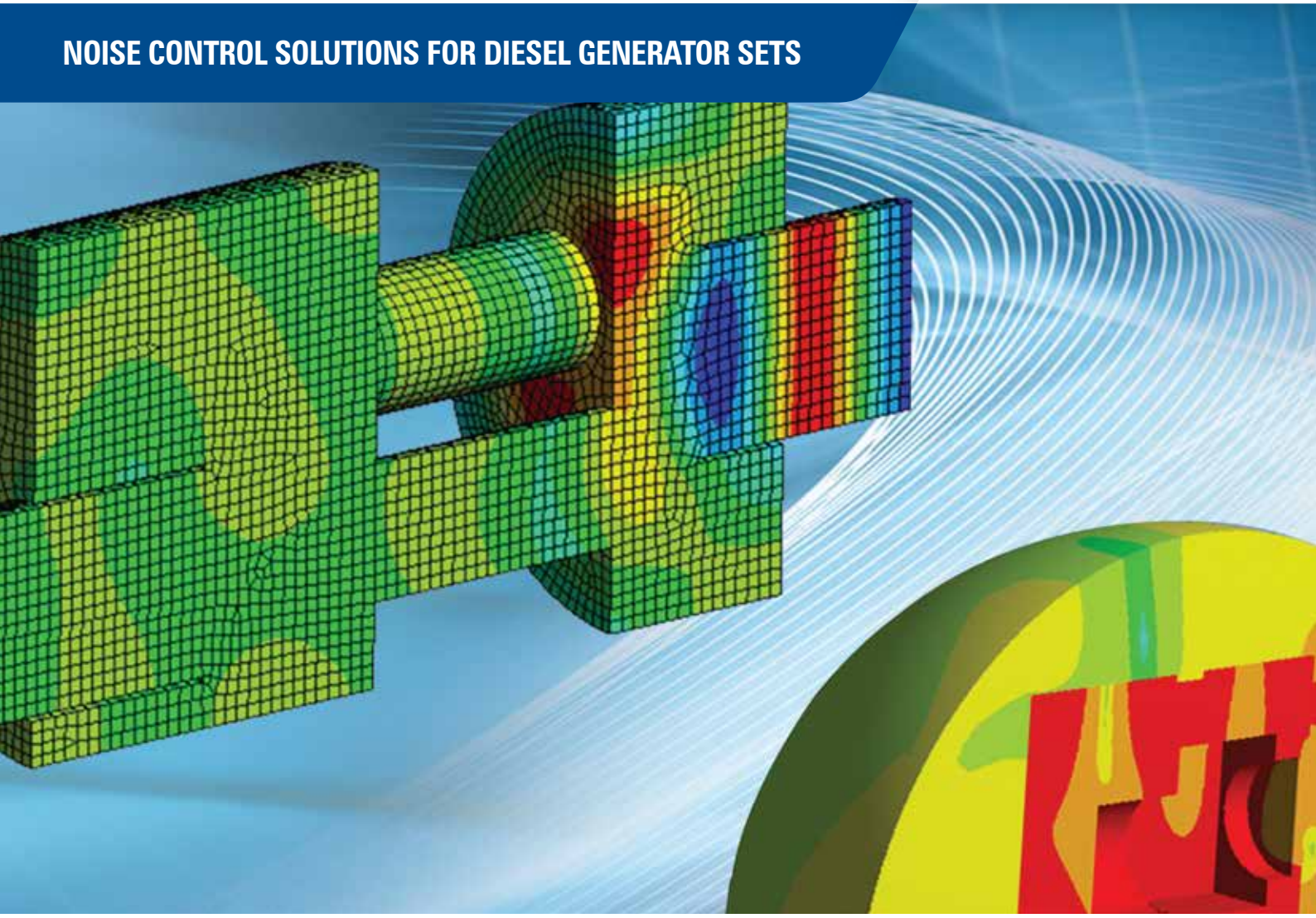
NOISE CONTROL SOLUTIONS FOR DIESEL GENERATOR SETS



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Today, the fight against the noise of the diesel generator, gained importance with the demand of people who want to live and work in an environment with less noise. To maintain or increase their share in the sector, companies are required to submit quieter products. One of the most frequently used in industrial applications to reduce noise is to store diesel generators in a cabin (box) audio. Taking into account the global problems that come with this solution, companies are required to produce practical and affordable solutions tailored to the needs of the user. You can find more information on the problems and noise control solutions diesel generator sets and basic acoustic definitions

Figure 1. Diesel Generating Group and Acoustic Canopy

INTRODUCTION

Physical description of sound can be done as " warning mechanism that occurs as the result of pressure fluctuations in the solid elastic media, liquid or gaseous " .. The formation of sound, as the perception of sound propagation and sound are separated into three main sections. The noise is very subjective concept, but a generally high level of industrial problem that bothers most people is unwanted sound that creates discontent.

Sound may occur in two different ways:

1- Direct sound forming in the air (turbulent)
2- Sounds generated by the vibratory motion of a solid body (church bells).

Under the terms of propagation:

1- Only if it comes out of the air, the air conduction (primary)
2. The sound is converted into another location, the source structure conduction vibration (secondary) may be divided into two groups.

The noise in our country is controlled by various regulations that have been implemented by the relevant ministries. Stricter laws are applied for several years in Europe and America. In addition, the demand for quieter products by customers increases.

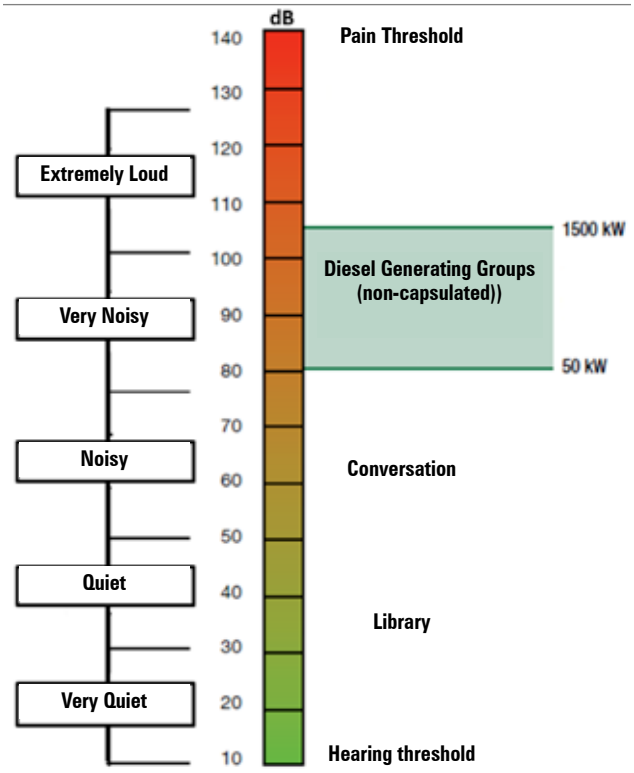

Figure 2. Noise Levels

Total noise control by reducing levels:

1- Determination of dominant noise source
2- Determination of dominant frequencies
3- Determination of noise by controlling the way that reaches the sensor.

NOISE SOURCES OF THE DIESEL GENERATING GROUP

The main sources of noise can be mentioned in the diesel generators into four units (Figure 3):

- **Engine Block Noise**

Fire or explosion in the cylinder and the noise caused by mechanical forces are usually broadband. (63 Hz - 8000 Hz). The prominent band of the low frequency is inversely proportional to the number of engine cylinders. Sound pressure level (1m) varies depending on the speed of operation and size of the engine, as between 100dB (A) and 125dB (A).

- **Radiator Fan Noise**

The noise made because of turbulence caused by high-speed air before and after the fan passage. The noise is more pronounced and broad-band in the mid and high frequency (250 Hz - 8000 Hz). The number of blades and the speed of rotation of the fan determines the dominant frequencies. Sound pressure level (1 m distance) is usually between 95 dB (A) and 105 dB (A).

- **Alternator Noise**

The noise caused by the air flow, friction and vibration (SIGINT) is broadband. Because engine noise generally has a sound pressure level less than 15 dB, it can be ignored in the calculations.

- **Exhaust Noise**

The noise caused by the motor cylinder explosion is greater than 20 dB in the case where a muffler is not inserted. Depending on exhaust noise muffler used, noise can be reduced from 10 dB - 40 dB.
The conduction of the vibration structure which was created by force unbalanced engine block noise and side panels on the sets of interaction is the low frequency noise which occurred indirectly. The precise determination of dynamic characteristics of vibration dampers between the ground and the system is critical to reduce the noise level.

Before the development of noise control application requires knowledge of the spectrum of the units must be above. Typically, these values are provided by the manufacturer. Alternatively, to determine the sound power level, measures in accordance with the standards ISO 3744: 2010 should be carried out properly.

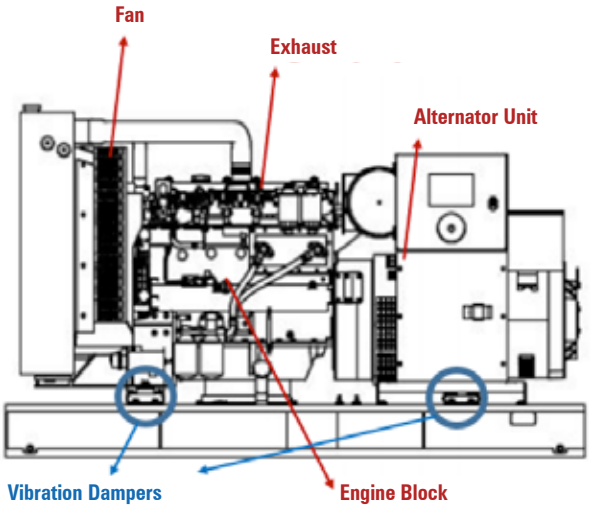

Figure. 3. Dominant noise sources on Diesel Generating Group

NOISE CONTROL STRATEGIES FOR DIESEL GENERATING GROUP

Some of the strategies implemented to reduce noise diesel generators are listed below:

1. Acoustic Cabinet

These are methods commonly used to reduce noise generators. The generator is surrounded with a composite panel is designed to reduce the noise emitted by 1 and 2-reflect depreciation mechanisms. To get the best performance, acoustically, the openings should not be left in the cabinet. But the air inlet and the air outlet openings, good design of the acoustic cabinet made possible by the joint evaluation of heat transfer solutions will be to prevent overheating in the generator. Acoustic performance of composite panels forming the cabinet is assessed by parameters' 'transmission loss'' and '' sound absorption coefficient '. The first parameter indicates the sound energy entering the panel, the second indicates the amount transform sound energy to heat energy. These two parameters are particularly in high frequency bands where noise is dominant, while at other frequencies should be at appropriate levels. The steel forming the panel (or aluminum), thickness and the physical parameters of the insulation material must be determined according to the predominant noise frequencies. Insulation materials are

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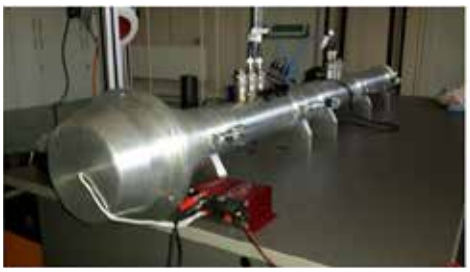

Figure. 4. Images of the impedance tube sections (left) and a Typical panel

2. Muffler Exhaust

The exhaust noise of the internal combustion engine reflecting the acoustic energy is reduced by the use of a silencer and damping paths. Acoustic properties of absorption material and the geometric dimensions of its parameters are taken into account in the design of the muffler. Or exhaust noise can not be silent enough with a single silencer, a second muffler or resonator system can be integrated. Acoustic performance of silencers evaluated on the loss or transmission loss of extension settings. Transmission loss is the logarithmic ratio of input parameters and the noise power at the output of exhaust and is very convenient to be numerically compared to plug loss account. The method consisting transfer matrix can be measured using a suitable tube impedance (ASTM E2611 - 09). Loss of extension is logarithmic ratio between the exit points of the system and without silent noise power. As the acoustic impedance effects at the entrance and exit are in the expansion loss parameters are more difficult to count, but it is easier to measure.

3. Vibration Absorbers

Ensure vibration isolation between the vibration that was created by the unbalanced forces in diesel engine sits where the surface is a point that must be strictly observed, particularly in large volume engines. measures taken to avoid any structural damage to the engine and his entourage also prevents secondary noise shaping (low frequency). Mechanical vibration damping parameters may be determined for the regions where the transmission rate is less than 1 (Fig. 5).

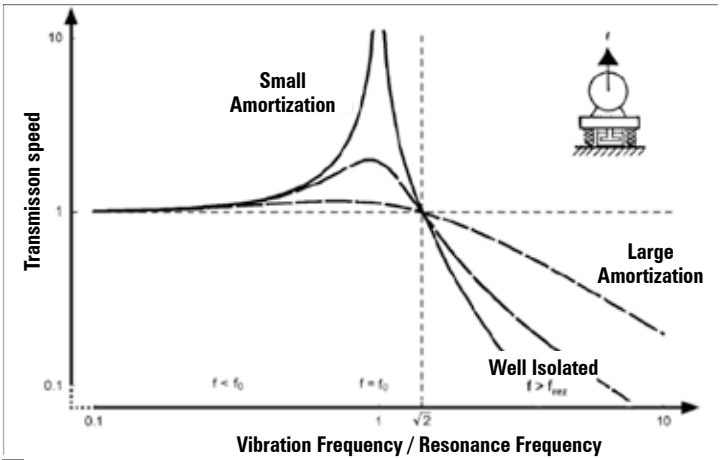

Figure 5. Function of the Transmisson Rate for vibration isolation

4. Other Strategies

Besides the main strategy mentioned above to reduce the noise of the generator;

- **Increase the Distance:**

The distance between the receiver (the human ear) and the source of noise is the noise will be less audible. If no reflective surfaces, moving away from the source of noise will be reduced by about 6 dB.

- **Optimal Positioning:** Given the location of the diesel generators receiver to be placed in the optimal position and location will be a reduction in the noise level in the destination.
- **Insulated and Barred Air Exhaust Channels:**

The insulating barriers can be applied around the openings of the cabinet.

Examples of Digital Calculation

Before converting to physical, acoustic control applications, acoustic calculations are conducted practically and with great accuracy, thanks to today's technology. Numerical finite element is the most widely used method.

Transmission Loss Calculations of the Panels

The acoustic transmission loss of cabinet panels can be calculated harmonically with the finite element method. As specified in ASTM e2611 - 09, in the case where a sound wave at right angles come to the planar material, the transmitted acoustic energy and damping is calculated. (Fig. 6).

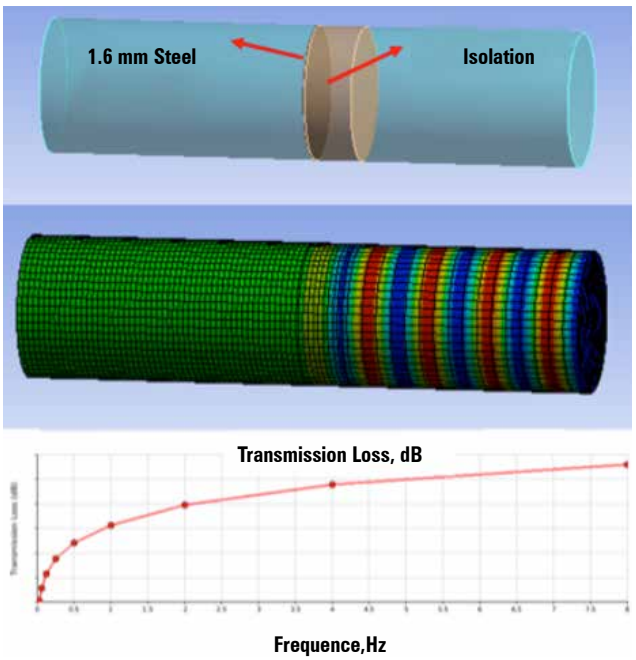

Figure 6. Images of Calculations of Transmission Loss in the Panels

Muffler Transmission Loss Calculations

The values of the transmission loss of the exhaust silencers can be found with the finite elements method. Works of perforated plates in the muffler is defined on the admittance matrix of 2x2 transfer. The damping effect of insulation materials can be calculated using the acoustic models Johnson-Champoux-Allard, Miki or Delany-Bazley. (Fig. 7)

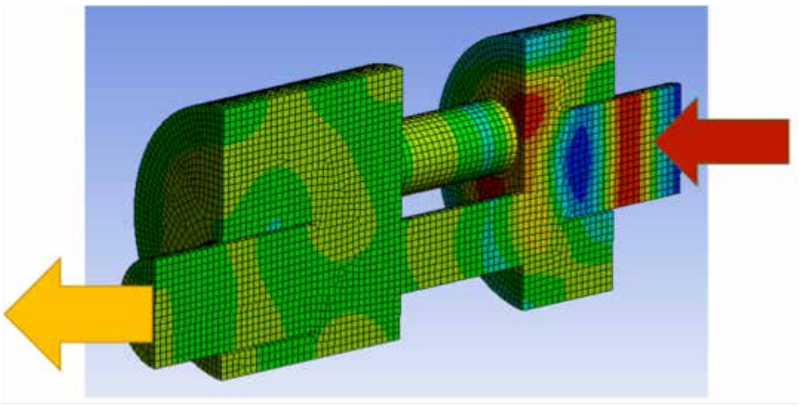

Figure. 7. Calculations of Acoustic Transmission Loss of Mufflers - Distribution of Acoustic Pressure

Sound Emission Calculations

The example of the noise distribution of solution around the cabin obtained with the finite element method is shown in Figure 8. Noise sources located inside the cabin can be identified by different routes (vibration speed the surface, the singular acoustic source, dual acoustic source). Insulation materials on various surfaces around the cabin can be incorporated into a mathematical model. The acoustic results far from finite element area can be calculated with the Kirchhoff integral method of surface.

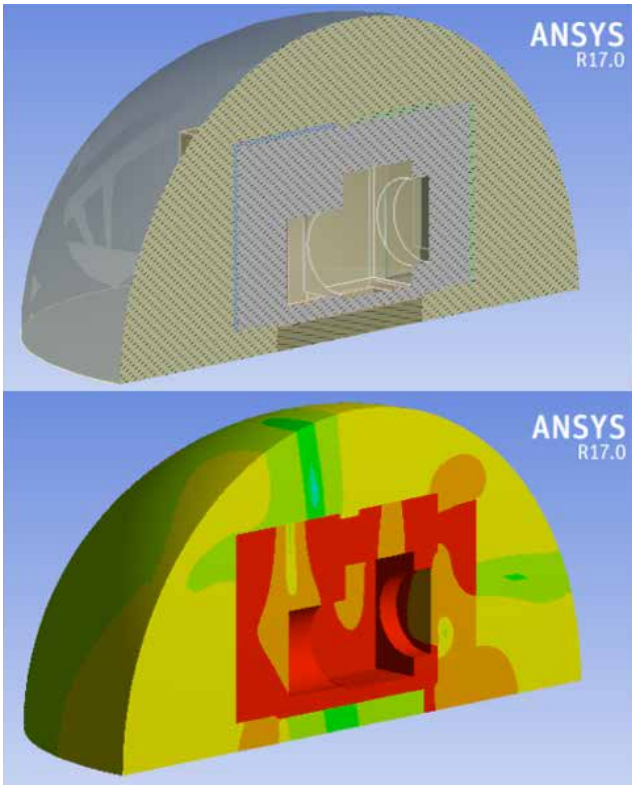

Figure. 8. Acoustic Pression Levels around Generating Group Cabinets

Conclusion

A diesel generator can generate noise levels that threaten the health and psychology of the people in this area, if the noise control is not well done. This is why the various methods should be applied to reduce noise. Acoustic calculations must be premade depending on the dispostion of the client as needed, with related types Using computational tools and implementation support on the basis of the acoustic expert strategy described in this document will enable the reduction of the targeted noise for diesel generators.