

Introduction

- Types of Generators
- Generator Noise Sources
- Noise Reduction Techniques
- Case Study

TECHNICAL COMMITTEE



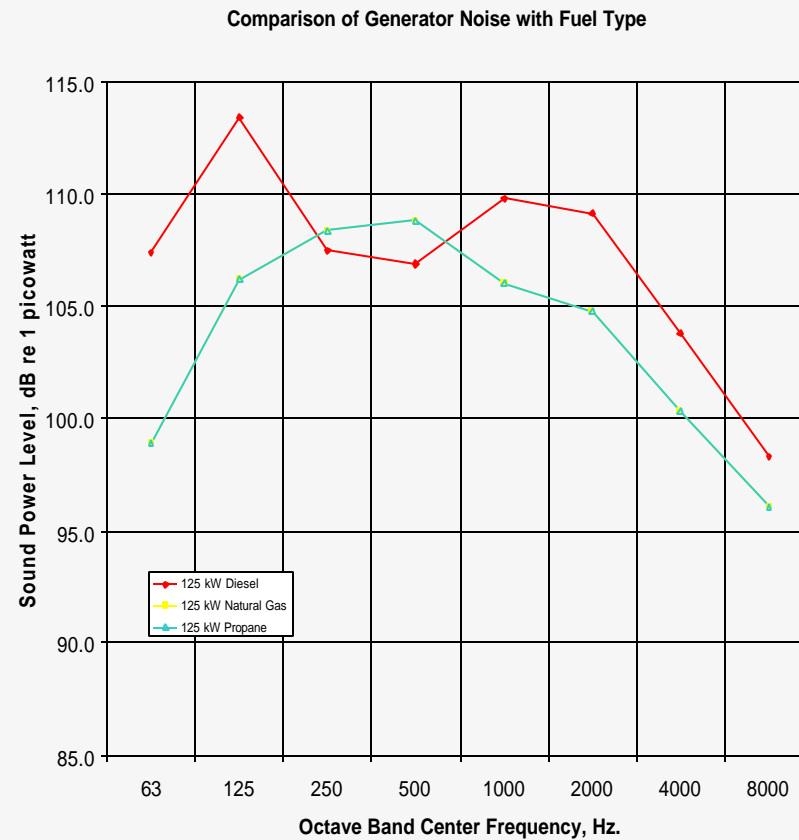
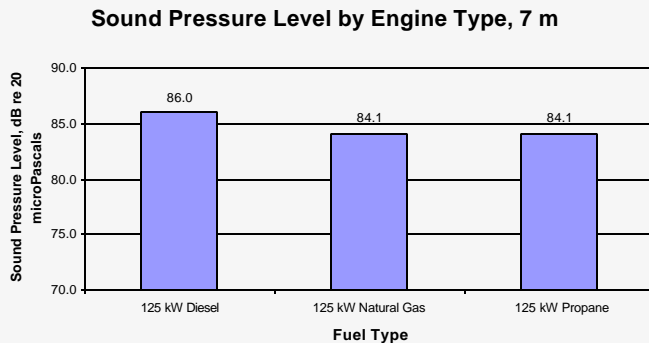
SOUND & VIBRATION

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- ❑ There are two categories of generators: Diesel and spark ignited. Spark ignited types include propane and natural gas engines.
- ❑ The right hand graph on the next page shows the sound power level difference between the two types of standard, unhoused generators. Y-axis is sound power level, x-axis is sound pressure level. As can be seen in the graph, the sound power level for natural gas and propane are the same.
- ❑ Sound power level is similar to horsepower – it relates to the total energy produced by the generator. Independent of distance or location.
- ❑ The left hand graph illustrates the variation of sound level with fuel type. This time the values are Sound Pressure Levels, dBA. Sound Pressure Level varies with distance and location from the source.
- ❑ For reference, the SPL of a quiet residential neighborhood is 45 dBA during daytime hours, 35 dBA at night. 100 feet from a busy freeway is 70 dBA. Normal conversation at 3 feet is 60 dBA.

Types of Generators

- Diesel
- Propane
- Natural Gas

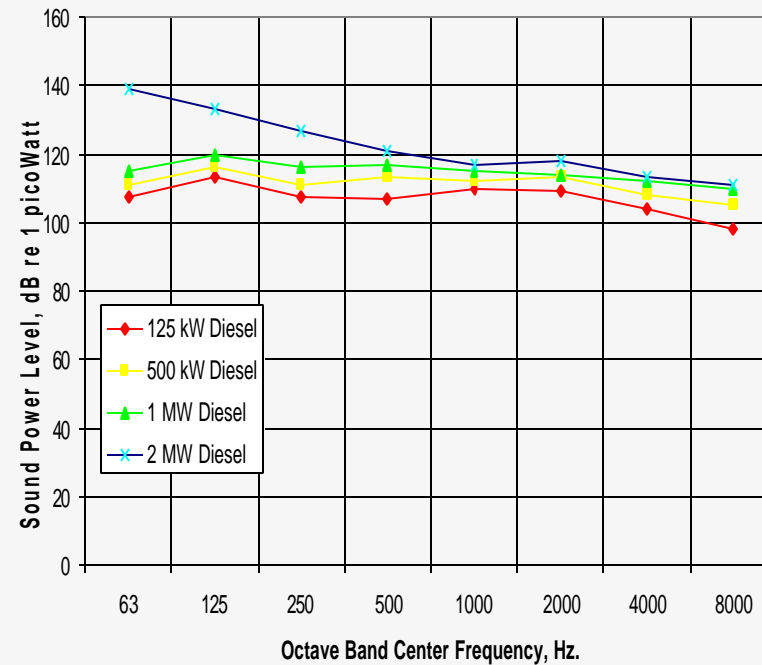
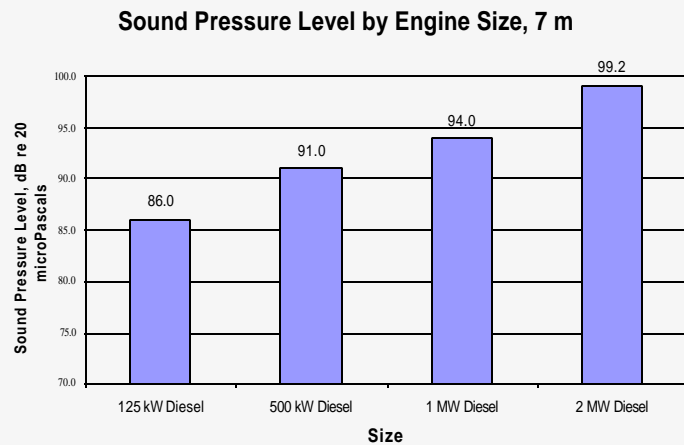


Types of Generators

As expected, noise levels increase with size of generator.

Much of the additional low frequency noise associated with the 2 MW generator is due to the noise from the radiator fan, as will be shown in a later slide

Comparison of Diesel Generator Noise with Size



Generator Noise Sources

- Generator Engine Block and Air Intake

This is the dominant source of noise out the air intake openings into rooms containing a generator.



Primary Noise Sources

□ Radiator Fan

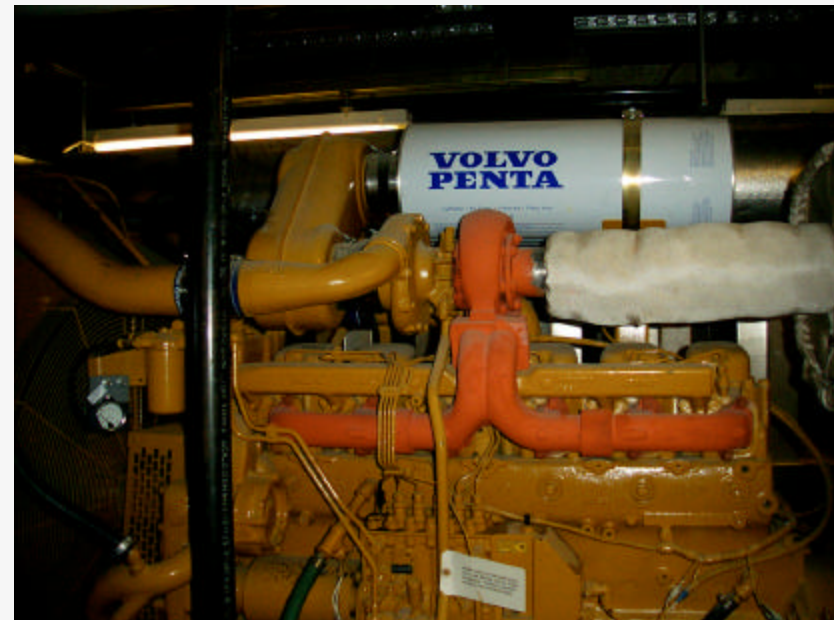
Radiator fan noise combines with the engine block to be the dominant sources of noise radiating out of the discharge air opening in rooms containing generators.

As we will see in the next slides, with larger engines the noise from the radiator fan can dominate at least some portions of the frequency spectrum produced by the generator.



Primary Noise Sources

- Exhaust
- Turbo Charger



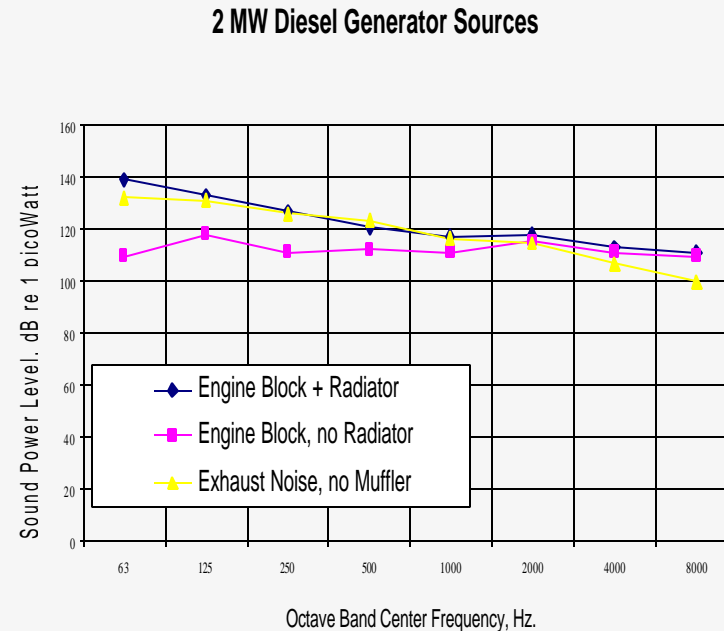
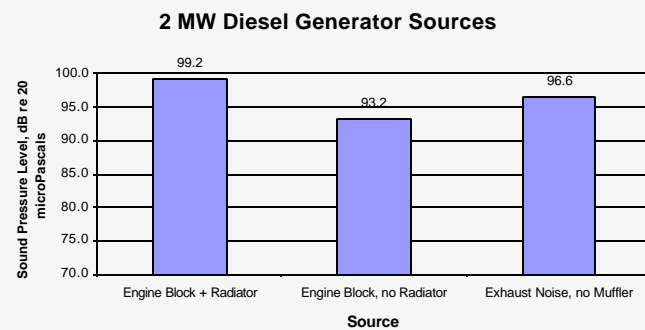
Primary Noise Sources

- Load Bank – 95 dBA @ 10 feet
- Vibration
 - Engine
 - Connections to ductwork, exhaust pipe, electrical

In our experience load banks are often portable, brought in for occasional testing. They are very noisy. Many noise ordinances will allow portable equipment to exceed a code limit. If the load bank is not portable, or if the noise ordinance does not allow an exemption, it would need to be placed inside the generator room.

Vibration is not normally a significant noise source, unless the generator is located on an upper floor or roof. Spring vibration isolators are normally used to reduce the vibration to the supporting structure. Larger engines can damage the supporting structure if vibration isolation is not provided.

Primary Noise Sources



The significance of radiator fan noise is apparent in this slide, which shows engine sound levels with and without radiator present. No exhaust noise is present unless noted.

Noise Reduction Techniques

- Generator Rooms
 - Room Enclosure
 - Roof
 - Walls
 - Doors
 - Internal Lining
 - Intake Air and Discharge Air
 - Duct Silencers
 - Acoustic Louvers
 - Exterior Screens



Noise Reduction Techniques

- Exhaust Noise
 - Resistive Mufflers
 - Active Noise Control
- Structure Borne Noise & Vibration
 - Spring Isolators on Generators larger than 175 kW.
 - If floor joint is present, weight of concrete beneath generator should be not less than twice the generator weight.
 - Flexible pipe connectors, duct connectors, electrical connection at generator.

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Resistive mufflers are available in at least three grades of effectiveness.

Industrial grade silencers reduce exhaust noise by 12-18 dBA.

Residential grade silencers reduce exhaust noise by 18-25 dBA.

Critical grade silencers reduce exhaust noise by 25-35 dBA.

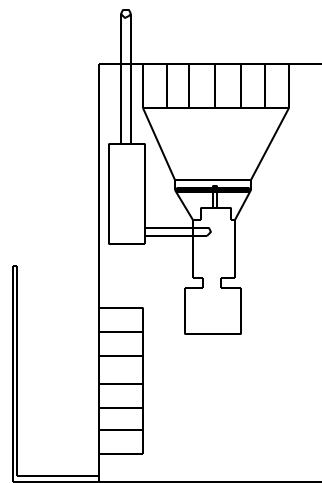
Active noise cancellation silencers used to be available as a manufactured product, but are not currently available. They were effective in reducing the low frequency tones associated with the cylinder firing.

Case Studies

- ❑ 1000 kW Generator, housed in equipment room
- ❑ Direct Radiator
- ❑ Closest Receiver Property 50 feet

Case Study

- ❑ 1000 kW Diesel Generator
- ❑ In generator room in lowest level of building
- ❑ 50 feet to closest property



This shows plan view of generator inside an enclosed room. This is the most typical installation. Duct silencers are shown on intake and discharge openings to room, a screen is on the outside of the intake opening, and a muffler on the exhaust pipe. Acoustical louvers are used sometimes instead of duct silencers.

Case Study

- Noise out of intake air opening to room
 - Unhoused generator SPL at 50 feet, free field = 89 dBA
 - If generator is in a room, internal 4" thick lining on two adjacent walls of room, with large inlet louvers close to the side of the generator as shown in previous slide, SPL at 50 feet = 88 dBA
 - If low pressure loss silencers are added to inlet (static pressure drop = 0.10 at -1000 fpm), SPL at 50 feet = 73 dBA.
 - If solid screen of sufficient size and mass is included outside of intake louvers, SPL at 50 feet = 65 dBA.

If the inlet louvers were substantially removed from the side of the generator, more reduction would be achieved by placing the generator in a room with acoustical absorption present.

In most cases, the size of the room is limited due to cost, and the outside air inlet louvers are very close to the engine generator.

Case Study

- Noise out of discharge air opening
 - Similar to intake opening.
 - Size of opening might be slightly less, but radiator fan is closer to discharge.
 - Expected noise levels would be the roughly the same as the intake – 89 dBA without room, 86 dBA with room, 73 dBA with silencers, 65 dBA with additional solid screen.

Case Study

□ Exhaust Noise

- In free field, at 50 feet, exhaust with no muffler is 84 dBA, in direction of exhaust.
- Point exhaust up, roughly 5 dBA attenuation, = 79 dBA at 50 feet.
- Add Industrial Silencer, 15 dBA attenuation, 64 dBA at 50 feet.
- Add Residential silencer instead, 22 dBA attenuation on average, 57 dBA at 50 feet.
- Add Critical grade silencer instead, 30 dBA average attenuation, 49 dBA at 50 feet.

Case Study

- ❑ Combine noise levels from various sources.
- ❑ Inlet = 65 dBA
- ❑ Discharge without screen = 73 dBA
- ❑ Exhaust noise = 57 dBA with residential grade silencer
- ❑ Combined level = 74 dBA
- ❑ With screen on discharge, combined level is 68 dBA.

Case Study

- ❑ 68 dBA is higher than most ordinance limits for residential use.
- ❑ Even with these significant noise control measures, required distance between generator room and closest residential property would need to be approximately 200 feet to reduce noise levels to 55 dBA.
- ❑ 55 dBA would be compatible with most noise ordinances at residential property.
- ❑ Another 20 dBA noise reduction in the room design can be achieved with longer duct silencers and multiple exhaust mufflers, but space requirements are substantial.
- ❑ Using remote generator radiators can further reduce noise levels from generator room.