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Precision Grade Acoustical Noise Measurements of PowerBox at the Acoustical Technology Center (ATC) by Using ISO Standards

■ White Paper

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Using the “lingua franca”: why ISO matters for acoustical data

A common language is essential when comparing acoustical testing data from different generator sets; International Organization for Standardization (ISO) standards, as the only rigorous global standard for testing, should be the default choice for these comparisons. When used for testing, ISO standards and methodologies also assist in achieving regulatory compliance and allow for consistent replication of results no matter where in the world testing occurs. Cummins' Acoustical Technology Center (ATC) has been built to comply to all of ISO's requirements for Precision-Grade testing; in this whitepaper, we look at the importance of full adherence to ISO standards and what engineers should pay attention to when evaluating generator sets, using the PowerBox product line as an example.

Why ISO for acoustical testing?

ISO acts as a “lingua franca” for comparing data sets from different generators and testing sites/scenarios. Because ISO standards are established by a global body for global use, they provide common parameters for testing and measurement. These, in turn, ensure that organizations are comparing “like and like” when evaluating the results of different products in a single category.

The rigor and depth of ISO standards also means that, when properly adhered to, any acoustical testing data can be replicated if the same methodologies and qualified measurement environments are used – regardless of the testing facility or location. This is especially relevant for acoustical testing, where noise levels at workspaces are regulated by federal governments to protect workers' safety. In addition, communities are increasingly enacting ordinances aimed at reducing sounds that are disruptive to nearby residents.

For example, in North America, typically permitted noise levels at the property line at daytime and nighttime are around 60 dB(A) and 50 dB(A), respectively. However, in certain special zones, local authorities have set even

lower noise limits. That's why it is very important to measure noise levels using appropriate and applicable national and international standards in order to establish an accurate platform for comparison.

Meeting ISO standards demands that generator manufacturers undergo the same procedures that they would to meet compliance regimes in many countries and regions. As in the above example, ISO also allows businesses to better predict a generator's performance in any specific regulatory climate. In other words, ISO testing provides a greater likelihood that any generator set is compliant with the region where one seeks to operate it.

ISO standards for testing infrastructure

ISO standards exist not just for acoustical tests, but also for the facilities in which these tests are conducted. Facility standards indicate the level of testing which a given facility is capable of providing, based on its resources and processes. For example, some facilities can provide engineering-grade acoustical testing, but not precision-grade acoustical testing (the highest grade for acoustical testing, which Cummins' Acoustical Technology Center (ATC) is certified to provide). Acoustical measurement facilities and environments are qualified/certified by independent third-party agencies along the ISO standard based certification guidelines.

Before comparing generator sets based on acoustical data, it may be worth familiarizing oneself with the ISO standards that each manufacturer claims to meet, then assessing their testing procedures to see how these stack up against the actual standards. The length, width and height of a particular generator set will define how many microphones should be used, their positioning, the length of time history of audio data required at each microphone location, and other related variables. The generator set's specifications sheet contains the relevant information to verify the manufacturer's claims: while this can take some time, it's a worthwhile investment to be confident that the chosen generator set fully address potential regulatory or community noise restrictions.

A look at the Cummins' Acoustical Technology Center (ATC) at Minneapolis, USA

The Cummins Power Generation's Acoustical Technology Center (ATC) is among the largest in the diesel and power generation industries, featuring a hemi-anechoic chamber certified as "Precision Grade," the maximum accuracy level per ISO 3745.

Its vast size is needed to accommodate large generator sets and the many microphone positions required for Precision-Grade testing, including those at 7 meters from the surface of the largest generator set Cummins manufactures.

By using the microphone setup according to ISO and ANSI standards (and per directives and regulations, such as CE and CPCB-II, etc.), measurements are conducted all around the generator set so that all unique noise characteristics of its components are captured and also the directionality of the noise sources studied. This precision-grade noise data increases the operator's confidence level and eventually helps in devising noise control strategies quickly and economically.

Testing the Cummins PowerBox generator sets – going beyond the minimum

When testing the Cummins PowerBox, standard procedure dictated that number of microphones was calculated based on each PowerBox generator's length, width and height, as were the positions (X, Y and Z coordinates) of microphones. The Cummins' ATC is equipped with Class-1 instrumentation, recommended per ISO standards for Precision Grade hemi-anechoic chambers. As one of the biggest testing centers in the world used by the Power Generation and Diesel industries, the ATC is also capable of accommodating generator sets that are much larger than the PowerBox generator set.

When taking acoustical measurements from the PowerBox, Cummins' engineers ensured that they exceeded minimum requirements. In particular, each microphone sample recorded 60 seconds of data – much more than the minimum 15 seconds stipulated by ISO 3744 and ISO 8528 – Part 10. This practice gives engineers and generator managers the most comprehensive audio image possible of any generator's noise output, allowing them to make calculations for situations that might go beyond ISO's explicit requirements.

In testing the PowerBox, all microphones used were calibrated and classified per Class-1 research grade criteria (rather than the basic instrumentation often used in the industry). This ensures that the quality of data is as high as possible. As a result, the ATC is able to minimize the chance of informational noise or anomalies in its resulting data, which could add variance in results despite adhering to the ISO methodology in question.

Considerations for applying ISO to acoustical data

Only compare “like and like”

Acoustical data from different generator sets should meet the same ISO standards in order to engage in a proper comparison. The specification sheet is the most comprehensive indicator to help engineers compare “like and like”. It is also important to understand the noise data acquired at the Precision Grade facility has higher fidelity and confidence level than the data acquired at Engineering or Survey Grade facilities.

Trust ISO for performance and compliance

ISO provides the most trusted global standard for acoustical testing. Engineers may consider giving more weightage to the product specification sheets that are based on the data collected per ISO standards and similar corollary standards, regulations, and directives that are based on the fundamental ISO standards, for example ISO 3744 and ISO 3745 etc. It is very difficult to accurately compare performance of those generator sets that are noise tested per established standards, which can result in unexpected results when the generator sets are deployed in the field. ISO is also extremely relevant to compliance in different regions: most of the regulations and directives for noise levels either refer to or are based on the ISO standards. For example, European Commission’s 2000/14/EC directive or CE Directive refers to the ISO 3744:1994 standards.

Assess testing chamber resources

Noise testing facilities should be sufficiently resourced to ensure compliance at the highest level they say they can provide. Engineers should at least check the number of microphones, their size, and their frequency specifications to ensure that a chamber meets its stated grade of testing. In certain situations, they may require that the testing chamber be able to collect larger acoustical samples than stipulated by ISO (a standard practice in the ATC). The better the chamber, the more effectively it will be able to quantify the qualitative experience of acoustic output/noise in actual deployment.

Here are some questions to consider when comparing generator set acoustical data from different manufacturers:

- Were the generators tested at the same engine load/power node?
- Were the generators tested at the same engine speed?
- Was the data collected with or without a set-mounted radiator?
- Are the units of measurement the same? (A-weighted Sound Pressure Level [SPLA] or A-weighted Sound Power Level [SPWLA])
- Were Sound Pressure Level measurements taken at the same distance?
- Was the same standard or measurement method used for the noise measurements?
- How reliable is the data?
- Were the measurements conducted at Precision-or Engineering-Grade test facilities?

For additional information about the PowerBox generator sets, visit power.cummins.com.



About the author

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Space Administration, and Transport Canada. He is an active contributor to the field of power generator noise research, including programs with the National Academy of Engineering, National Institute for Occupational Safety and Health and the U.S. National Park Service. He is a member of the Institute of Noise Control Engineering and a reviewer of journal papers published in prestigious journals such as International Journal of Environmental Research and Public Health, Basel, Switzerland; Journal of the Acoustical Society of America, USA; and Noise Control Engineering Journal, USA.



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