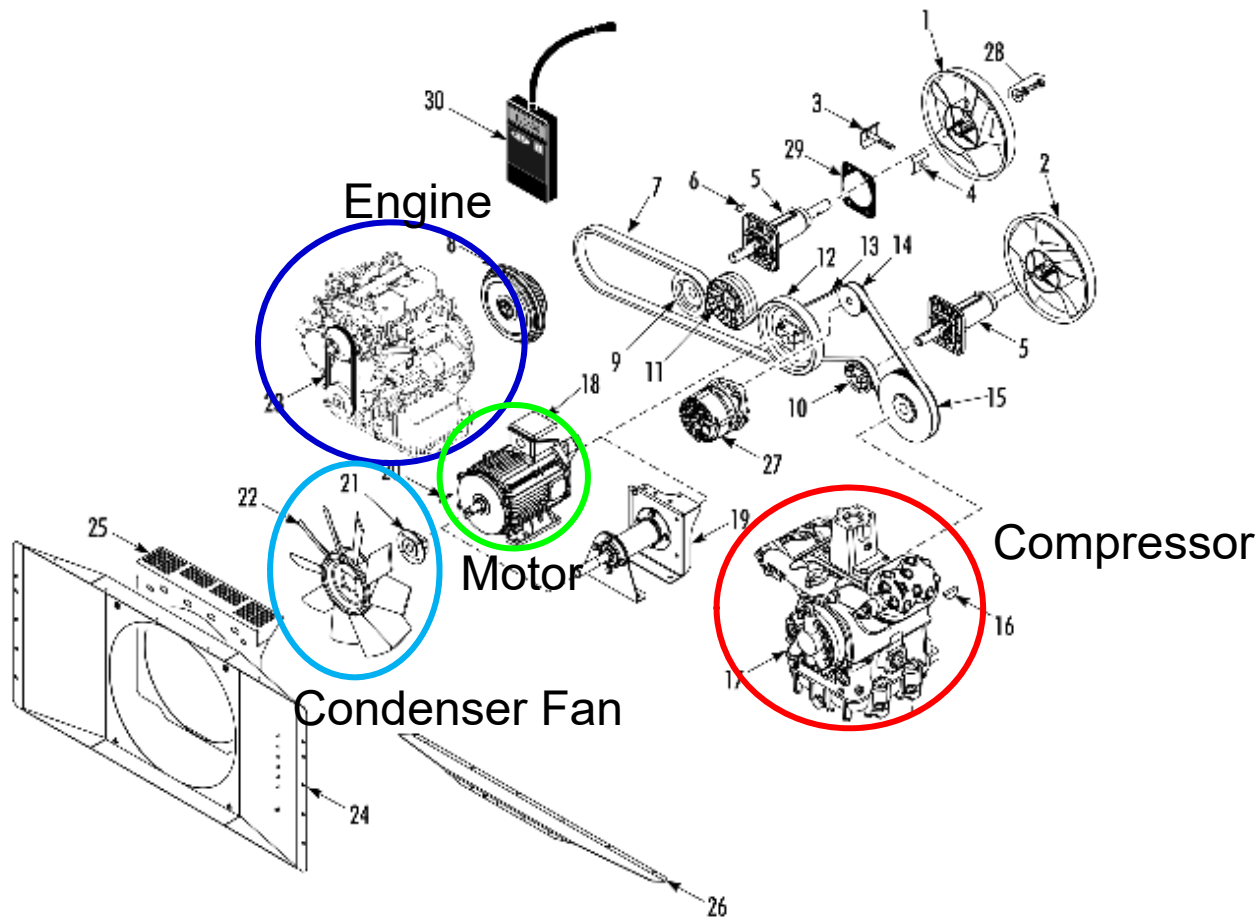
1. Engine
2. Compressor
3. Condenser Fan
4. Intake
5. Exhaust
6. Motor
7. Engine Belt
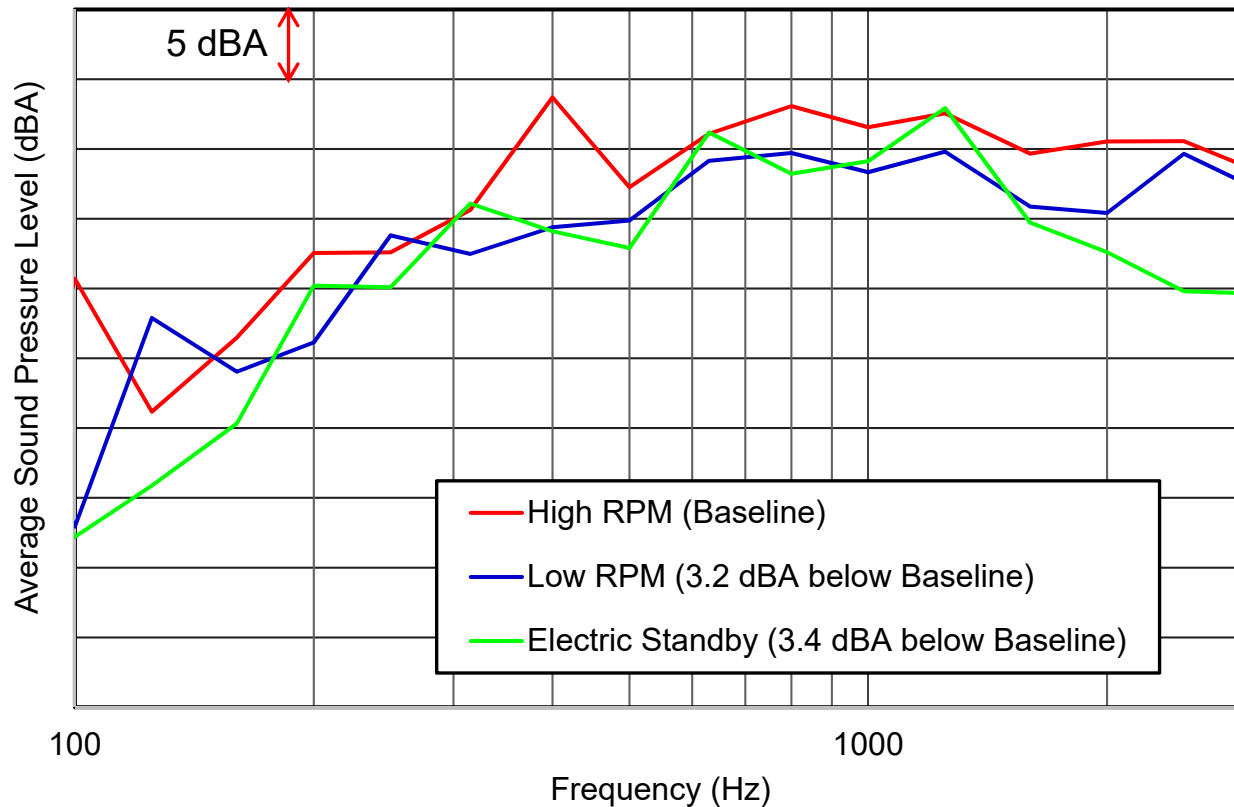8. Evaporator Fans
9. Compressor Belt
10. Alternator

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Important Paths

Refrigeration Unit NVH

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Different Operational Modes

Refrigeration Unit NVH

Notes
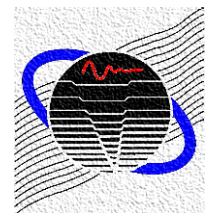Measurements performed with standard sound absorption kit.

Deduction
Compressor is an important source especially at low RPM.

Legend:
- High RPM (Baseline)
- Low RPM (3.2 dBA below Baseline)
- Electric Standby (3.4 dBA below Baseline)

Axes: Average Sound Pressure Level (dBA) vs Frequency (Hz), 5 dBA scale marker.

Primary noise contributors are very unit dependent.

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Noise Control Treatments
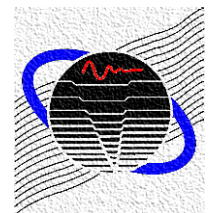
Refrigeration Unit NVH
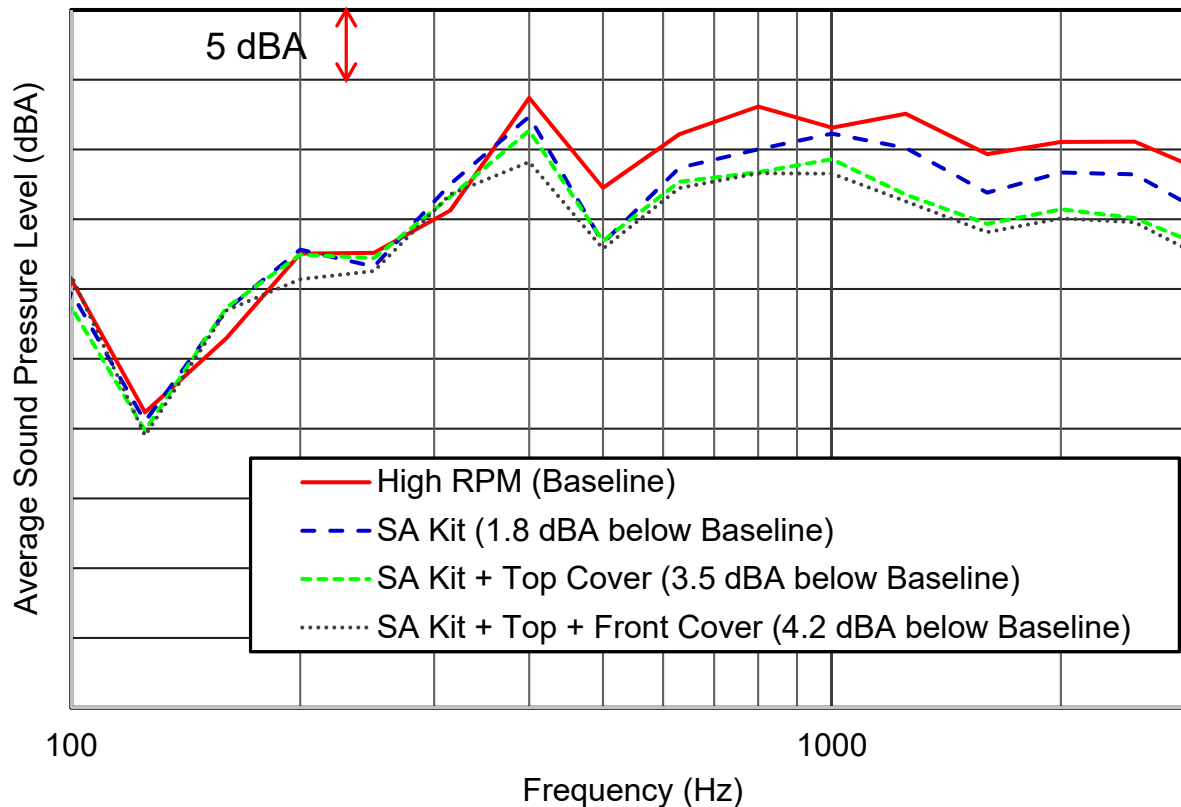
Notes
SA kit provides greater sound absorptive interior coverage. The kit was rapidly assembled to show the impact of sound absorption in the enclosure.

Deduction
Improved sound absorption kit plus covering top and front openings results in ~4 dBA reduction.

Chart legend:
- High RPM (Baseline)
- SA Kit (1.8 dBA below Baseline)
- SA Kit + Top Cover (3.5 dBA below Baseline)
- SA Kit + Top + Front Cover (4.2 dBA below Baseline)

Axis labels: Average Sound Pressure Level (dBA) vs Frequency (Hz), 5 dBA

A sound absorption (SA) kit plus covering openings reduced the level by ~4 dBA. This kit illustrates the potential to reduce airborne noise.
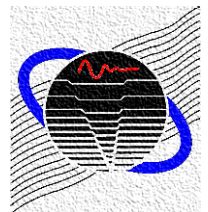
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Treatments Barriers on Top / Front

Refrigeration Unit NVH
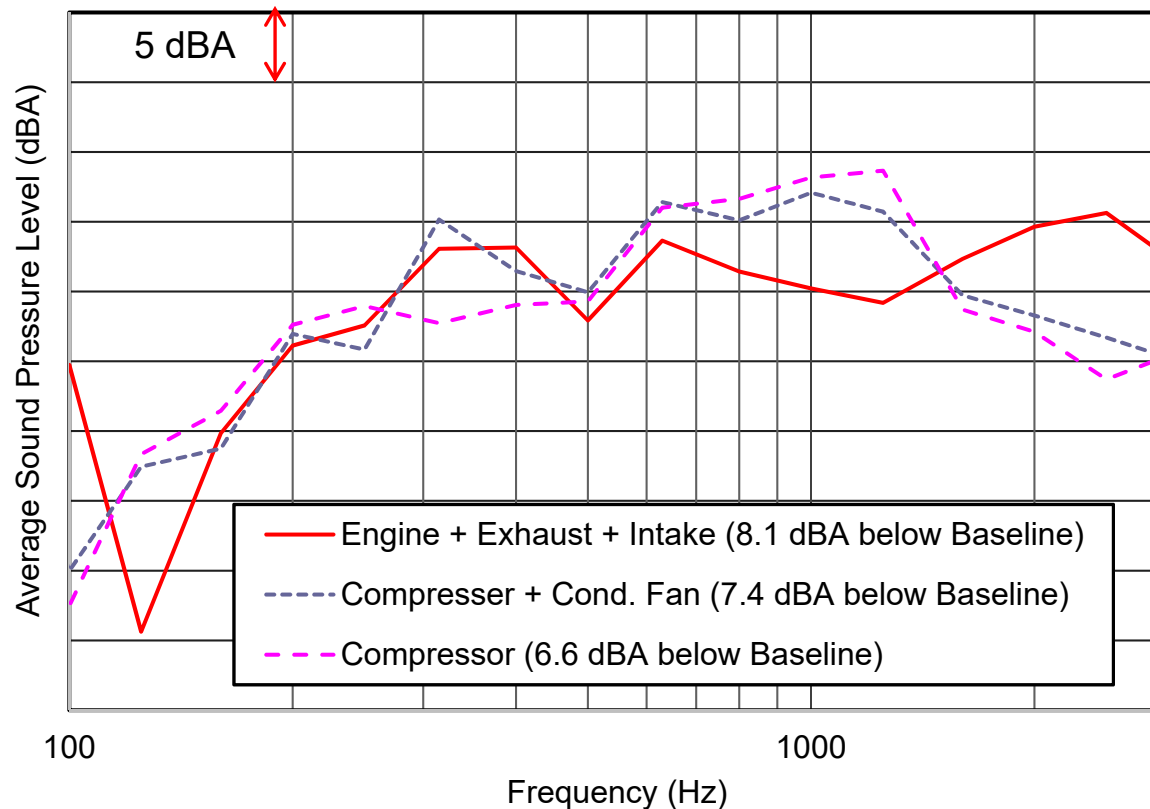

Notes
Coverage of the top and front is not practical long term. This study is performed to assess the airborne paths.

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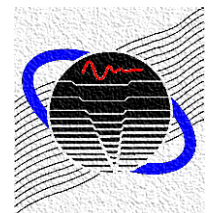8

Source Ranking

Refrigeration Unit NVH

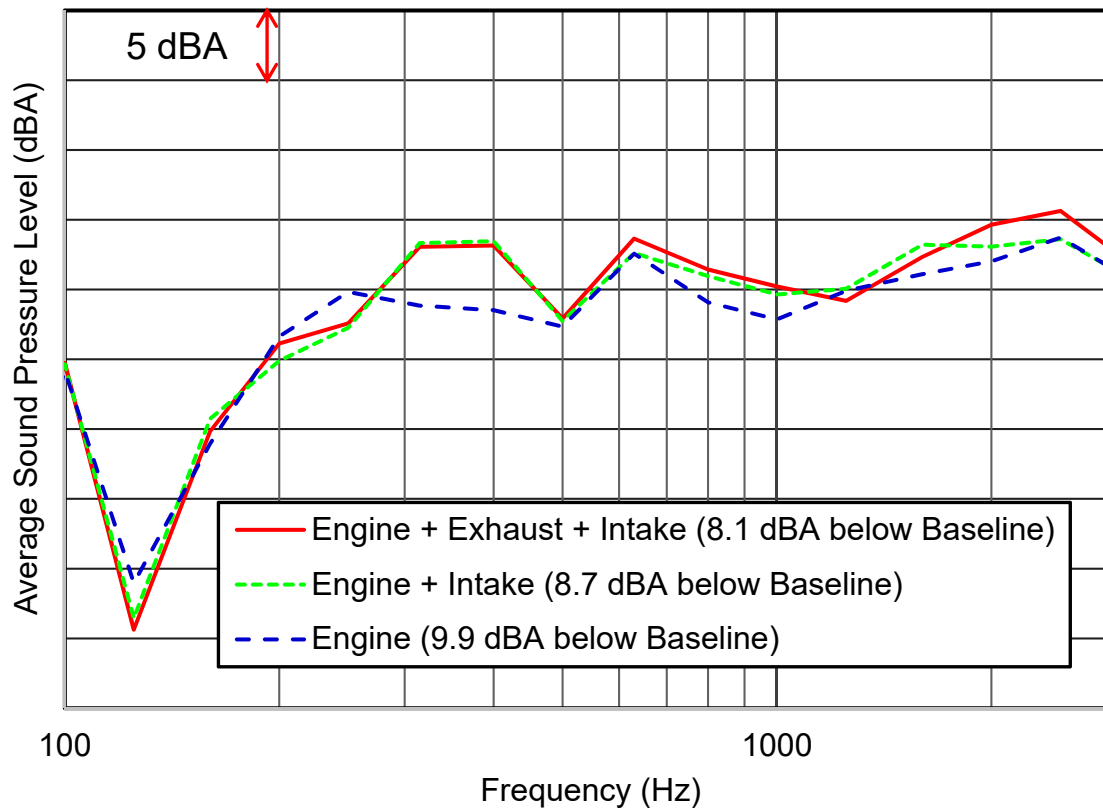**Notes**
After SA kit is applied to unit.

Deductions
Opportunities for further noise reduction can be identified by running sources individually. Compressor noise is dominant from 600-1100 Hz.

Chart labels:
- Y-axis: Average Sound Pressure Level (dBA)
- X-axis: Frequency (Hz)
- 5 dBA
- Engine + Exhaust + Intake (8.1 dBA below Baseline)
- Compresser + Cond. Fan (7.4 dBA below Baseline)
- Compressor (6.6 dBA below Baseline)
- 100
- 1000

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Source Ranking Engine Components

Refrigeration Unit NVH

5 dBA

Average Sound Pressure Level (dBA)

— Engine + Exhaust + Intake (8.1 dBA below Baseline)

- - - Engine + Intake (8.7 dBA below Baseline)

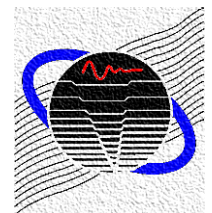- - - Engine (9.9 dBA below Baseline)

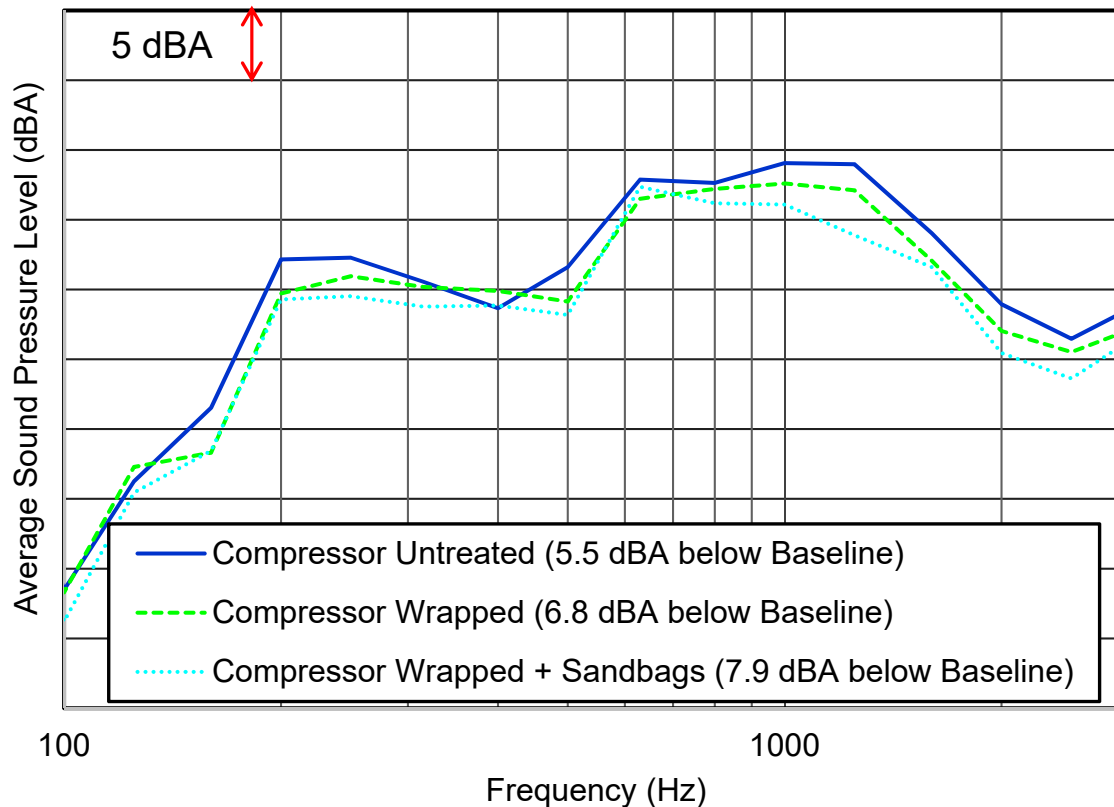Frequency (Hz)

100

1000

Notes
SA kit is applied to unit.

Deductions
Small improvements can be achieved by improving the intake and exhaust. Structureborne / Airborne engine noise are dominant.

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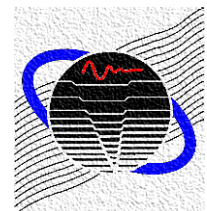# Source Ranking Compressor

Refrigeration Unit NVH

Notes
SA kit is applied to unit.

Deductions
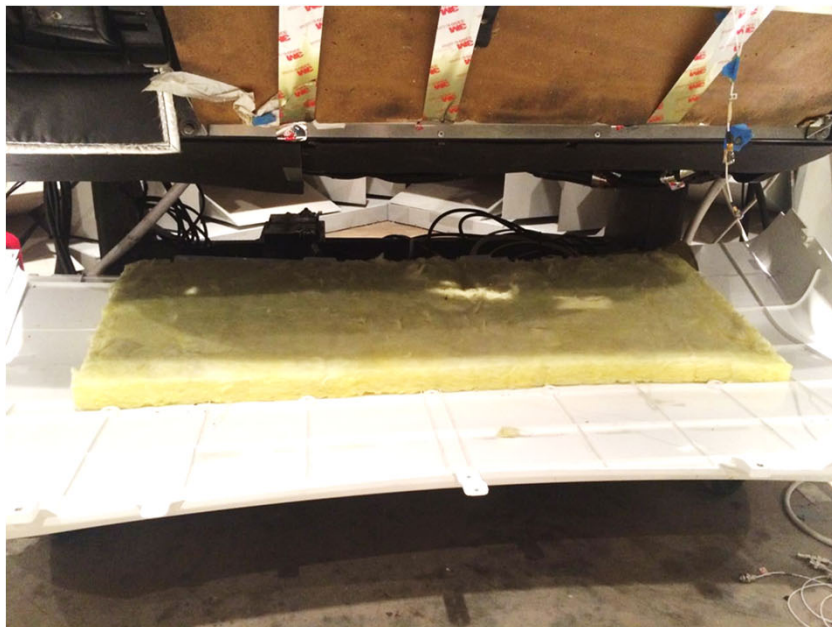Both structureborne and airborne compressor noise are important.
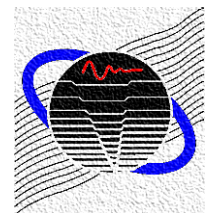More work needed to better understand structureborne / airborne contributions.

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Source Ranking Compressor

Refrigeration Unit NVH

Sound Absorption Treatments

Sandbags on Power Tray

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Source Treatments Compressor

Refrigeration Unit NVH

5 dBA

Average Sound Pressure Level (dBA)

Frequency (Hz)

100   1000

Compressor Untreated (5.5 dBA below Baseline)

Compressor Jacked Up (6.2 dBA below Baseline)
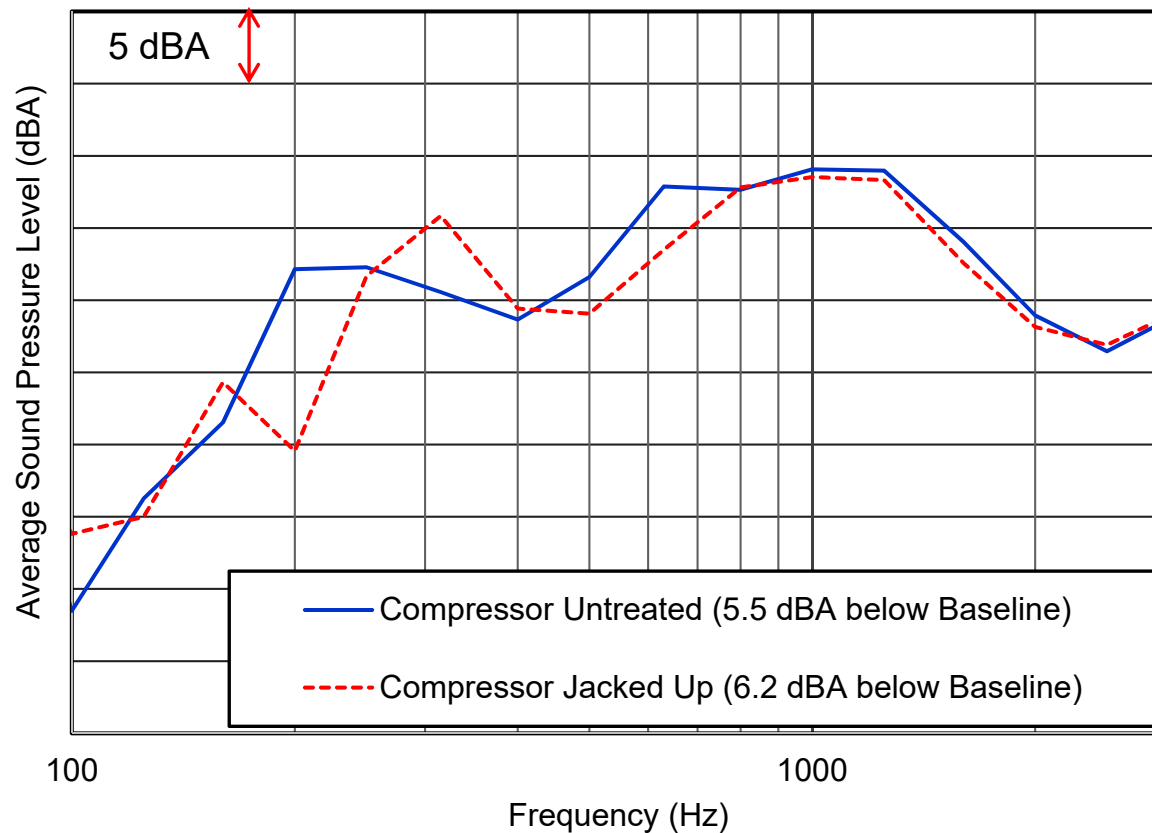
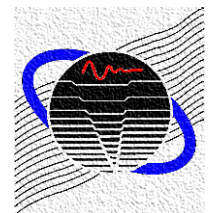**Notes**
SA kit is applied to unit.

Deductions
Both isolation and damping treatments may positively affect the compressor contribution.

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Source Treatments Compressor

Refrigeration Unit NVH

Compressor Jacked Up

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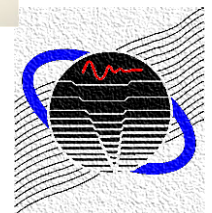
Summary

Refrigeration Unit NVH

- Targeted experiments are useful for identifying important airborne and structureborne paths.

- Meeting noise targets typically implies applying multiple source and path treatments.

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