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## **Turbines and turbine sets — Measurement of emitted airborne noise — Engineering/survey method**

*Turbines et groupes de turbines — Mesurage du bruit aérien émis —  
Méthode d'expertise/de contrôle*



Reference number  
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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 192, *Gas Turbines*, in collaboration with Technical Committee IEC/TC 5, *Steam Turbines*.

This second edition cancels and replaces the first edition (ISO 10494:1993), which has been technically revised.

The main changes compared to the previous edition are as follows:

- the measurement of airborne noise from steam turbines and steam turbine sets has been added;
- the content has been aligned with ISO 3744:2010 and ISO 3746:2010;
- the title has been updated.

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## Introduction

### 0.1 Background

Control of noise from machines or equipment requires effective exchange of acoustical information among the several parties concerned. These include the manufacturer, specifier, installer and user of the machine or equipment. This acoustical information is obtained from measurements.

These measurements are useful only if they are carried out under specified conditions to obtain defined acoustical quantities using standardized instruments.

The sound power level data determined according to this document is essentially independent of the environment in which the data are obtained. This is one of the reasons for using sound power level to characterize the sound emitted by various types of machine equipment.

Sound power level data are useful for the following:

- a) calculating the approximate sound pressure level at a given distance from a machine operating in a specified environment;
- b) comparing the noise radiated by machines of the same type and size;
- c) comparing the noise radiated by machines of different types and sizes;
- d) determining whether a machine complies with a specified upper limit of noise emission;
- e) planning in order to determine the amount of transmission loss or noise control required under certain circumstances;
- f) engineering work to assist in developing quiet machinery and equipment.

This document gives requirements for the measurement of the noise emission of turbines and turbine sets. It has been prepared in accordance with ISO 3740:2000 on the basis of ISO 3744:2010. Due to the special conditions concerning turbines and turbine sets, it is necessary to define different noise sources and to use measurement surfaces differing from those specified in ISO 3744:2010.

For some environmental conditions, it can be necessary to use the survey methods based on ISO 3746:2010 resulting in a lower grade of accuracy. Frequency information is still recorded and reported.

### 0.2 Aims

The methods defined in this document apply to the measurement of the noise emission of a turbine or turbine set under steady-state operating conditions. The results are expressed as sound pressure levels, and sound power levels in A-weighted and in octave bands.

The aim of this document is a grade 2 (engineering) result (see [Table 1](#)). When the correction for background noise exceeds the limit of 1.3 dB but is less than 3 dB and/or the correction for environment exceeds the limits of 4 dB but is less than 7 dB, then a grade 3 (survey) result is obtained (see [Table 2](#)).

Measurements made in conformity with this document should result in standard deviations which are equal to or less than those given in [Table 3](#). The uncertainties in [Table 3](#) depend not only on the accuracies with which sound pressure levels and measurement surface areas are determined, but also on the "near-field error" which increases for smaller measurement distances and lower frequencies (i.e. those below 250 Hz). The near-field error always leads to measured sound power levels which are higher than the real sound power levels.

NOTE 1 If the methods specified in this document are used to compare the sound power levels of similar machines that are omnidirectional and radiate broad-band noise, the uncertainty in this comparison tends to result in standard deviations which are less than those given in [Table 3](#), provided that the measurements are performed in the same environment with the same shape of measurement surface.

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NOTE 2 The standard deviations given in Table 3 reflect the cumulative effects of all causes of measurement uncertainty, excluding variations in the sound power levels from test to test which can be caused, for example, by changes in the mounting or operating conditions of the source. The reproducibility and repeatability of the test result can be considerably better (i.e. smaller standard deviations) than the uncertainties given in Table 3 would indicate.

**Table 1 — International Standards specifying various methods for determining the sound power levels of machines and equipment**

| International Standard   | Classification of method                             | Test environment   | Volume of source  | Character of noise  | Sound power levels obtainable                            |
|--|--|--|---|---|--|
| <b>Normative</b>   |  |  |   |   |  |
| ISO 3744   | Grade 2 (engineering)                                | Outdoors or in large rooms   | No restrictions; limited only by available test environment | Any   | A-weighted and in octave bands or one-third octave bands |
| ISO 3746   | Grade 3 (survey)                                     | No special test environment  | No restrictions; limited only by available test environment | Any   | A-weighted   |
| <b>Informative</b>   |  |  |   |   |  |
| ISO 3741   | Grade 1 (precision)                                  | Reverberation room meeting specified requirements  | Less than 2 % of test room volume                           | Steady, non-steady, fluctuating, isolated bursts of sound energy, broadband, discrete frequency | A-weighted and in octave bands or one-third octave bands |
| ISO 3743-1   | Grade 2 (engineering)                                | Hard-walled test room  | Less than 2,5 % of test room volume                         | Steady, non-steady, fluctuating, isolated bursts of sound energy                                | A-weighted and in octave bands                           |
| ISO 3743-2   | Grade 2 (engineering)                                | Special reverberation test room  | Preferably less than 1 % of test room volume                | Steady, non-steady, fluctuating, broadband, narrow-band, discrete frequency                     | A-weighted and in octave bands                           |
| ISO 3745   | Grade 1 (precision)                                  | Anechoic- or hemi-anechoic room  | Preferably less than 0,5 % of test room volume              | Any   | A-weighted and in one-third octave bands                 |
| ISO 3747   | Grade 2 and 3 (engineering and survey)               | No special test environment, but sufficiently reverberant; source under test non-movable | No restrictions; limited only by available test environment | Steady, non-steady, fluctuating, isolated bursts of sound energy, primarily broad-band          | A-weighted and in octave bands                           |
| ISO 9614-1   | Grade 1, 2 and 3 (precision, engineering and survey) | No special test environment  | No restrictions <sup>b</sup>                                | Any, but stationary in time   | A-weighted and in octave bands or one-third octave       |
| <sup>a</sup> Method to determine the sound power of airborne noise caused by machinery surface vibration specifically.<br><sup>b</sup> For measurements in anechoic or hemi-anechoic rooms limited by the size of the test room. |  |  |   |   |  |

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**Table 1 (continued)**

| International Standard     | Classification of method               | Test environment            | Volume of source             | Character of noise          | Sound power levels obtainable                            |
|----------------------------|--|-----------------------------|------------------------------|-----------------------------|--|
| ISO 9614-2                 | Grade 2 and 3 (engineering and survey) | No special test environment | No restrictions <sup>b</sup> | Any, but stationary in time | A-weighted and in octave bands or one-third octave bands |
| ISO 9614-3                 | Grade 1 (precision)                    | No special test environment | No restrictions <sup>b</sup> | Any, but stationary in time | A-weighted and in octave bands or one-third octave bands |
| ISO/TS 7849-1 <sup>a</sup> | Grade 3 (survey)                       | No special test environment | No restrictions              | Any                         | A-weighted   |
| ISO/TS 7849-2 <sup>a</sup> | Grade 2 (engineering)                  | No special test environment | No restrictions              | Any                         | A-weighted and in octave bands or one-third octave bands |

<sup>a</sup> Method to determine the sound power of airborne noise caused by machinery surface vibration specifically.

<sup>b</sup> For measurements in anechoic or hemi-anechoic rooms limited by the size of the test room.

**Table 2 — Limits for correction**

| Grade of accuracy         | Background noise correction<br>dB | Environment correction<br>dB |
|---------------------------|-----------------------------------|------------------------------|
| Grade 2                   | ≤1,3                              | ≤4                           |
| Grade 3                   | ≤3                                | ≤7                           |
| Special case <sup>a</sup> | >3                                | >7                           |

<sup>a</sup> For higher values of background noise and/or environmental corrections, the real sound power level cannot be determined with acceptable uncertainty, but the results can be useful to estimate an upper limit of the noise emission of the turbine or the turbine set to be tested.

**Table 3 — Uncertainty in determining sound power levels and sound pressure levels, expressed as the standard deviation**

| Grade of accuracy | Octave band centre frequency<br>dB |        |                  |                      |          | A-weighted<br>dB |
|-------------------|------------------------------------|--------|------------------|----------------------|----------|------------------|
|                   | 31,5 Hz to 63 Hz                   | 125 Hz | 250 Hz to 500 Hz | 1 000 Hz to 4 000 Hz | 8 000 Hz |                  |
| Grade 2           | 5                                  | 3      | 2                | 1,5                  | 2,5      | 2                |
| Grade 3           |                                    |        |                  |                      |          | 3                |

NOTE 1 Grade 3 uncertainty is related to stable conditions.

NOTE 2 The value of the standard deviation for air intake and gas exhaust outlet of gas turbines can be higher.