



GEK 110392b
Revised March 2005

GE Energy

Standard Noise Assessment Procedure

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes the matter should be referred to the GE Company.

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I. TEST PHILOSOPHY

This “Standard Noise Assessment Procedure” is intended to present an overview of the factors involved in the testing of large Gas Turbine and Combined Cycle Power Plant equipment, and to provide assurance to our customers that these procedures adhere to the pertinent standards set forth by ANSI/ASME and ISO.

This document defines the methods that will be used to assess the noise emissions of GE supplied equipment in a power plant, to verify compliance with the noise guarantee of the contract. It describes techniques to obtain near field and far field (if applicable) noise levels while the power plant is operating at base load together with all its ancillary cooling and electrical equipment.

This procedure is based on industry recognized standards, namely ANSI/ASME PTC 36-1985 "Measurement of Industrial Sound", ANSI B133.8 -1977 "(R2001) Gas Turbine Installation - Sound Emissions", ISO 10494 “Gas turbines and gas turbine sets – Measurement of emitted airborne noise – Engineering/survey method, ISO 3746 “Acoustics – Determination of sound power levels of noise sources using sound pressure – Survey method using an enveloping measurement surface over a reflecting plane”, and ISO 6190 “Acoustics – Measurement of sound pressure levels of gas turbine installations for evaluating environmental noise – Survey method”. Table 1 shows the relationship of these documents.

Table 1. Corresponding ISO and ANSI/ASME Standards

	Near Field Measurement Standard ¹	Far Field Measurement Standard
ISO	ISO 10494 ² /ISO 3746 ³	ISO 6190 ⁴
ANSI/ASME	ANSI/ASME PTC 36	ANSI 133.8

¹All the referenced near field measurement standards are designed to determine equipment sound power level based on sound pressure level measurements. For determination of equipment near-field sound levels, the measurement provisions of each standard will be applied. The calculation to determine sound power level is not applicable for near-field compliance and will not be incorporated into this test procedure.

²ISO 10494 has been prepared in accordance with ISO 3740 on the basis of ISO 3744 to address measurement requirements specific to gas turbines. Measurements of the gas turbine shall be performed in accordance with ISO 10494 as appropriate. Measurements of the remaining plant equipment will be measured in accordance with ISO 3744/ISO 3746.

³ISO 3744 and ISO 3746 are very similar standards forming the ISO 3740 series of standards. ISO 3744 is an engineering grade standard; ISO 3746 is a survey grade standard. The survey grade test method is general sufficient for near-field acoustic measurements within power stations.

⁴ISO 6190 has expired without being reaffirmed by the ISO standards committee. Provisions of these standard are still appropriate for gas turbine far-field measurement and will be used to form a basis for this acoustic test procedure.

The described assessment(s) shall be conducted or supervised by a competent noise control specialist with industrial or power station experience.

II. ACOUSTIC ENVIRONMENT FOR FAR FIELD MEASUREMENT

A number of environmental factors affect the sound level measured at a given orientation and distance relative to the GE supplied equipment, including both weather and surrounding terrain. While weather conditions are not controllable, the time of measurement should be chosen to minimize their effect.

A. Atmospheric Conditions

Measurements shall be made when the wind velocity does not exceed 7mph (3m/s) (an average wind speed of up to, but not exceeding 11mph (5m/s) may be accepted and must be recorded in the test report). For any outdoor location, measurements shall be made when no precipitation is evident. If traffic noise is evident, no measurements will be made during wet road conditions. Exceptional conditions of temperature and humidity or other atmospheric conditions at the site should be avoided. Cloudy or nighttime conditions with wind speeds in the range of 1 to 3 m/s are preferred to minimize unusual effects due to temperature gradients.

B. Standard Terrain

If obstacles of sufficient size to affect the measurement of acoustic performance exist, data should be modified in accordance with ANSI B133.8 to compensate for this effect, or the measuring position may be moved or eliminated.

C. Background Noise

In order to obtain a true representation of the emitted noise from the GE supplied equipment without any influence from other sources in the vicinity, the background noise level shall be at least 4 dB less than the measured noise level with the gas turbine plant operating. If the noise level difference is less than or equal to 3dB, measurement positions should be moved to another location, subject to agreement of the relevant parties. Noise from equipment that is not within the testing scope should be considered as background noise. If the background noise is more than 10 dBA less than the operational noise, then no background corrections are necessary.

III. INSTRUMENTATION FOR NOISE MEASUREMENT

A. Sound Level Meter

Noise measurements shall be made with instrumentation meeting the minimum requirements of IEC 60651 Type I or II instrument and IEC 60804. The instrument shall have both dBA and octave band frequency measurement capability. The instrument shall be set at the “Fast” meter response.

B. Calibration

Instruments shall be acoustically calibrated before and after each survey, using a sound level calibrator or pistonphone of known sound pressure level. Both the calibrator and the meter shall have been calibrated within the last 12 months with their traceable calibration records. If there is a discrepancy exceeding 0.5dB between the pre-survey and post survey calibrations, the test shall be repeated, but only if the calibration change affects the pass or fail status of the test. Reference: IEC 942:1988 “Sound Calibrators”.

C. Windscreen

A microphone windscreen shall be used to minimize any wind induced noise.

IV. MEASUREMENT PROCEDURE

The power plant will be running at normal operating base load condition, when measurements are taken. During testing all enclosure doors and access panels will be closed unless otherwise specified. An Installation Quality check shall be conducted prior to testing, to ensure that all noise control equipment (such as barrier walls, enclosures, seals, skirting) is properly installed, and that no gaps or holes exist, which would allow noise to escape from enclosed areas.

A. Microphone Position

The microphone shall be located between 4ft (1.2m) and 5.3ft (1.6m) above the Contract specified level, and at least 11.5ft (3.5m) from walls or other sound reflecting structures. If these distances cannot be achieved, appropriate correction should be applied as per Section V of this document. Measurements shall not be taken at positions less than 3 ft (1 m) to the nearest part of a radiating noise source or reflecting surface.

B. Near Field Measurement

The near field measurements shall be made in accordance with the guidelines set forth in ANSI PTC 36, ISO 10494 and ISO 3746. The measurement positions shall be located along the perimeter of the GE supplied equipment and its auxiliary equipment as defined in the relevant contract document. Measurements will not be made on the upper surfaces of machinery or enclosure surfaces but will be confined to the areas specified in the contract that are normally accessible and are no closer than 3ft (1m) to the nearest part of the equipment surface. Near field measurements shall be taken at approximately 10ft (3m) intervals around the gas turbine, steam turbine, generator power train(s) and their auxiliary equipment.

C. Far Field Measurement

The far field measurements shall be made at the measurement locations identified in the contract documents. If the contract states the measurements are to be conducted in direct accordance with the applicable procedures, the measurements shall be made at eight locations in accordance with the guidelines set forth in ANSI B133.8 (re. Figure 2 of ANSI B133.8) and ISO 6190. The distance between the noise assessment location and the noise source(s) shall be an agreed upon value stated in the noise specification and/or contract. The measurement positions may be eliminated or moved depending on local conditions (background noise, accessibility, reflecting surfaces, screens or topographical conditions).

D. Type of Data

The equivalent continuous sound pressure level shall be determined over a minimum time interval of 30 seconds for the near field assessment and two (2) minutes for the far field assessment or of sufficient duration to ensure a measurement representative of the equipment noise emissions. Near Field measurements shall not be performed during periods when unusual activities are taking place (such as construction) that may influence the measured noise levels. For Far Field measurements, the instrument may be placed on "pause" during the measurement period to exclude transient non-plant sound such as the passing of automobiles; such activity must be documented in the test report.

V. CORRECTIONS TO SOUND LEVELS

The following explanations of measurement corrections and uncertainties (section V and VI) are taken from the applicable ANSI/ASME and ISO standards (referenced above). GE policy regarding these corrections and uncertainties is outlined in section VII.

A. Correction for Reflections (If Required)

The far field measurements should be corrected to the extent possible for reflective surfaces. The correction factors (provided in Table 2 of ANSI B133.8) will be applied when there are major buildings, fences, walls, or other large structures with dimensions greater than 3m (10 ft) within a distance of 5λ (λ is the wavelength at the lowest frequency of interest) of the equipment being measured or the microphone position. The near field measurements should be corrected for free field condition in accordance with ANSI PTC 36 and/or ISO 10494.

B. Correction for Background Noise (If Required)

The sound pressure levels recorded at each microphone position shall be corrected for the influence of the background noise at the same location (adapted from ISO 6190 Table 1 and ISO 10494 Table 4). Corrections will be made in accordance with Table 2. If the background noise is unsteady, additional statistical sound pressure level (L10, and L90) should be measured.

Table 2. Correction for Background Noise Expressed in dB (re. 2×10^{-5} Pa)

Difference between sound pressure level measured with Gas Turbine plant operating and background sound pressure level alone dB	Correction to be subtracted from sound pressure level measured with Gas Turbine plant operating to obtain sound pressure level due to gas turbine alone dB
> 10	0
9	1
8	1
7	1
6	1
5	2
4	2
≤ 3	Measurement invalid

C. Data Averaging

The average sound pressure level is calculated from the measurements taken at all relevant test positions, and shall be calculated as an arithmetic or logarithmic average, as specified in the contract.

D. Correction for Distance (If Required)

The measurements may be made at distances other than the compliance locations to accommodate access restrictions or to mitigate the effect of structures or background noise. If the measurements are conducted at distances other than the compliance locations, the measurement results, after correction for background noise, shall be extrapolated to the noise assessment location (ANSI B133.8, and ISO

6190). The measurement location shall be approved by all parties involved. The formula for this extrapolation is as follows.

$$SL_{pl} = SL_{tp} + 20 \log(D_{tp}/D_{pl}) - C$$

SL_{pl} = Noise level at assessment location

SL_{tp} = Noise level at other test point

D_{pl} = Distance from GT plant boundary to assessment location

D_{tp} = Distance from GT plant boundary to test point

C = Atmospheric absorption correction between the two distances

VI. MEASUREMENT UNCERTAINTY

Measurements carried out in accordance with standard procedure usually result in uncertainties, as detailed in the ANSI/ASME and ISO standards referenced above. Typical values are shown in Table 3. The values reflect the cumulative effects of all causes of measurement uncertainty, which include instrumentation accuracy, environmental factors, calibration, directional, measurement distance, fluctuation of the source noise level etc. In instances where these uncertainties cannot be controlled, it is appropriate to apply the correction factors to the measured values.

Table 3. Uncertainties for Sound Pressure Levels in dB

Frequency – Weighted Sound Pressure	Center Frequencies of Octave Band Sound Pressure Levels		
Overall dB(A)	31.5 - 125 Hz	250 Hz	500 – 8000 Hz
3	5	4	3

VII. MEASUREMENT TOLERANCE POLICY

Unless conditions contributing to the corrections and uncertainties described in the preceding sections are exceptional and/or cannot be corrected to a reasonable degree (such as untreated interior walls of the Turbine building), GE policy is to apply a general tolerance number to both Near Field and Far Field test measurements (Table 4), rather than applying separate tolerances for each possible correction and/or uncertainty. This tolerance is significantly smaller than the cumulative total of all of the corrections and uncertainties specified and/or allowed in the applicable ANSI/ASME and ISO codes. Deviation from this policy will be discussed and agreed upon between GE and the customer.

Table 4. Tolerances for Test Measurements in dB

	Near Field measurement Tolerance (dB)	Far Field measurement Tolerance (dB)
Overall dB(A)	2	3

NOTE

ISO 10494 Table 3 Specifies an “uncertainty” of 2dBA for a Grade 2 test and 5dBA for a Grade 3 test for near field noise levels. This combines allowances for both background and environmental (reflective surfaces, noise contribution) corrections.

VIII. CALCULATION OF NOMINAL SOUND LEVEL**A. Near Field**

The average of all near field levels measured around all of the GE supplied equipment, after correction for background noise and free field condition, shall be considered the nominal sound level of the power plant. If this value, minus the test tolerance shown in Table 4, is equal to or less than the guaranteed level the plant shall be considered in compliance with the contractual near field requirements.

B. Far Field

Far Field noise levels shall be reported in accordance with the applicable ANSI/ASME and ISO standards and the far field noise requirements specific to the site being tested. If the measured sound level at the specified compliance locations, minus the test tolerance shown in Table 4, is equal to or less than the guaranteed level the plant shall be considered in compliance with the contractual far field requirements.

IX. INFORMATION TO BE REPORTED

The noise measurement report will include the following information.

A. Power Plant

1. Location
2. Model and configuration of equipment in operation
3. Description of units including auxiliary equipment and noise control treatment
4. Full details of the operating condition of the power station during the test
5. Any other appropriate information

B. Acoustic Environment

1. Dimensioned sketch showing the GE supplied equipment, measurement positions, significant buildings, structures, and/or other reflecting objects.
2. Meteorological conditions at a noted measurement position, including temperature, relative humidity, wind speed and wind direction.

C. Instrumentation

Details of the instrument(s) used, including name, manufacturer, model number, serial number and calibration certificates.

D. Acoustic Data

1. Background noise levels used for any correction
2. The results of the measurement at each position as dB(A) and octave band values.

E. General Data

1. Personnel performing and observing the test
2. Date and time of measurement.

F. Any Exceptions to this Procedure**GE Energy**

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