INTERNATIONAL STANDARD

ISO 15664

First edition
2001-05-01

Acoustics — Noise control design procedures for open plant

Acoustique — Modes opératoires de contrôle du bruit dans les installations ouvertes

Reference number
ISO 15664:2001(E)

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Printed in Switzerland

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 15664 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

Annexes A to I of this International Standard are for information only.

Introduction

This International Standard defines procedures for the noise control design of open plants, including oil refineries, chemical plants, gas plants, unenclosed powerplants, steelworks, gravel washing plants, cement plants, concrete batch plants and other continuous, batch or intermittent operation plants located in the open, in order to achieve optimal environmental, occupational, technical and economic benefits.

This International Standard is applicable to the design of new plants and to the modification/extension of existing plants. It is based on experience in the design, construction, operation and maintenance of such facilities and identifies the major technical and procedural issues that should be addressed in a good plant noise control design.

The users of this International Standard should be familiar with the type of plant involved and have sufficient technical expertise and experience in industrial plant noise control design. This International Standard is intended to be flexible to suit the nature and location of the plant being designed, and the technical abilities of the parties involved.

Where there is any conflict between this International Standard and any local regulations, the requirements of the local regulations should be complied with.

It is specifically intended that the end-user and the contractor agree on the nature and extent of the work to be done and the reporting on the work, and which party carries out what work.

This International Standard is not intended specifically to be a contract document, but it is recognized that annex B and any additional requirements specified separately may form part of a contract between the end-user and the contractor.

This International Standard is not considered suitable for reference in procurements specifications (requisitions) of individual equipment as it addresses issues that are often beyond the scope of an individual equipment item vendor.

A list of standards related to this International Standard is given in the Bibliography.

Acoustics — Noise control design procedures for open plant

1 Scope

This International Standard defines the procedures for noise control of mainly open plants.

It is applicable to the following:

— specification of procedures for noise control during engineering of a new plant and modification/extension of existing plants (construction noise procedures are outside the scope of this International Standard but should be considered);

— definition of responsibilities of parties involved, viz. “end-user”, “engineering contractor” and “equipment supplier”;

— description of general procedures to arrive at noise requirements for individual equipment, on the basis of overall noise requirements for the plant.

A schematic flowchart, reviewing the noise control process, is presented in annex A and a summary of action items is presented in annex B.

NOTE Concerning specific engineering methods for the acoustic design and analysis of plants, use should be made of other standards and textbooks.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 1996-1, *Acoustics — Description and measurement of environmental noise — Part 1: Basic quantities and procedures*

ISO 1996-2, *Acoustics — Description and measurement of environmental noise — Part 2: Acquisition of data pertinent to land use*

ISO 3864, *Safety colours and safety signs*

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

3.1 General terms

3.1.1
end-user
party which initiates the project and ultimately owns or operates the plant, or pays for its design and construction

NOTE The end-user will generally specify the technical objectives and/or requirements.

3.1.2
contractor
party which carries out all or part of the design, engineering, procurement, construction and commissioning for the project

3.1.3
manufacturer
supplier
party which manufactures or supplies equipment and services to perform the duties specified by the contractor

3.1.4
work area
any position not less than 1 m from equipment surfaces accessible to personnel, and any position where a worker's ear may be exposed to noise in the normal course of his duty

NOTE The work area includes any platform, walkway or ladder.

3.1.5
project specification
document defining the scope of a project

NOTE It can contain descriptions of the process, project management, responsibilities and engineering requirements. These include safety and environmental requirements.

3.1.6
governing authorities
local, regional, national or other authorities that specify and enforce criteria for environmental and occupational health noise

3.2 Terms specific to noise

3.2.1
noise limit
noise levels not to be exceeded and given as a sound power level, sound pressure level or noise exposure level

3.2.1.1
authority noise limits
noise limits set by governing authorities

3.2.1.3
contractual noise limits
noise limits set by the end-user as part of a legal contract between the end-user and the contractor, considering authority noise limits and company requirements

3.2.1.4
equipment noise limits
noise limits set by an end-user or contractor for a manufacturer/supplier for an individual equipment item

3.2.2
tonal noise
noise which is dominated by one or several clearly distinguishable tone(s)

NOTE See ISO 1996-2.

3.2.3
impulsive noise
noise consisting of one or more bursts of sound energy of duration less than about 1 s

NOTE See ISO 1996-2 (environmental noise), ISO 1999 (in-plant noise) and ISO 12001 (equipment emission).

3.2.4
fluctuating noise
noise whose level varies continuously and to an appreciable extent during the period of observation

[ISO 12001:1996, definition 3.19.1]

3.2.5
intermittent noise
noise whose level abruptly drops to the level of the background noise several times during the period of observation

[ISO 12001:1996; definition 3.19.2]

NOTE The time during which the level remains at a constant value different from that of the ambient is of the order of 1 s or more.

3.2.6
noise emission
airborne sound radiated by well-defined noise source, such as a machine, equipment, part of a plant or an entire plant

NOTE See ISO 12001 and ISO 11690-1.

3.2.7
noise immission
total amount of noise from all contributing sources at a given position

NOTE See ISO 11690-1.

3.2.8
noise exposure
all noises that arrive, over a specific time period, T, at a person's ear in the actual situation

NOTE See ISO 11690-1; for the purposes of this International Standard, this term is also used for specific positions in the environment.

4 General requirements

The control of noise in a plant is necessary for the following reasons:

— to prevent noise-induced hearing loss;

— to reduce work, speech and concentration interference;

— to provide quiet living accommodation for personnel;

- to protect the environment;
- to prevent annoyance to the neighbouring community.

Noise limits can be given for each of the above aspects of noise control, relative to certain areas inside or outside the plant. For the purposes of this International Standard, they are referred to as “general noise limits”. They are specified in clause 5.

Noise limits for each item of equipment shall be derived from the general noise limits, as applicable for the equipment in its specific position in the plant. These are commonly referred to as “equipment noise limits”. Procedures for deriving equipment noise limits are specified in clause 6.

Each potential noise source shall be subject to the requirements of this International Standard.

Authorities may enforce obligations to reduce noise levels as far as reasonably practicable. Recommendations for noise limits may be found in national or International Standards, e.g. ISO 11690-1 (work place), ISO 9921-1 (speech communication) and ISO 1996 series (environment).

The specified limits shall be met for the design operating conditions of the plant. They shall also hold for other operating conditions which occur occasionally, such as start-up, shutdown, regeneration and maintenance, unless specified otherwise by the end-user and agreed with the contractor. The only requirement for emergency situations (i.e. any conditions other than just described) which can be foreseen or predicted (e.g. relief valve operation) is that the absolute limit specified in 5.1.2 shall not be exceeded.

The end-user may set specific noise limits applicable to the construction phase of the project. These limits may be set to meet environmental requirements.

This International Standard deals with noise from more or less stationary equipment. However, noise radiated from mobile noise sources, such as transportation vehicles (lorries, trucks, railway equipment) or mobile maintenance equipment, in the plant or workshops might have to be taken into consideration. Noise due to mobile sources is more important if relatively high numbers of vehicles are present near the boundaries of the plant, also because noise reduction is often hard to achieve for this type of source. Therefore parties shall investigate whether or not this kind of transportation noise has to be considered as part of the noise control procedures.

The planning for and extent of the noise control engineering for a plant is based heavily on the project specification. It is always vital that all of the noise limits and any other noise requirements specified by the end-user be carefully and completely defined in the project specification. This is particularly true where more than one contractor is involved or where the plant (or part thereof) might be operated by other than the end-user or contractor. In addition to the noise limits, the project specification should include all applicable items from annex C.

This International Standard defines a number of specific tasks that may be performed during a project. These tasks are assigned an action item (A1, A2, A3, etc.). The responsibility for the execution of these action items is assigned to either the end-user or the contractor as stated in annex B, where a summary of the action items is included.

5 General noise limits (immission requirements)

5.1 In-plant noise

5.1.1 General

(A1) The end-user shall investigate all governing authority requirements with respect to noise in the plant, with respect to hearing conservation, speech and work interference, noise levels for accommodation, etc.

Noise limits are often based on noise exposure of workers. In that case work patterns leading to noise exposure shall be agreed by the parties involved. Noise limits may also be based on maximum sound pressure levels for work areas.

(A2) The most stringent noise limits and other requirements shall be determined from the requirements of governing authorities and end-users. The applicable contractual noise limits shall be stated in the project specification.

Where there are no authority limits, the guidelines of ISO 11690-1 and other International Standards should be considered.

5.1.2 Absolute work area noise limit

The absolute limit is the sound pressure level anywhere in the work area that shall not be exceeded in any situation, including emergencies; for example the operation of safety equipment.

The absolute limit is determined in action item (A2).

5.1.3 Work area noise limit

The work area noise limit, which may be different for different areas, defines the noise level that shall not be exceeded in order to comply with the limits as determined in action item (A2).

5.1.4 Restricted area

Restricted areas are those work areas in the plant where, according to the state of the art, it is not reasonably practicable to reduce the noise level at or below the work area limit. The absolute limit remains valid in such areas.

If it is unavoidable that the work area limit will be exceeded around particular equipment, action should be taken to limit the area involved as far as is economically and technically feasible. This may include the erection of an acoustic enclosure. Areas inside acoustic enclosures around such equipment may be restricted areas.

(A3) The contractor shall identify the potential restricted areas to the end-user. Written permission shall be obtained from the end-user to designate an area as a restricted area. The end-user and contractor shall discuss and agree the noise levels that may be permitted in these noise restricted areas, taking into account authority requirements.

(A4) Permanent warning signs to indicate the mandatory use of ear protectors shall be erected at the boundaries of restricted areas. The signs shall be of the type specified in ISO 3864.

5.2 Environmental noise

Limits for environmental noise are often set by governing authorities and may be linked to existing noise levels. The regulations can also include methods for measurement and calculation of environmental noise immission based on the sound power emitted by noise sources. Regulations can include requirements for permits and environmental assessments. See ISO 1996-1 and ISO 1996-2.

(A5) The end-user shall investigate applicable regulations. In order to avoid misunderstandings, it can be useful to discuss the interpretation of the regulations with the authorities.

Environmental noise limits are often different for day, evening and nights, and for week-ends. All of the above requirements shall be taken into account so that all of the requirements are met at all times.

(A6) Where requirements for environmental noise do not exist or are considered insufficient, this aspect of plant design shall still be considered at the project definition stage to anticipate adverse community reactions at some later date.

(A7) Authorities usually specify environmental noise limits for normal and sometimes for emergency operation as a sound pressure level limit at specified locations in the vicinity of the plant or at the plant boundary line. Such limits can be converted into contractual noise limits in terms of sound power level for a number of composing parts of the plant under consideration. In these cases the resultant sound power level limits shall be included in the project specification.

Calculation of environmental noise immission on the basis of source sound power levels and vice versa shall be carried out in accordance with recognized calculation models specified or agreed by authorities and the end-user. Examples of recognized calculation methods (e.g. those in ISO 9613-2) are given in the Bibliography.

NOTE There are many ways to convert sound pressure level limits into sound power level limits for composing parts of a plant or large equipment items. The sound power level limits usually must be specified as octave or one-third-octave spectra and also must include directivity restrictions.

5.3 Exceptional or emergency operating conditions

(A8) It shall be ensured that any allowances for occasional higher noise levels that may be acceptable to governing authorities (such as for emergencies, start-up, shutdown and maintenance activities) are included in the project specification.

(A9) Any noise limits applicable during construction of the plant shall be stated separately in the project specification.

5.4 Additional restrictions for tonal or impulsive noise

Further restrictions may apply if the noise contains tonal or impulsive components and these shall be taken into account when specifying equipment noise limits (see 6.3.5).

6 Equipment noise limits (emission requirements)

6.1 General

Equipment noise limits shall be derived from the noise immission or exposure limits of the work area (A2) and the sound power level limits obtained from 5.2 (A7), or any other limits that may be stated in the project specification.

If the results of the investigation indicate that one or more of the limits will be exceeded, consideration should be given to replacing the equipment concerned by equipment emitting less noise or, if this is not reasonably practicable, noise control measures such as insulation or acoustic enclosures should be installed. The extent of noise control measures to be taken shall be in accordance with the severity of the requirements.

6.2 Sound power level limit for equipment

For plants where no other limit than the work area limit (see 5.1.3) is applicable and not many significant noise sources are located near each other, the equipment sound power level limit need not to be determined.

The sound power level limit for individual equipment shall be determined at an early stage of the project in order to comply with the noise limits of the plant.

The allocation of sound power level limits to individual equipment items at an early stage of a project can best be performed using vendor data, noise declarations (see, for example, ISO 4871), databases and experience, taking into account the type, size and operating conditions of the equipment. However, where actual sound power levels are known, they should be used. They may also be calculated from equipment sound pressure levels, assuming that the requirements of 6.3 will just be met.

The derivation of the sound power level limit for each item of equipment is an iterative process. If a sound power level limit for a plant, or a number of parts of a plant, is specified (5.2), it is only required that the sum of the sound power limits for equipment items in that plant does not exceed the overall limit. If the environmental limit is not provided as a sound power level limit, the total environmental immission sound pressure level at the locations where the environmental limits apply shall be computed (predicted). The sound pressure levels due to each noise-producing item at the community location of interest can be added together. Noise propagation calculations shall be carried out in accordance with recognized calculation models specified or agreed by the authorities and end-users (see, for example, ISO 9613-2). It can then be decided if individual equipment sound power level limits can be increased or decreased so that the community sound pressure level limit is met. The allocation of any safety