INTERNATIONAL STANDARD

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Acoustics — Recommended practice for the design of low-noise workplaces containing machinery —

Part 2:
Noise control measures

Acoustique — Pratique recommandée pour la conception de lieux de travail à bruit réduit contenant des machines —

Partie 2: Moyens de réduction du bruit

Reference number
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Contents

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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.

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.

International Standard ISO 11690-2 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

ISO 11690 consists of the following parts, under the general title *Acoustics — Recommended practice for the design of low-noise workplaces containing machinery*:

— *Part 1: Noise control strategies*

— *Part 2: Noise control measures*

— *Part 3: Sound propagation and noise prediction in workrooms*

Part 1 is the central document in the series. Parts 2 and 3 give additional technical and explanatory information. It is therefore recommended to start with part 1.

Annexes A to K of this part of ISO 11690 are for information only.

Introduction

Most of the existing International Standards prepared in ISO/TC 43/SC 1 specify methods for measurement and/or evaluation of noise. The final objective of ISO 11690, however, is noise reduction.

A number of noise control measures are offered. However, in order to be effective, the most appropriate noise control measure(s) should be chosen for a given situation.

It is important when non-acoustic engineers are involved in noise control practice for these engineers to have a basic knowledge of noise emission and propagation characteristics and to understand the basic principles of noise control.

To assist in the development of noise control in the workplace, it is essential that the information contained in these recommended practices is disseminated through International Standards.

In order to reduce noise as a hazard in the workplace, individual countries have produced national legislation. Generally, such national legislation requires noise control measures to be carried out in order to achieve the lowest reasonable levels of noise emission, noise immission and noise exposure, taking into account:

— known available measures;

— the state of the art regarding technical progress;

— the treatment of noise at source;

— appropriate planning, procurement and installation of machines and equipment.

This part of ISO 11690, together with the two other parts in the series, outlines procedures to be considered when dealing with noise control at workplaces, within workrooms and in the open. These recommended practices give in relatively simple terms the basic information necessary for all parties involved in noise control in workplaces and in the design of low-noise workplaces to promote the understanding of the desired noise control requirements.

The purpose of the ISO 11690 series is to bridge the gap between existing literature on noise control and the practical implementation of noise control measures. In principle, the series applies to all workplaces and its main function is:

— to provide simple, brief information on some aspects of noise control in workplaces;

— to act as a guide to help in the understanding of requirements in standards, directives, text books, manuals, reports and other specialized technical documents;

— to provide assistance in decision making when assessing the various measures available.

The ISO 11690 series should be useful to persons such as plant personnel, health and safety officers, engineers, managers, staff in planning and purchasing departments, architects and suppliers of plants, machines and equipment. However, the above-mentioned parties should keep in mind that adherence to the recommendations of the ISO 11690 series is not all that is necessary to create a safe workplace.

The effects of noise on health, well-being and human activity are many. By giving guidelines for noise control strategies and measures, the ISO 11690 series aims at a reduction of the impact of noise on human beings at workplaces. Assessment of the impact of noise on human beings is dealt with in other documents.

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Acoustics — Recommended practice for the design of low-noise workplaces containing machinery —

Part 2:
Noise control measures

1 Scope

This part of ISO 11690 deals with the technical aspects of noise control in workplaces. The various technical measures are stated, the related acoustical quantities described, the magnitude of noise reduction discussed and the verification methods outlined.

This part of ISO 11690 deals only with audible sound.

NOTE 1 Annex K lists relevant International Standards and other literature on noise control measures.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this part of ISO 11690. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this part of ISO 11690 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 11690-1:1996, *Acoustics — Recommended practice for the design of low-noise workplaces containing machinery — Part 1: Noise control strategies.*

3 Definitions

For the purposes of this part of ISO 11690, the definitions given in ISO 11690-1 apply.

4 Technical aspects of noise control

Noise reduction measures can be applied at source (emission), between the source and the receiver (transmission path), and at the work station (receiver). (See figure 1.)

When dealing with the noise emission of a machine, an installation or a production process, etc., all possible noise reduction measures should be considered (see clause 5 and ISO 11690-1). To determine whether noise emission is as low as reasonably practicable, it is necessary to consider noise emission quantities; these are given in the noise emission declaration (see ISO 11690-1:1996, clause 8) or determined by measurements (carried out in compliance with the relevant standard).

An assessment of noise control devices such as enclosures, partial enclosures, barriers and screens, silencers, etc. can be carried out by using, for example, the insertion loss data (see 6.2).

The acoustic quality of workrooms and buildings is assessed with reference to the sound insulation regarding airborne and structure-borne sound (see 6.4), and that of workrooms with reference to sound propagation parameters (see 6.3).

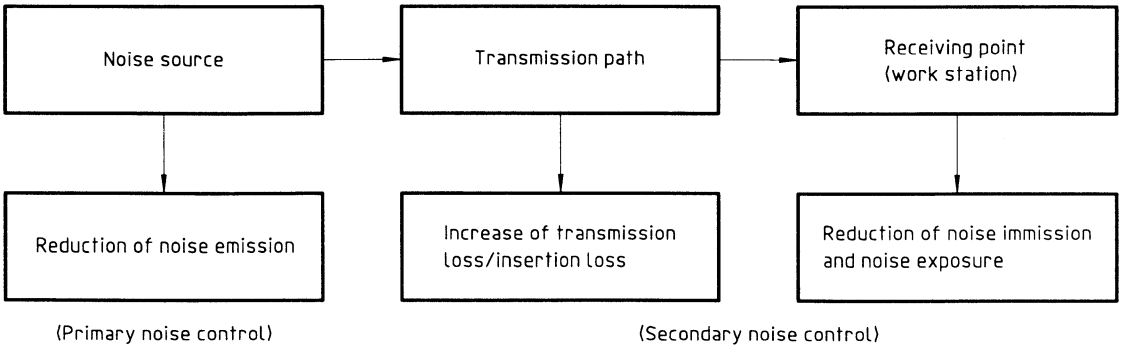

Figure 1 — Basic aspects of noise control

The overall effectiveness of noise control measures is determined from the noise immission values at the work stations.

Generally, people located at a work station or in the vicinity of a machine are affected by the direct noise emitted by the machine. Therefore, to reduce noise in the workplace, the most effective solution is to reduce noise at source (primary measures). Additional measures on the transmission paths (secondary measures) may be impractical because they hinder the work task and the production process. When assessing the state of noise reduction technology, low noise emission of sound sources is therefore given high priority with regard to occupational safety.

The basic aspects of noise control (see also ISO 11690-1) are illustrated in figure 1. These are reviewed in clauses 5 to 7.

In order to minimize noise at the workplace, all noise control measures should be considered *a priori* (see figure 2).

Noise control is most effective if it is carried out when planning, modifying, changing existing machinery or equipment, or when acquiring new machinery or equipment in plants, workrooms and buildings. From the outset, all parties involved (see ISO 11690-1:1996, clause 6) and, in particular, the noise experts, should take part in the process. Noise control measures are most effective if they are integrated at the design stage of machines, production processes, workrooms and tasks (see ISO 11690-1:1996, clause 7). Machine operation, material transport, safety technology, ergonomics and environmental protection should also be considered at that stage.

5 Noise control at source

5.1 General

The measures described in this clause deal with the reduction of noise generated by working processes and machines. They should be implemented at the design stage because retrospective measures can affect operational requirements and are generally more expensive. However, they are also recommended for existing noise sources, when practicable.

Noise control at source in workplaces deals in particular with the noise reduction of existing machines, the development and selection of low-noise working processes and production technologies, the replacement of machine parts and the assessment of the results obtained.

The effectiveness of noise control at source is based on measurements and is assessed by comparison with the noise emission data, for example, provided by the supplier/manufacturer (see ISO 11690-1:1996, clause 8).

5.2 Noise control at source by design

When machine noise (or noise from technical production equipment) is considered, two types of noise generation should be distinguished: fluid dynamic noise generation (gas and/or liquid) and mechanical generation.

Fluid dynamic noise arises from temporary fluctuations in pressure and velocity of fluids. Examples are combustion processes, fans, blow-out openings and hydraulic systems.

Mechanically generated noise is caused by vibrations of machine components that are excited by dynamic forces which are generated, for example, by impacts or out-of-balance masses. The vibrations are transmitted to noise-radiating surfaces, such as machine casing, workpieces, etc. Examples are tooth-wheel gears, electric motors, hammers, shakers and mechanical presses (see figure 3).

In order to control noise at source, the noise-generation mechanism should be taken into account.

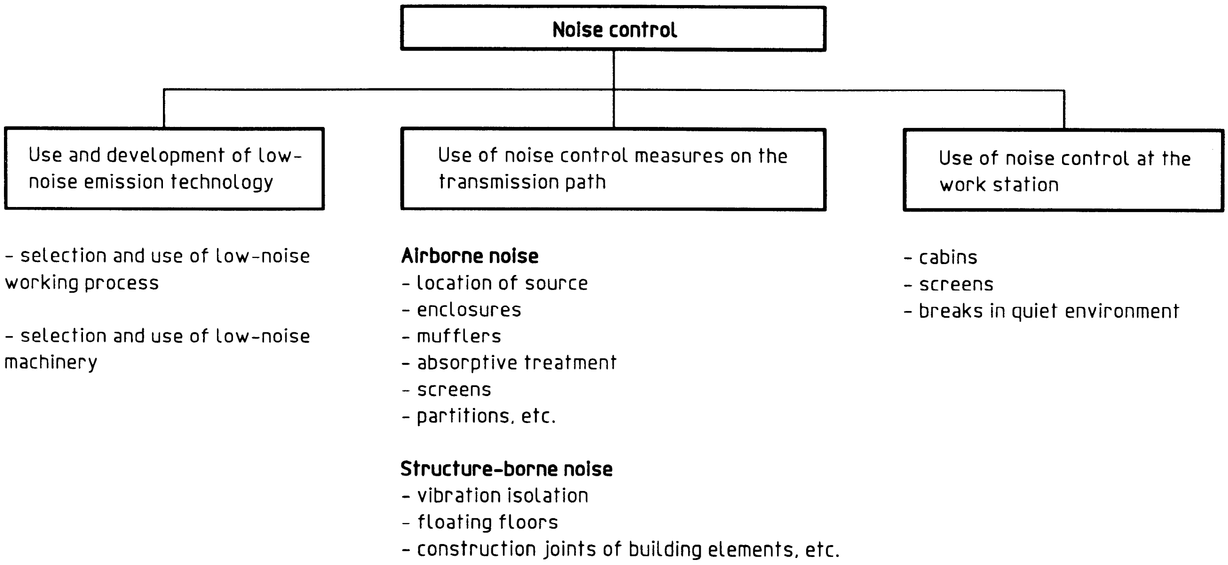

Figure 2 — Steps for the implementation of noise control measures

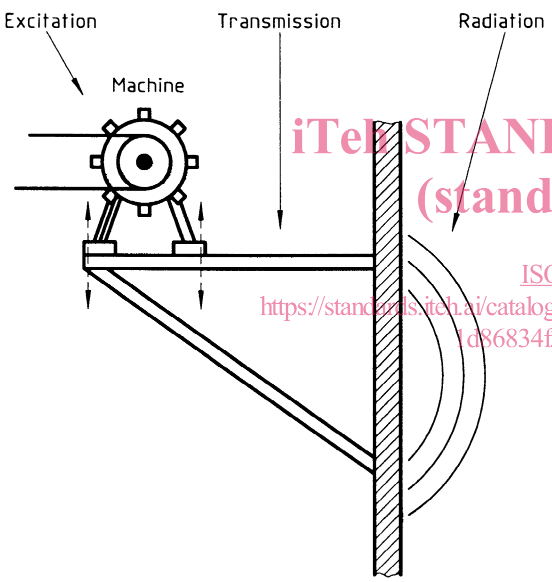

Figure 3 — Generation process of mechanical noise

Examples of reduction of fluid dynamic noise are the following:

a) reduction of periodical pressure fluctuations at the excitation source;

b) reduction of flow velocities;

c) avoidance of sudden changes in pressure;

d) effective design of through-flow components.

Examples of reduction of mechanically generated noise are the following:

a) reduction of exciting dynamic forces (e.g. by means of elastic layers to extend the impulse duration of impacts);

b) reduction of the vibrational velocity of the machine structure at the excitation point for a given dynamic force [e.g. by means of stiffeners or additional masses (inertia blocks)];

c) reduction of the vibration (structure-borne sound) transmission from the excitation point to the sound-radiating surfaces [e.g. by using elastic elements and materials with high internal damping (cast iron)];

d) reduction of the sound radiated by a vibrating structure, for example by use of

— thin walls with ribs instead of thick stiff walls,

— damping layers on thin metal sheets,

— perforated metal sheets (provided noise insulation is not required);

e) sound-insulating wrappings or thick-walled structures (thin damped metal sheets near the radiating surface).

Further information on noise reduction at source can be found in ISO/TR 11688-1 and ISO/TR 11688-2.

5.3 Information on noise emission

In addition to the information on noise emission given by suppliers/manufacturers in technical documentation (see ISO 11690-1:1996, clause 8), there may be measures specific to industrial sectors. Information on such measures can be found in databases, professional magazines, trade association journals, etc.

For some machine families, there are lists of noise emission data obtained under specified operating conditions. These lists can help purchasers select low-noise machines/equipment (see ISO 11690-1:1996, annex A).

5.4 Use of low-noise machines

In some circumstances, rather than implementing costly retrospective noise control measures, it is feasible to replace a noisy unit in a plant with a low-noise one (see table 1).

There are also noisy operations which are not connected with fixed machines, for example from the use of hand-held tools. These can often be the dominating noise sources in a workroom. If care is taken in selecting the tools or the working arrangement (e.g. sound-deadened hammers, cushioned work tables, low-noise grinding discs, magnetic damping mats, etc.), considerable noise reductions can be achieved as shown in figures 4 to 7.

5.5 Modification or replacement of machine components

It is possible, by replacing or modifying machine components, to reduce noise transmission inside the machine and noise radiation by the machine surface, without affecting performance. Annex A gives examples of such noise reduction measures.

5.6 Low-noise working and production technologies

It is always beneficial, if feasible, to replace a particularly noisy machine or unit in a plant with a quieter one, for example by using a machine that works to a different principle (e.g. replacing an impact screwdriver by a continuous direct-driven screwdriver).

With regard to existing processes, particular attention should be paid to the possibility of substituting the process with an equally effective but quieter method.

When substituting a production process, low-noise alternatives should be systematically searched for.

The successive replacement of machines, plant items and processes by less noisy ones will in the long term lead to quieter working environments even though low-noise machines have to be positioned alongside existing noisy ones.

Table 1 — Examples of alternative processes with lower noise

High-noise processes	Low-noise processes
Percussion riveting	Compression and roll riveting
Drive by compressed air or internal combustion engine	Electrical drive
Cutting or making holes in, for example, stone or concrete by the use of pneumatic or internal combustion percussive machines	Use of machines that can be fitted with drills or circular saw blades equipped with diamond teeth
Heading in the die	Tapering/full-forward extrusion
Push cutting	Pull cutting
Flow drying	Radiation drying
Plasma oxygen cutting	Plasma cutting under water
Cutting shock, punching	Laser-beam cutting
Conventional TIG/TAG welding	TIG/TAG shielded arc welding
Flame-hardening	Laser-beam hardening
Fastening with rivets	Pressure fixing
Stroke forming	Hydraulic pressing
Spot welding	Seam welding

NOTES

1 A change of the material and/or form of the component under manufacture may allow the use of low-noise production processes.

2 This list is by no means exhaustive.

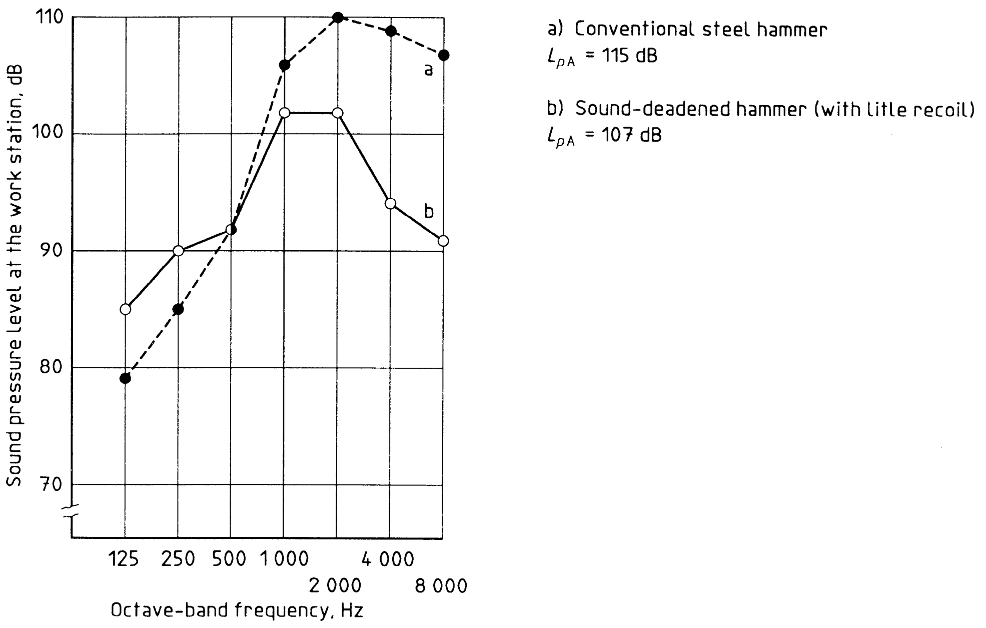

Figure 4 — Example of sound pressure level during hammering

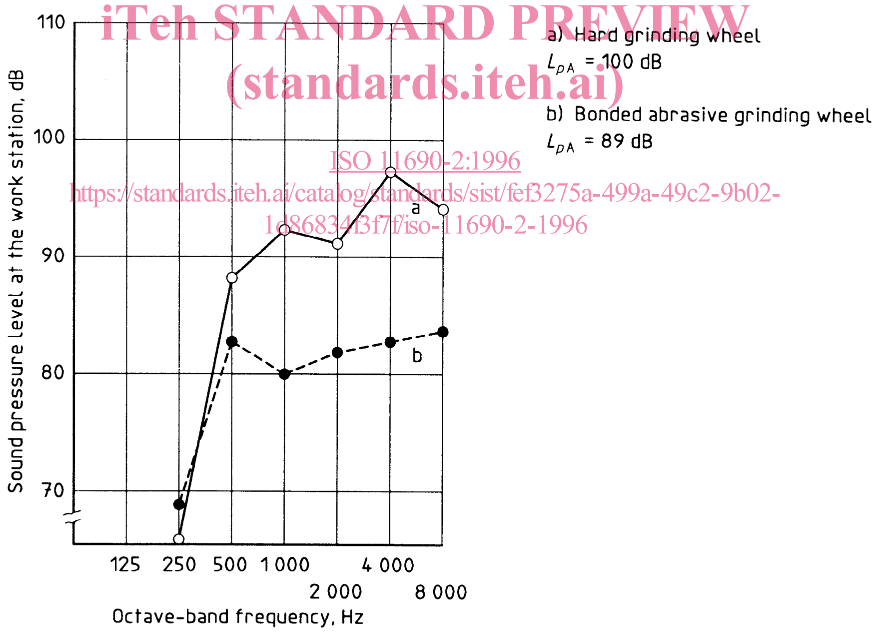

Figure 5 — Example of sound pressure level when grinding during the cleaning of a cast iron electromotor housing

5.7 Maintenance of machines and noise control devices

Noise emission levels from machines or processes can be unnecessarily high due to lack of maintenance, poor lubrication, misalignment, unbalanced and loose parts, etc. Optimum operating conditions should be maintained at all times. Any maintenance defect normally increases the noise levels.

Maintenance of noise control devices is also of prime importance. Therefore the function of enclosures, screens and silencers should be carefully monitored.

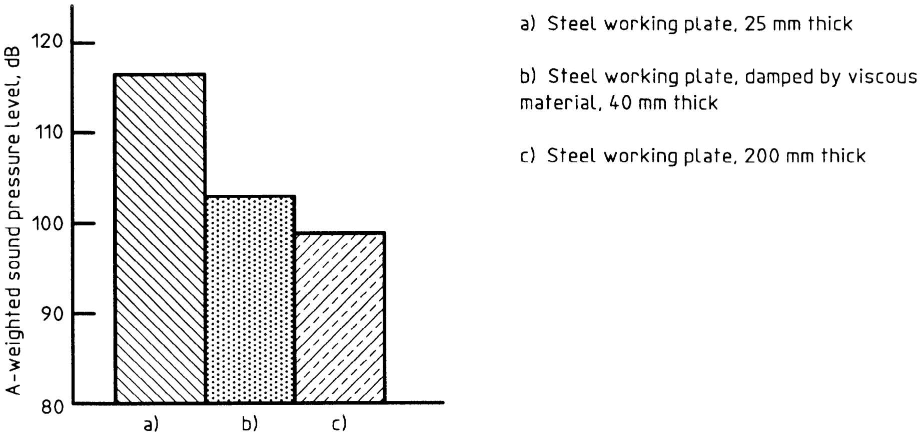

Figure 6 — Example of sound pressure level when hammering

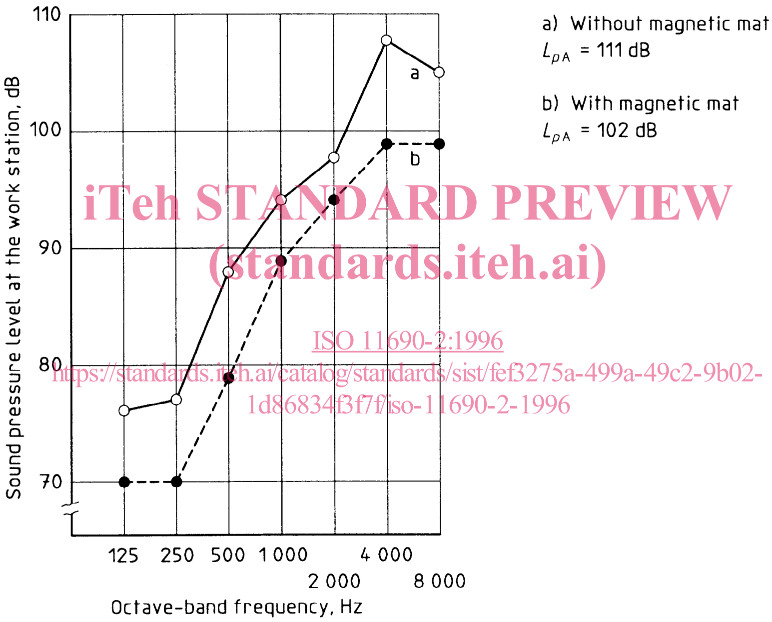

Figure 7 — Example of sound pressure level when grinding a steel plate

6 Noise control on the transmission path

6.1 Noise control by means of a proper spatial arrangement of the noise sources

An optimized spatial arrangement of machines can provide a substantial noise level reduction at work stations. This is mainly applicable when planning new plants and installations but should also be considered for existing plants.

Noise reduction can be obtained by increasing the distance between the noise sources and the work stations (see annex B).

6.2 Use of noise control devices

Enclosures (see annex C), silencers (see annex D) and screens (see annex E) can be effective measures for the reduction of the noise emitted from machines, installations, piping systems and openings.

An enclosure is a structure completely surrounding the machine or installation. It consists mainly of a sound-insulating shell (metal, wood, concrete, etc.) with an internal sound-absorbing lining. The achievable noise reduction depends on the insulation of airborne sound provided by the shell and on the degree of absorption by the internal surface of the enclosure. In practice, it