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Foreword

This final draft European Telecommunication Standard (ETS) has been produced by the Equipment Engineering (EE) Technical Committee of the European Telecommunications Standards Institute (ETSI), and is now submitted for the Voting phase of the ETSI standards approval procedure.

Proposed transposition dates	
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Introduction

Compatibility with the end-use environment is a primary concern for purchasers and manufacturers of telecommunications equipment. An important compatibility issue is the amount of acoustic noise emitted by the equipment. This ETS is intended to meet four primary needs of purchasers and manufacturers with regard to this issue:

- specification of acoustic noise emission measurement methods;
- specification of acoustic noise emission limits;
- specification of a method for reporting acoustic noise emission;
- specification of a method for verification of declared noise emission values.

To develop practical specifications and to have the capacity to make fair comparisons between equipment, it is essential to have a single, technically established method for the measurement of acoustic emission. Therefore, this ETS specifies the use of sound power measurement and, more specifically, adopts ISO 7779 [1] as the primary measurement document.

Sound power levels can be used for direct comparison of noise emission for functionally similar equipment manufactured by different vendors, and/or in the calculation of estimated sound pressure levels for spaces where the equipment is to be installed. The use of sound *power* level, instead of emission sound *pressure* level, as the specified quantity for product noise emission has clear precedent within the international noise control community.

The acceptability of the acoustic emission from a piece of equipment depends upon a number of details that vary from installation to installation, and the number of possible installations is extensive. Accordingly, the goal of this ETS is to specify limits that are applicable to the major installation categories.

The fundamental concern prompting the development of this ETS is the potential adverse impact that excessive equipment noise can have on people. For that reason, the impact of noise upon human activities has been carefully considered, and the intent has been to ensure that the acoustic noise emitted is at, or below, generally accepted levels. The perceptual issues considered included task concentration, speech communication, annoyance and other similar parameters. Generally, the relevant noise exposure levels are well below those needed to ensure worker safety and health. Requirements related to worker safety and health (including those related to infrasound and ultrasound) can be found in EEC Directive 86/188/EEC [4].

This ETS specifies that manufacturers report measured A-weighted sound power values for equipment. Given that it is impractical and unnecessary to measure every manufactured unit, the reported sound power value should be one that all, or nearly all, units of a particular model will not exceed. This means that the reported value needs to take into account both production variation and the precision of the measurement method. ISO 9296 [2] specifies methods that address these issues and is therefore specified in this ETS as the method for declaring sound power values. ISO 9296 [2] also specifies a method for verification of declared sound power values.

For further information regarding the motivation for the development of this standard, see annex D.

1 Scope

This European Telecommunication Standard (ETS) specifies acoustic noise emission limits for equipment used in telecommunication locations as specified in the ETS 300 019-1 [3] series. This ETS covers switching, transmission, power, supervisory, as well as tariff and billing equipment.

This ETS also specifies methods for measuring, reporting and verifying the noise emission of telecommunications equipment. The details of the methods are found in ISO 7779 [1] and ISO 9296 [2]. The descriptor used to quantify acoustic noise emission is the declared A-weighted sound power level in units of bels.

The limits contained herein apply only to the airborne acoustic noise generated by equipment during normal operation. That is, the limits do not apply when operating under emergency conditions or when the equipment is being serviced. Also, the limits do not apply to equipment features which produce sound as an intentional aspect of their operation, e.g. alarm signals, attention signals, speech signals and so on. (For more information on that topic, see ETR 116 [5]). Furthermore, the present document does not specify maximum sound pressure level limits in specific environments.

Contained within the present document are 6 annexes. Annex A specifies methods for measuring the acoustic noise emitted from equipment manufactured for open air outdoor locations. Annex B contains tables of recommended A-weighted sound power limits for open air outdoor equipment. Annex C discusses the emission of pure tones from equipment. Annex D reviews the motivation for the creation of this ETS. Annex E discusses the relationship between sound power and sound pressure. Annex F briefly summarizes the sound power measurement methods used within this ETS.

2 Normative references

This ETS incorporates by dated or undated reference provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] ISO 7779: "Acoustics - Measurement of Airborne Noise Emitted by Computers and Business Equipment".

[2] ISO 9296: "Acoustics - Declared Noise Emission Values of Computer and Business Equipment".

[3] ETS 300 019-1 (1994): "Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment Part 1: Classification of environmental conditions" (this ETS has eight sub-parts).

[4] EEC Directive 86/188/EEC: "On the Protection of Workers From the Risks Related to Exposure of Noise at Work" [OJ L 137 24.05.86 p.28 modified by L 001 03.01.94 p.484].

[5] ETR 116 (1994): "Human Factors (HF); Human factors guidelines for ISDN Terminal equipment design".

[6] ECMA TR/27: "Method for prediction of installation noise levels".

3 Definitions and symbols

3.1 Definitions

For the purposes of this ETS, the following definitions apply.

The following terms have the meanings as defined in ISO 7779 [1] and ISO 9296 [2], which are here repeated for the sake of convenience:

sound power level (L_W): The logarithm (base 10) of the ratio of a given sound power to the reference sound power. The weighting network (A-weighting) or the width of the frequency band used needs to be indicated. The reference sound power is 1 pW. Units: bels.

declared A-weighted sound power level (L_{WAd}): A statistical maximum A-weighted sound power level for manufactured units, taking into account tolerances of production and measurement variance, described in ISO 9296 [2]. Units: bels.

NOTE 1: Typically, L_{WAd} is 0,3 bels higher than the A-weighted sound power level measured on an average manufactured unit. L_{WAd} is used for all equipment classes and in the specification of noise emission limits.

sound pressure level (L_P): Ten times the logarithm (base 10) of the ratio of the time-mean-square sound pressure to the square of the reference sound pressure. The weighting network (A-weighting) or the width of the frequency band used needs to be indicated. The reference sound pressure is 20 µPa. Units: decibels.

A-weighting filter: Response characteristic of a filter used in acoustic measurement systems which attenuates low frequency and high frequency acoustic energy. This filter is used to provide a frequency response characteristic similar to that of the human auditory system.

The following definitions are peculiar to this ETS:

high temperature A-weighted sound power level (HL_{WAd}): A statistical maximum A-weighted sound power level for manufactured units, taking into account tolerances of production and measurement variance. The method for determining the high temperature A-weighted sound power level is similar to that used in the determination of declared sound power values, as described in ISO 9296 [2]. HL_{WAd} is used for equipment whose operational noise varies with temperature. Units: bels.

high temperature limit: The maximum temperature specified for the stated environmental class of the equipment under test according to the relevant subpart of ETS 300 019-1 [3].

telecommunication equipment room: An area dedicated to large telecommunication systems. Unattended rooms are typically occupied only for service and maintenance activities. These activities may last for periods of time greater than one hour.

business area: An area where the principal activity is office / clerical work or similar activities. These areas typically contain multiple single-person work areas. Sound levels should be low enough to provide good conditions for task concentration and speech communication.

office: An area where individuals are primarily engaged in individual or small group intellectual tasks which require excellent conditions for task concentration and speech communication. A typical example would be a single-person closed office.

power room: Defined as an area designed to house heavy equipment including, but not limited to, power generation equipment, heating equipment, and ventilation equipment. Typically occupied only for short periods during servicing.

underground vault: Defined as a sealed underground enclosure which is large enough to be entered for servicing equipment contained therein. Typically occupied only for service and maintenance activities. These activities may last for periods of time greater than one hour.

protected area: Location intended to be used for rest, recuperation and contemplation.

NOTE 2: There is no IEC description for this class but there is a requirement of some European countries for this special category. These areas could be adjacent to hospitals, churches, libraries, etc.

rural: Relating to areas, typically, in the countryside with low population density.

urban: Relating to areas, typically, in towns and cities with high population density.

industrial: Relating to areas, typically, of transient population and heavy manufacturing activity.

daytime: The part of the day considered to extend over normal waking hours. Typically, the period during which people are most likely to be engaged in activities related to business, education, active recreation, etc.

Night-time: The part of the day considered to be normal sleeping hours. This period includes evening and early morning hours when people are likely to be awake but not yet fully involved in typical daytime activities.

3.2 Symbols

For the purposes of this ETS, the following symbols apply:

L_W	sound power level
L_{WAd}	declared A-weighted sound power level
L_p	sound pressure level
HL_{WAd}	high temperature declared A-weighted sound power level

4 Measurement methodology

The measurement methods specified in ISO 7779 [1] shall be used for determining the sound power of products. Annex A contains additional methods and measurements relating to open air outdoor equipment.

5 Installation and operation of equipment

The installation and operation conditions specified in ISO 7779 [1] shall be used for determining the sound power of products. Where there are differences between this ETS and ISO 7779 [1], the requirements contained herein shall be followed.

The equipment shall be configured and operated according to its normal intended use. Within that constraint and the constraints specified below, the equipment shall be configured and operated to ensure worst case acoustic noise emission.

5.1 Equipment installation

The specific installation will depend upon the sound power measurement technique being used (reverberation room or free-field over a reflecting plane), and upon the normal installation requirements of the equipment being measured.

5.2 Equipment operation "in-use"

For telecommunication equipment whose operational noise varies with functional load, the electrical input and load conditions of the equipment shall be chosen to obtain full functional utilization of the equipment under test. Dissipation shall be maximized by selection of supply power and load conditions.

Only the sound power of continuous, steady-state noise sources shall be measured. Therefore, the equipment is to be operated such that intermittent sources are not active. Such sources include (but are not restricted to) alarms, attention signals, printing mechanisms, disk-drive seeking mechanisms and so on.

For telecommunication equipment whose operational noise varies with temperature (e.g. equipment using variable speed air moving devices), the sound power will be measured with the equipment operating under the two conditions specified in subclauses 5.2.1 and 5.2.2.

5.2.1 Variable emissions - standard temperature test

For the first test, the ambient temperature in the test environment shall be 23°C ± 2°C, in accordance with ISO 7779 [1]. Data obtained from testing as specified in this clause is to be used in the determination of the declared A-weighted sound power level (L_{WAd}) for the equipment.

5.2.2 Variable emissions - high temperature test

For the second test, the sound power shall be measured with the equipment operating as it would in an ambient temperature equal to the high temperature limit (see next paragraph). Data obtained from testing as specified in this clause is to be used in the determination of the high temperature A-weighted sound power level (HL_{WAd}) for the equipment.

This requirement can be satisfied using one of two methods. In the first method, the ambient temperature in the test environment shall be the high temperature limit. In the second method, the ambient temperature in the test environment shall be 23°C ± 2°C but, the rotational speed of air moving devices within the equipment under test shall be set to the speed that the devices would run at when the equipment is operating in an ambient temperature equal to the high temperature limit.

6 Acoustic noise emission limits

Maximum acoustic noise emission levels for telecommunication equipment are specified in tables 1 to 4. Entries are organized according to the Environmental Classes specified in ETS 300 019-1 [3] and to the environmental descriptions found in subclause 3.1 of the present ETS. In accordance with ISO 9296 [2], these maximum product emission levels are declared A-weighted sound power levels, L_{WAd}, in units of bels. As specified in clause 8, manufacturers are to provide declared A-weighted sound power levels for their products. Consequently, the data provided by manufacturers can be compared directly to the values in tables 1 to 4. In order to avoid possible conflict with noise exposure regulations that exist within some European countries, open air outdoor equipment noise emission is not addressed here but is discussed in separate annexes (annexes A and B).

The limits apply only to L_{WAd} values, and are not applicable to HL_{WAd} values. Furthermore, the limits apply to the "in-use" operational conditions specified in subclause 5.2.

Note that some environmental descriptions have sub-categories based upon typical equipment placement. Equipment intended to be located in close proximity to desk work locations has lower acceptable limits than equipment intended to be located far from desk work locations.

These limits apply to a functional unit as defined in clause 4 of ISO 7779 [1]. If a functional unit consists of multiple frames, these limits apply to a single frame as described in subclause 5.5 of ISO 7779 [1].

Table 1: Limits for stationary equipment used in weather protected locations

Environmental description	L_{WAd} units	Environmental class 3.1	3.2	3.3
Telecommunication equipment room (unattended)	bels	7,5	7,5	7,5
Telecommunication equipment room (attended)	bels	7,2	7,2	7,2
Business area (>4 m from desk work locations)	bels	6,8	nr	nr
Business area (<4 m from desk work locations)	bels	6,3	nr	nr
Office (floor-standing equipment)	bels	5,5	nr	nr
Office (desktop equipment)	bels	5,0	nr	nr
Power room	bels	8,3	8,3	8,3

Table 2: Limits for ship environment equipment

Environmental description	L_{WAd} units	Environmental class 6.1
Telecommunication equipment room (unattended)	bels	7,5
Telecommunication equipment room (attended)	bels	7,2
Business area (>4 m from desk work locations)	bels	6,8
Business area (<4 m from desk work locations)	bels	6,3
Office (floor-standing equipment)	bels	5,5
Office (desktop equipment)	bels	5,0
Power room	bels	8,3

Table 3: Limits for portable and non-stationary use equipment

Environmental description	L_{WAd} units	Environmental class 7.1	7.2
Telecommunication equipment room (unattended)	bels	7,5	7,5
Telecommunication equipment room (attended)	bels	7,2	7,2
Business area (>4 m from desk work locations)	bels	6,8	nr
Business area (<4 m from desk work locations)	bels	6,3	nr
Office (floor-standing equipment)	bels	5,5	nr
Office (desktop equipment)	bels	5,0	nr

Table 4: Limits for stationary equipment used in underground locations

Environmental description	L_{WAd} units	Environmental class 8.1
Underground vaults	bels	7,5

NOTE 1: "nr" indicates that these table entries are not relevant to telecommunication equipment.

NOTE 2: Environmental Classes 3.4, 3.5, 4.1, 4.1E, 6.2, 6.3 and 7.3 are discussed in annex B. Environmental Classes 5.1 and 5.2 are not covered in this ETS.

7 Information to be recorded

1) The information to be recorded shall be as specified in ISO 7779 [1], including bystander and/or operator sound pressure levels.

2) For telecommunication equipment whose operational noise varies with temperature, the high temperature A-weighted sound power level shall be recorded in bels, to the nearest 0,1 bels. Similarly, the high temperature limit (in °C) and the test method used per subclause 5.2.2 shall be recorded.

8 Information to be reported

The following information shall be given in implementation conformance statements:

1) a statement specifying which Environmental Classes (see ETS 300 019-1 [3]) and environmental descriptions (as found in subclause 3.1) are relevant to the equipment;

2) a statement that sound power levels have been obtained in full conformance with the procedures of this ETS;

3) the declared A-weighted sound power level of the product, L_{WAd}. The value L_{WAd} shall be determined according to the method specified in ISO 9296 [2] and using data obtained as specified in subclause 5.2.1;

4) for equipment whose operational noise varies with temperature, the high temperature A-weighted sound power level, HL_{WAd}. The value HL_{WAd} shall be determined according to the method specified in ISO 9296 [2] and using data obtained as specified in subclause 5.2.2.

   NOTE: As described in ISO 9296 [2], A-weighted sound power measurements are to be made on a number of manufactured units and this data used to obtain a declared sound power level or a high temperature sound power level for the production series or a portion thereof. This ETS does not require that the sound power of every manufactured unit be measured.

9 Verification of declared A-weighted sound power levels

This clause specifies a verification method for declared A-weighted sound power values, L_{WAd}.

The verification method specified in ISO 9296 [2] shall be used when verification of compliance with this ETS is required. When conducting sound power measurements, the equipment shall be operated as specified in this ETS.

Annex A (normative): Measurement methods for acoustic noise emission from open air outdoor equipment

This annex specifies additional methods for the measurement of noise emitted by equipment designed for open air outdoor locations. This information has been provided in a separate annex since the associated limits (annex B) are currently only recommended values. It is anticipated that this annex will be incorporated into the main body of this ETS at a future date.

A.1 Scope

In accordance with the main body of this ETS, this annex requires that the declared A-weighted sound power level, L_{WAd}, of relevant products be measured and recorded. Additionally, this annex specifies that additional sound pressure measurements be performed for the purpose of providing an indication of source directionality. All relevant clauses of the main body of the ETS shall be adhered to in conducting the measurements, and in the recording and reporting of data. Where there are differences between this annex and the main body of the ETS, the requirements contained herein shall be followed.

A.2 Source directionality

In addition to the measurement of sound power, an indication of the source directionality shall be obtained by using only the *bystander position* measurement method specified in clause 7 of ISO 7779 [1]. That clause shall be adhered to in conducting the measurements, and in the recording and reporting of data. For this measurement, the equipment shall be installed and operated as specified in subclause A.3.1.

A.3 Installation and operation of equipment

The installation and operation conditions specified in clause 5 of this ETS shall be used for determining the A-weighted sound power of products. Where there are differences between this annex and clause 5, the requirements contained herein shall be followed.

The A-weighted sound power shall be measured with the equipment operating as it would in an ambient temperature equal to the temperature specified in tables B.1 to B.4.

This requirement can be satisfied using one of two methods. In the first method, the ambient temperature in the test environment shall be equal to the temperature specified in tables B.1 to B.4. In the second method, the ambient temperature in the test environment shall be 23°C ± 2°C in accordance with ISO 7779 [1] but, the rotational speed of air moving devices within the equipment under test shall be set to the speed that the devices will run at when the equipment is operating in an ambient temperature equal to the temperature specified in tables B.1 to B.4.

A.3.1 Daytime simulation

The equipment shall be configured in such a manner that it simulates a functional maximum operational condition. All cooling and other noise generating devices shall be active including cyclical devices such as air conditioning compressors.

A.3.2 Night-time simulation

The equipment shall be configured in such a manner that it simulates a functional minimum operational condition. All cooling and other noise generating devices shall be active including cyclical devices such as air conditioning compressors.

A.4 Information to be recorded

The sound power information to be recorded shall be as specified in clause 7 of the present ETS. If directionality information is requested, the four bystander sound pressure levels shall be recorded.

A.5 Information to be reported

The sound power information to be reported shall be as specified in clause 8 of the present ETS. If directionality information is requested, the four bystander sound pressure levels shall be reported.

Annex B (normative): Recommended sound power limits for open air outdoor equipment

This annex provides recommended noise emission limits for open air outdoor equipment. In accordance with the main body of this ETS, the limits are specified as declared A-weighted sound power values.

This information has been provided in a separate annex since there is currently not enough relevant data to support the setting of definitive limits. It is anticipated that a revised version of this annex will be incorporated into the main body of this ETS at a future date. These recommended limits are intended to be used for design guidance. Care should be taken when comparing these values to field measurements of A-weighted sound power.

Recommended maximum A-weighted sound power levels for telecommunication equipment are provided in tables B.1 to B.4 below. Entries are organized according to the Environmental Classes specified in ETS 300 019-1 [3] and to the various environmental descriptions In accordance with ISO 9296 [2], these maximum A-weighted sound power levels, L_{WAd}, are in units of bels. Manufacturers should provide declared A-weighted sound power levels for their relevant products. These values can then be directly compared to the values in the tables.

These recommended limits apply to a functional unit as defined in clause 4 of ISO 7779 [1]. If a functional unit consists of multiple frames, these limits apply to a single frame as described in subclause 5.5 of ISO 7779 [1].

NOTE: The daytime A-weighted sound power limits apply to the high temperature limits for the relevant environmental class. For outdoor equipment, the highest noise emission values are the primary source of concern. As such, high temperature limits were used in setting the recommended A-weighted sound power limits.

Table B.1: Recommended limits for stationary equipment used in weather protected locations

Daytime			
		Environmental class	
Environmental description	**L_{WAd} units**	**3.4**	**3.5**
Protected area	bels	5,6	6,1
Rural	bels	6,1	6,7
Urban	bels	7,1	7,6
Industrial	bels	8,1	8,1
Night-time			
		Environmental class	
Environmental description	**L_{WAd} units**	**3.4 at 15°C**	**3.5 at 25°C**
Protected area	bels	5,1	5,6
Rural	bels	5,6	6,1
Urban	bels	6,1	6,6
Industrial	bels	7,1	7,1

Table B.2: Recommended limits for stationary equipment used in non-weather protected locations

Daytime			
		Environmental class	
Environmental description	**L_{WAd} units**	**4.1**	**4.1E**
Protected area	bels	5,6	6,1
Rural	bels	6,1	6,7
Urban	bels	7,1	7,6
Industrial	bels	8,1	8,1
Night-time			
		Environmental class	
Environmental description	**L_{WAd} units**	**4.1 at 15°C**	**4.1E at 25°C**
Protected area	bels	5,1	5,6
Rural	bels	5,6	6,1
Urban	bels	6,1	6,6
Industrial	bels	7,1	7,1

Table B.3: Recommended limits for ship environment

Daytime			
		Environmental class	
Environmental description	**L_{WAd} units**	**6.2**	**6.3**
Ship	bels	8,1	8,1
Night-time			
		Environmental class	
Environmental description	**L_{WAd} units**	**6.2 at 15°C**	**6.3 at 25°C**
Ship	bels	7,1	7,1

Table B.4: Recommended limits for portable and non-stationary use equipment

Daytime		
		Environmental class
Environmental description	**L_{WAd} units**	**7.3**
Protected area	bels	5,6
Rural	bels	6,1
Urban	bels	7,1
Industrial	bels	8,1
Night-time		
		Environmental class
Environmental description	**L_{WAd} units**	**7.3 at 15°C**
Protected area	bels	5,1
Rural	bels	5,6
Urban	bels	6,1
Industrial	bels	7,1

Annex C (informative): Recommended method for the detection and reporting of prominent discrete tones

Often the primary acoustic noise sources in telecommunications equipment are rotating machinery such as air-moving devices. Consequently, it is not unusual for the acoustic noise emitted by equipment to contain discrete tones. As the tones become more prominent, the likelihood that the noise will be perceived as annoying increases. Unfortunately, unlike loudness, annoyance is an inherently difficult subjective response to measure accurately.

A method for addressing the emission of prominent tones has been developed and included within ISO 7779 [1]. However, given the nature of the problem, the information regarding the measurement and reporting of prominent tones is presented in a non-normative annex of that document. This approach has been adopted in this ETS.

All relevant sections of ISO 7779 [1] apply.

Annex D (informative): Motivation for this ETS

New and emerging technologies are bringing about widespread changes in telecommunications. The impact of these changes is dramatic and has affected all aspects of design including details relevant to the generation of acoustic noise. In the past, telecommunication systems tended to be centrally located in isolated facilities where there was a limited amount of human activity. More recently, there has been a movement toward flexibility and decentralization in the design of communication systems. As a result, equipment is often placed in close proximity to work or living areas, and the noise generated by the equipment can have adverse effects on activities in these areas. The primary concerns usually revolve around the effect of noise upon speech communication, task concentration and similar perceptual issues. With the recent advent of distributed wireless systems, the issue of noise impact on residential activities is also of concern. The primary intent of this ETS is to assist in ensuring that the acoustic noise levels generated by telecommunication equipment are at, or below, generally accepted noise levels. Thus, the impact on human activity within relevant environments will be minimized.

Individual manufacturers and users have developed a variety of proprietary methods for measuring and specifying product acoustic noise. The lack of a standardized approach has been a source of confusion, and has hampered efforts to address noise control within the industry. Furthermore, some of the proprietary approaches have not been in accordance with accepted engineering practice in noise control. A secondary goal of this ETS is to remedy these problems through the use of standardized measurement and declaration procedures, namely ISO 7779 [1] and ISO 9296 [2].

Annex E (informative): The relationship between sound power and sound pressure

Over the past several years, there has been a world-wide movement toward the development of product noise standards which specify the measurement of source sound power instead of the more familiar sound pressure. Source sound power has gained prominence because sound power test methods are far less susceptible to ambiguities than sound pressure test methods. Therefore, standards written around sound power provide the desired result that the noise emission of different systems or devices can be simply and fairly compared.

Sound *pressure* is a measure of the small pressure fluctuations caused by an acoustic disturbance. The sound pressure at a point in space is the summation of all the pressure waves arriving at that point. For the simple case of a single source placed in a room, this summation includes direct sound and sound reflected from room surfaces and objects.

Source sound *power* is a measure of the amount of energy (per unit time) that an acoustic source radiates. It is, for most situations, independent of the environment in which the source is placed. This key difference makes sound power an inherently less ambiguous descriptor than sound pressure.

An analogy can be drawn between acoustic fields and other environmental parameters such as temperature or light level. For example, the temperature field developed in a room is determined by how much heat the source radiates (source power) and how this energy interacts with the room itself. Obviously, the temperature field developed will depend upon how the energy radiated by the heat source is absorbed or reflected at the boundaries. Besides including the effects of doors, walls, windows, etc., the boundary conditions may also include the effects of external heat sources and sinks. For the case of a heating unit manufacturer, the key specification required is the power output in watts. The determination as to whether or not the desired temperature will be achieved is the responsibility of the purchaser. Similarly, the sound pressure field developed in a room depends on how much sound power is radiated from the source and how this radiated sound interacts with objects in the room and room boundaries. In either the thermal or the acoustic case, if the source power and room conditions are known, the corresponding temperature or sound pressure field in the room can be estimated.

With recent advances in noise control and circuit design, the noise level in a typical telecommunication site is often not attributable to the telecommunication equipment alone (e.g., building air-handling equipment is a common contributor to noise fields in and around telecommunication sites). Furthermore, in a large installation, the system is made up of a variety of subsystems (which may be supplied by multiple manufacturers). Consequently, the sound pressure field is not necessarily dominated by a particular device or system, but is composed of contributions from multiple noise sources. Since predictions of sound pressure levels require a thorough description of the environment the equipment operates in and an analysis of the interaction of each major source within the environment, it is clear that prediction of sound pressure fields cannot be done generically. A full acoustic analysis is clearly beyond the responsibility of equipment manufacturers since detailed knowledge of the operating environment cannot be known *a priori*. However, manufacturers should be responsible for providing accurate sound power data since this is an essential ingredient in the estimation of emission sound pressure values. It is recommended that manufacturers measure the sound power levels of their equipment in octave or one-third octave bands (100 Hz to 10, 000 Hz) and record this information. Such data will be useful to equipment users who perform emission noise level estimations. (For more information on such calculations, see ECMA TR/27 [6]).

Finally, it also clear that sound power measurement standards will remain applicable even if the set of likely equipment locations continues to become more diverse. While new categories for limits may have to be created, the underlying fundamental concept of sound power measurement will remain relevant.

Annex F (informative): Sound power measurement methods

The following information provides an overview of the two sound power measurement techniques relevant to ISO 7779 [1] and therefore to this ETS. Either of the techniques will provide equivalent results if carried out correctly. The election of a specific method is at the discretion of the user, and depends upon the availability of specific test facilities and/or instrumentation. The detailed information required to conduct the tests can be found in ISO 7779 [1].

F.1 Reverberation room technique

F.1.1 Concept

In a reverberation room, nearly all the sound energy that impinges on the room boundaries is reflected back into the room, thereby creating a diffuse field condition.

ISO 7779 [1] uses a particular method referred to as the *comparison method.* The technique is based on the fact that, in a reverberation room, the difference between sound pressure and power is only a function of the parameters of the particular room in which the measurement is made. Any source measured in the same space will exhibit the same difference between space-time averaged sound pressure level and sound power level. So, the first step in the comparison method is to make sound pressure measurements on a calibrated reference sound source whose sound power is known *a priori.* The difference between the measured data and the calibration data for this calibrated source is recorded. Subsequent sound pressure level measurements made on the equipment under test are readily converted into sound power data using these difference values.

Guidelines for determining if a test environment is suitable for measurements according to this method are specified in ISO 7779 [1]. That document also specifies an allowed amount of background noise in the test facility.

F.1.2 Measurement procedure

The comparison procedure specified in ISO 7779 [1] is used. Temporally averaged sound pressure level measurements are made at several points in the reverberant field of the test environment with the reference sound source operating, and then repeated with the equipment under test operating. One-third octave band sound pressure level measurements are performed. The background noise in one-third octave bands is also measured. A-weighted sound pressure levels are not measured directly. The A-weighted sound power level is calculated from the one-third octave band sound pressure level data.

F.2 Free field over a reflecting plane technique

F.2.1 Concept

This technique is based on the premise that in a free field the sound pressure at any point far from a source (in an acoustic sense) is determined only by the energy radiating from the source. That is, there is no energy reflected back into the measurement area by nearby boundaries (other than the reflecting plane). In such an environment, the radiated sound power can be estimated from measurements of the mean-squared pressure averaged in time and space over a hypothetical surface surrounding the equipment under test. In a free field over a reflecting plane environment, the average mean-squared pressure will be directly proportional to the sound power of the source, and inversely proportional to the area of the measurement surface (provided certain guidelines are followed in selecting the measurement surface). There is to be no significant contribution from background noise or sound reflected from boundaries other than the reflecting plane. These requirements are best met under laboratory conditions in an anechoic or semi-anechoic room, but where this is not possible, less ideal environments may be acceptable according to the relevant provisions of ISO 7779 [1].

F.2.2 Measurement procedure

The free field over a reflecting plane procedure specified in ISO 7779 [1] is described here. Measurements of sound pressure levels are made at the specified microphone locations. A hypothetical reference surface is defined on which the sound pressure level measurement positions are located. Since the measurements directly provide an absolute result (i.e. unlike the reverberation room method where the pre-calibrated reference source is used), particular attention is paid to calibration and other measurement details during the testing process. Details of the surface shape, size and the measurement locations are provided in ISO 7779 [1]. Unlike the reverberation room method, A-weighted sound power values are calculated directly from the measured A-weighted sound pressure data.

History

Document history			
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