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ASME Noise Standards – Present and Future

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Current ASME noise standards include PTC 36-2004 (Reaffirmed: 2013), "Measurement of Industrial Sound" and B133.8-2011, "Gas Turbine Installation Sound Emissions." The standards have been used as a basis of industrial sound testing for more than three decades. The PTC 36 Code provides measurement procedures to quantify the sound emissions of industrial equipment and facilities in indoor and outdoor settings. The B133.8-2011 Standard is more specialized, relating to industrial, pipeline, and utility applications of gas turbine installations. Both provide procedures for measuring and averaging near field and far field sound pressure levels as well as providing information on measuring and correcting for background noise and far field distance corrections. The PTC 36 committee is currently updating and revising the Code to provide enhanced methods for environmental corrections as well as addressing various issues associated with the testing and correcting of large, complex, industrial noise sources and facilities. The in-process revision of PTC 36 will be the first step to incorporate the gas turbine specific concepts used in the more specialized B133.8 standard and will result in the gradual phasing out of B133.8.

1 INTRODUCTION

The American Society of Mechanical Engineers (ASME) develops voluntary codes and standards associated with the practice of mechanical engineering to enhance public safety and quality of life while reflecting best available industry practices. ASME's noise standards committees are comprised of volunteers from a diverse range of interests, including manufacturers, end-users, academia, government and general interest with related expertise. The

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committees work toward developing and revising the standards based on user feedback, technical data, and changes in philosophies or available technologies.

While only a small portion of the ASME codes and standards are related to noise, they play an important role through standardization of methods needed to evaluate and quantify the unique noise features associated with large mechanical equipment. The standards also balance manufacturers' and end users' expectations and needs by offering both a standardized format for equipment specifications and a basis for determining contractual compliance of noise guarantees.

This paper describes the existing noise standards developed under the Performance Test Codes (PTC) committees and their future direction.

2 CODES AND STANDARDS THAT ADDRESS NOISE

Of the standards falling under the various Performance Test Code committees, two are specifically related to noise, while three others only mention noise in passing. The two main standards (items 1 and 2 below) are the primary focus of this paper but the others are also listed below for reference. A brief summary regarding the noise content of each is provided.

1. PTC 36 (2007) "*Measurement of Industrial Sound*"
2. *B133.8 (2011)* "*Gas Turbine Installation Sound Emissions*"
3. PTC 30.1 (2007) "*Air-Cooled Condensers*"
4. PTC 46 "*Performance Test Code on Overall Plant Performance*"
5. PTC 55 (2013) "*Gas Turbine Aircraft Engines*"

2.1 PTC 36 (2007) "Measurement of Industrial Sound"

The PTC 36 Code provides extensive measurement procedures to quantify the sound emissions of industrial equipment and facilities in indoor and outdoor settings. PTC 36 is currently under a major revision as will be discussed further in Section 3.

2.2 B133.8 (2011) "Gas Turbine Installation Sound Emissions"

Like PTC 36, the B133.8-2011 provides extensive measurement procedures to quantify the sound emissions for indoor and outdoor settings but is a more specialized standard, relating to industrial, pipeline, and utility applications of gas turbine installations. Unlike the more general PTC 36, this standard presents an equipment specific basis for <u>specifying and validating</u> the noise requirements.

While the B133.8 standard is not currently subject to the prescribed periodic review/re-approval cycle schedule, it may eventually be rolled into a version of PTC 36 as will be discussed in Section 4.

2.3 PTC 30.1 (2007) "Air-Cooled Condensers"

Within PTC 30.1 there is a specific disclaimer (Section 1-2) that "This Code does not address procedures for assessing noise." Elsewhere in PTC 30.1 is the requirement (Section 3-4.1(e)) that "The noise abatement equipment, as applicable, shall be in place" as a necessary part of test preparations. No other mention is made specifically regarding the sound, or 'noise', emissions from Air Cooled Condensers.

2.4 PTC 46 "Performance Test Code on Overall Plant Performance"

Within PTC 46 there is mention of 'noise' in only two places. At the outset (Section 1.2) noise emissions are clearly intended to be included within the scope of PTC 46. However, in the body of the Code (Section 3.1.2.7), "emissions" are defined as including noise, while at the same time they are inexplicably excluded from the scope of the Code.

2.5 PTC 55 (2013) "Gas Turbine Aircraft Engines"

Within PTC 55 there is an introductory note (Section 1-2) to the effect that certain "military and commercial specifications" often include noise requirements as "secondary parameters", and that "brief guidance, procedures and recommendations are included [within PTC 55] to address the measurement of those parameters." In fact, no further guidance or procedures are given. Mention is made in several sections (Section 3-5.2.1(d); Section 3-5.2.2.1; Section 3-5.2.2.2) that an effect of grids located in the inlets of test cells may be used to provide noise suppression. In an additional note regarding exhaust systems of test cells (Section 3-5.2.1(e)), and in particular regarding the use of flow augmentors, mention is made of such augmentors providing noise reduction. The Figures included in the standard describing the general types of test cell configurations (Figure 3-5.2.2.2-1; Figure 3-5.2.2.3-1) depict both inlet and exhaust silencers, but no further discussion of their types or effectiveness is provided. Lastly, the Code states that "Other uses for an outdoor test cell are acoustic testing….", but no further guidance is provided.

3 STATUS OF PTC 36 "MEASUREMENT OF INDUSTRIAL SOUND"

3.1 The Current Version of PTC 36

The current PTC 36-2004 (R2013) Code is a revision of the original 1985 version. PTC 36 provides a means of quantifying the sound emission of entire industrial facilities or pieces of stationary equipment used within them. PTC 36 is often used as a basis of testing to determine compliance with contractual guarantees between and among EPC contractors, equipment manufacturers and facility owners.

The current standard provides a set of rules for measuring and reporting the airborne sound of the sources with the objective of providing a method capable of repeatable results within a level of uncertainty. The standard allows measuring sound from equipment located indoors or outdoors and may include the enclosures or entire buildings as the noise sources. The standard offers options for using sound pressure level or sound intensity and provides techniques and procedures for eliminating background noise and building reverberation effects. Employing the methods described within the standard also enables the calculation of sound power level.

PTC 36 extensively references other ASME, ASTM, IEC and ANSI standards as the basis of performing the testing. Key portions of PTC 36 are based on references to the ASME B133.8 standard's handling of measurements of large sound sources including its corrections to free-field conditions and distance. This is problematic in that the PTC 36 standard should, ideally, be the "parent" sound measurement document. Of particular interest is the introduction of measuring far field sound from the facility or equipment relative to a "sound source envelope," which is defined as the smallest rectangular perimeter that just encloses the source component, or multiple components, of interest.

Listings of PTC 36's referenced standards are shown below.

- ANSI B133.8, Gas Turbine Installation Sound Emissions
- ANSI S1.1, Acoustical Terminology
- ANSI S1.4, Sound Level Meters
- ANSI S1.11, Specifications for Octave, Half-Octave, and Third-Octave Band Filter Sets
- ANSI S1.13, Methods of Measurement of Sound Pressure Levels
- ANSI S12.12, Engineering Method for the Determination of Sound Power Levels of Noise Sources Using Sound Intensity
- ANSI S12.18, Procedures for Outdoor Measurement of Sound Pressure Levels
- ANSI S12.36, Survey Methods for the Determination of the Sound Power Levels of Noise Sources
- ASTM E 1124, Standard Test Method for Field Measurement of Sound Power Level by the Two-Surface Method
- IEC 60651, Sound Level Meters
- ISO/TAG4/WG3, Guide to the Expression of Uncertainty in Measurement

When sound level tests are conducted in accordance with the PTC 36 Code, the test results are expected to yield the best indication of the actual sound emissions and acoustical performance of the tested equipment. However, with the various methods allowed for measuring, correcting and reporting the sound levels, the repeatability of the results are enveloped, as always, by a range of uncertainty.

3.2 Issues Being Addressed with Future Revisions of PTC 36

Several issues are currently being review and modified regarding the usability and repeatability of sound measurements based on PTC 36. Current issues being addressed include:

- Eliminating the extensive cross-referencing of the procedures and concepts used in the ASME B133.8 standard by incorporating them directly into PTC 36,
- removing non-standardized acoustic terminology,
- retaining sound pressure level measurement and eliminating sound intensity measurement as the basis for quantifying the sound emissions from the facility or equipment,
- eliminating extensive referencing of non-mandatory appendices,
- defining qualifications for personnel performing the testing,
- refining the corrections used for determining "free-field" conditions,
- determining whether or not to include procedures for measuring Wind Turbine noise,
- adding specific guidance for the measurement of outdoor low frequency noise and infrasound,
- possibly offering alternative methods for measuring and correcting data with varying levels of uncertainty such as survey grade and engineering grade accuracy.

The largest issues relate to incorporating concepts of standards, such as ASME B133.8, directly into PTC 36 and reducing the number of methods available to perform the testing. The overall intent is to reduce the range of uncertainty by eliminating both non-mandatory procedures and a proliferation of different permissible measurement techniques, while enhancing those used most often in industry.

Perhaps the most vital of the elements to be added to PTC 36 are clearer definitions of the location of measurement positions for near field and far field measurements.

In obtaining near field sound level measurements the scheme depicted in Figure 1 will be called for. Figure 1 shows a hypothetical arrangement of equipment to be regarded as a single acoustical source, but for the case where the equipment forms something other than a simple rectangular shape. The equipment arrangement shown in Figure 1 is conceptual only, therefore the selection of near field measurement positions, referred to as the near field source envelope contour or measurement contour, is modified as necessary for specific cases through mutual agreement among all parties in consideration of site specific constraints. The key features are the requirement of a rectilinear course for the measurement contour and the prohibition of reentrants in the measurement contour.

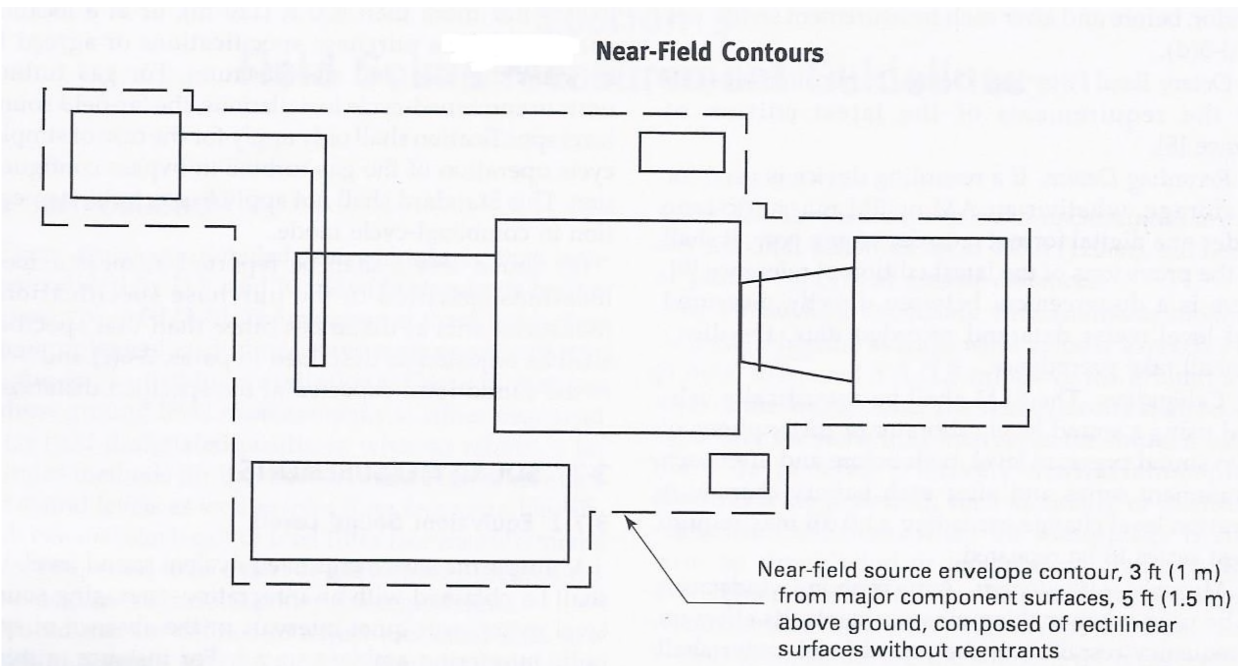

Fig. 1 – Definition of Near Field Contour

In obtaining far field sound level measurements, one of the schemes illustrated in Figure 2 will be called for. Figure 2 shows several hypothetical arrangements of equipment to be regarded as a single acoustical source, including both a simple rectangular shape, but also for the case where the equipment forms something other than a simple rectangular shape. The equipment arrangements shown in Figure 2 are conceptual only; therefore the selection of far field measurement positions, in specific cases, shall be modified as necessary through mutual agreement among all parties in consideration of site specific constraints. The key features are measurement along the cardinal axes and principal diagonals, as the case may be, and the requirement to prescribe a specification distance from the smallest rectangle which just encloses the sound sources. The revised PTC 36 Code will include the clarification of the far field measurement positions.

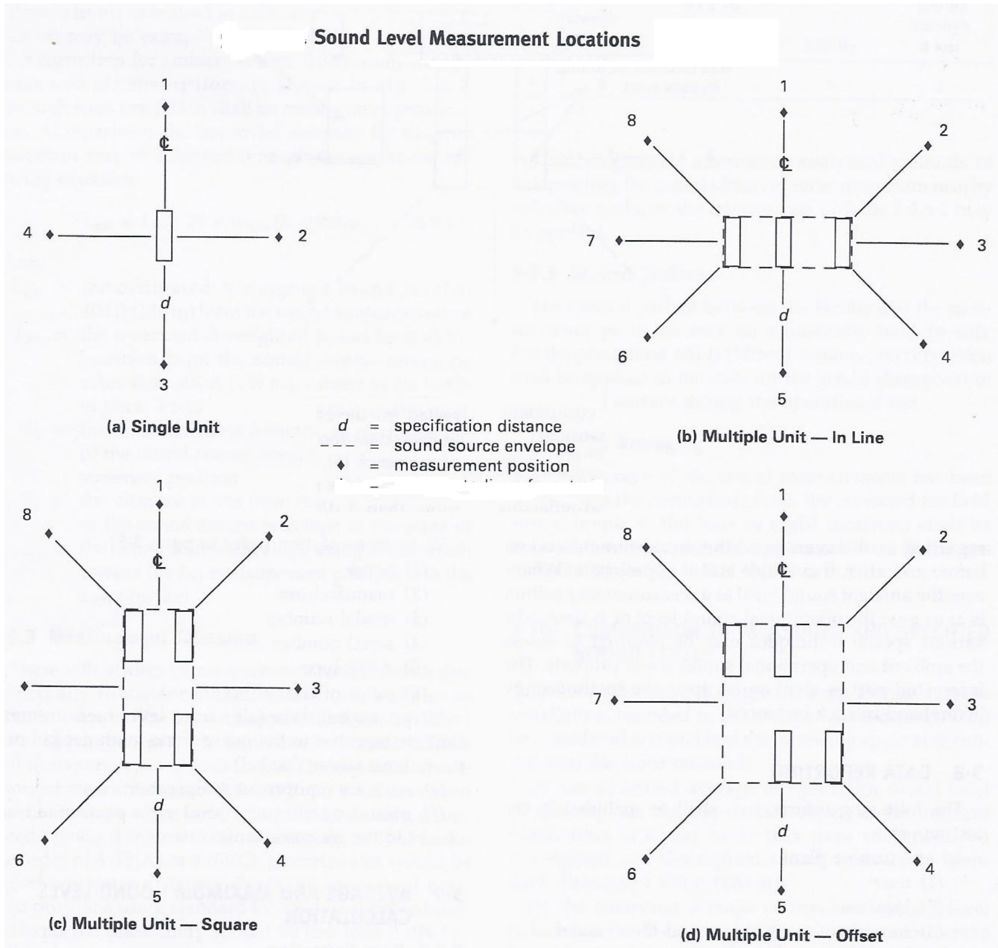

Fig. 2 – Definition of Far Field Measurement Locations for Various Sound Source Arrangements

Commercially, contractual noise guarantees are often evaluated on the basis of PTC 36 test results. The standard does not specify the means of comparing or interpreting results relative to contractual guarantees. Furthermore, with contractual guarantees beyond the scope of PTC Codes, the matter of test uncertainty is often neglected. While it is desirable to have an agreement between parties on the treatment of uncertainty before signing a contract, it is often not discussed until a formal test procedure is written or sometimes not until the sound compliance testing is completed. While both parties must ultimately agree to accept or not accept a level of uncertainty associated with a commercial test, it is beyond the scope of any standard to determine how commercial comparisons are made. Often the actual or calculated uncertainty yields to a negotiated level of uncertainty between parties.

Generally, neither party will dispute the existence of test uncertainty, but all parties believe they have full ownership of all/any uncertainty allowances.

The Revision Committee recognizes that whenever contractual test tolerance (often used interchangeably, and erroneously, with ‘uncertainty’ in contractual documents) is negotiated separately and specified within the contractual documents, it will completely supplant a rigorously calculated acoustical test uncertainty developed in terms of test-specific conditions and calculated in accordance with procedures defined within the Code. In such cases the called-for application of the Mandatory Appendix for the calculation of test uncertainty presents a potential conflict. For this reason, the upcoming revisions to the PTC 36 Code will need to clarify the issue, permitting such contractual test tolerances, where they exist, to supplant the Mandatory Appendix requirement.

4 STATUS OF B133.8, "GAS TURBINE INSTALLATION SOUND EMISSIONS."

4.1 The Current Version of B133.8

The B133.8 standard was initially set to be withdrawn by ASME in the 1990's as the main B133 Committee decided to abandon the B133 standards in favor of the ISO 3977 series of gas turbine procurement standards. The B133 Committee(s) were disbanded and all B133 standards other than B133.8 were withdrawn. B133.8 was kept as it was considered to have sufficient interest in U.S. industry to merit retention. Since all B133 committees were disbanded, the B133.8 standard was added to the PTC 36 committee's responsibilities for updating and revision.

The current ASME B133.8-2011 code is the first revision of the original ASME/ANSI B133.8-1977 (R2001) with its purpose to provide the format and criteria for the preparation of gas turbine procurement acoustical specifications for industrial, pipeline, and utility applications. The standard also provides sound measurement and reporting guidelines to determine if the specified sound emissions are compliant with the specifications. The Introduction of B133.8 states, "*…The PTC 36 Committee believes that although there are many test procedures available to users of this Standard, procurement and testing are inextricably and unavoidably connected*."

B133.8 applications are limited to simple cycle gas turbines or gas turbines with an exhaust stack diverter used in combined cycle applications and cannot be used directly for specification or measurement of full combined cycle plants or equipment that support combined cycle applications.

Although B133.8 is a "procurement standard," it is most often referenced for the rule set it offers regarding measuring and reporting the airborne sound of stationary gas turbines through a method capable of providing repeatable results and corrections to free-field conditions for equipment located both indoors or outdoors.

Some of the same issues apply to B133.8 as to the PTC 36 standard including the use of non-mandatory appendices, the use of non-standardized acoustic terminology, and the need for refined corrections to "free-field" conditions.

While the B133.8 standard continues to exist, there is a desire to incorporate much of the measurement philosophy and techniques into a future version of PTC 36.

4.2 Issues Being Addressed with Future Revisions of B133.8

The B133.8 standard is not actively being revised at this time but the PTC 36 committee has been made aware of several minor typographical errors located in the Nonmandatory Appendix A - Guide to Determining Acceptable A-Weighted Sound Level. Some of the typos have existed since the standard's first edition issued in 1977. These errors will be eventually corrected if the B133.8 standard is not abandoned and completely incorporated into a revision of PTC 36.

5 SUMMARY

The Revision Committee of PTC 36 is progressing toward completion. The Committee has drafted, as of this writing, most of the sections to be revised and is currently in the process of finalizing those revisions. The inclusion of all relevant sections from B133.8, modified as necessary to apply to the more general requirements of PTC 36, may enable future simplification of the ASME catalog, but that decision is in abeyance and users should continue to regard standard B133.8 as fully in force. The schedule which the Committee has set calls for a consensus document to be presented for final balloting in the 2016 calendar year.