

Guide to the Use of Acoustical Standards in Canada

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1 Scope / *Domaine d'application*

1.1

This Guide describes Canadian and international acoustical and noise control Standards recommended for use in Canada. In addition, recommendations are provided for the appropriate application and use of each Standard.

Ce guide décrit des normes canadiennes et internationales en acoustique et en contrôle du bruit recommandées pour une utilisation au Canada. En outre, des recommandations sont formulées pour l'application et l'utilisation appropriée de chaque norme.

1.2 Access to Standards / *Disponibilité des normes*

All of the standards identified in this Guide can be purchased from the standards development organizations responsible for their publication, as listed below:

Toutes les normes définies dans le guide peuvent être achetés des organismes d'élaboration des normes responsables des publications, tel indiqué ci-dessous :

ANSI standards *Normes acoustiques ANSI*	Acoustical Society of America http://asastore.aip.org/
ASTM standards *Normes ASTM*	ASTM International http://www.astm.org/Standard/
CSA standards *Normes CSA*	CSA Group / *Groupe CSA* http://shop.csa.ca/
IEC and ISO standards *Normes CEI et ISO*	Standards Council of Canada / *Conseil canadien des normes* https://www.standardsstore.ca/eSpecs/index.jsp

1.3 Organization of this Guide / *Structure du guide*

The acoustical and noise control Standards described in this Guide are from the following acoustical fields:

Les normes en acoustique et en contrôle du bruit décrites dans ce guide sont regroupées selon les champs suivants :

Clause 2 – Terminology	*Article 2 – Terminologie (Clause 2)*
Clause 3 – Building acoustics	*Article 3 – Acoustique du bâtiment*
Clause 4 – Acoustical measuring equipment and calibration	*Article 4 – Équipement de mesure en acoustique et calibrage*
Clause 5 – Environmental noise	*Article 5 – Bruit environnemental*
Clause 6 – Hearing measurement and protection	*Article 6 – Mesures et protection auditive*
Clause 7 – Human exposure to vibration	*Article 7 – Exposition aux vibrations chez l'humain*
Clause 8 – Industrial noise	*Article 8 – Bruit industriel*

2 Terminology / *Terminologie*

2.1 Introduction

An ANSI Standard (see Clause 2.2) has been recommended for use in Canada in order to harmonize acoustical terminology, abbreviations, and symbols throughout North America. ISO and IEC Standards on terminology do exist, but they have yet to be fully adopted in North America.

2.2 ANSI S1.1-1994 (R2004), Acoustical Terminology

This Standard provides definitions of a wide variety of terms, abbreviations, and letter symbols used in acoustics and electroacoustics. Terms of general use in all branches of acoustics are defined, as well as many terms of special use for architectural acoustics, acoustical instruments, mechanical vibration and shock, physiological acoustics, underwater sound, sonics and ultrasonics, and music.

2.3 ANSI/ASA S1.6-1984 (R2011), Preferred Frequencies, Frequency Levels, and Band Numbers for Acoustical Measurements

This standard defines the preferred frequencies, or nominal band-center frequencies to be used for acoustical measurements. Frequency levels or band numbers are associated with these sets of frequencies and the preferred frequencies are rounded values obtained from those for which the corresponding frequency levels or band numbers are integers.

2.4 ANSI/ASA S1.8-1989 (R2011), Reference Quantities for Acoustical Levels

This Standard provides certain reference quantities to be used for acoustical levels. Reference quantities are stated in the International System of Units (SI). The unit of most acoustical levels is the decibel. Acoustical levels are equal to ten (or twenty) times the common (base-10) logarithm of an appropriate non-dimensional ratio of a variable quantity (in the numerator) to a reference quantity of the same kind (in the denominator). The multiplier ten is used when the numerator is a power or power-like quantity (such as the time-average of the square of a time-varying sound pressure or vibration acceleration) or an energy-like quantity (such as sound exposure). The multiplier twenty is used when the numerator is the root-mean-square of a field quantity or an instantaneous quantity, such as a peak or maximum sound pressure.

3 Building acoustics / *Acoustique du bâtiment*

3.1 Introduction

For noise control in buildings, and for evaluation of building products, a number of ASTM Standards have historically been used in Canada, and referenced in regulations such as the national and provincial building codes. It should be noted that there is a corresponding group of ISO Standards, but these use different terminology, and have small technical differences that prevent simple equivalence of ratings. However, the ISO Standards are advancing in scope and quality beyond the ASTM Standards; hence ISO

Standards are recommended where there is no ASTM counterpart. The standards for building acoustics are arranged in groups, by topic:

- Sound Transmission through Building Assemblies (Clause 3.2)
- Sound Transmission into a Room in a Building (Clause 3.3)
- Single-Number Ratings for Sound Transmission (Clause 3.4)
- Office and Classroom Spaces (Clause 3.5)
- Sound Absorption (Clause 3.6)

3.2 Sound Transmission through Building Assemblies

3.2.1 ASTM E 90-09, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

ASTM E 90 is part of a set of standards for evaluating the sound-insulating properties of building elements. This test method covers laboratory measurement of airborne sound transmission loss through building partitions such as walls, operable partitions, floor-ceiling assemblies, doors, windows, roofs, panels, and other space-dividing elements. The corresponding ISO standards are ISO 10140-Parts 1 and 2. ASTM E 90 is referenced in the National Building Code of Canada (NBCC) and in all of the provincial and municipal codes based on the NBCC. Building specifications may require that partitions have a certain minimum transmission loss (TL) for specific frequency bands, but more commonly use the single-number sound transmission class (STC) determined from ASTM E 90 results using the rating method in ASTM E 413.

3.2.2 ASTM E 492-09, Standard Test Method for Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine

ASTM E492 defines the procedures for laboratory measurement of impact sound transmission of floor-ceiling assemblies, using a standardized tapping machine. It is assumed that the test specimen constitutes the primary sound transmission path into a receiving room located directly below. Measurements may be conducted on floor-ceiling assemblies of all kinds, including those with floating-floor or suspended ceiling elements, or both, and floor-ceiling assemblies surfaced with any type of floor-surfacing or floor-covering material. For floor coverings installed on concrete floors, ASTM E2179 provides additional details to establish their reduction of the impact noise from a standard tapping machine. The corresponding ISO standards are ISO 10140-Parts 1 and 3. The associated single-figure rating is the impact insulation class (IIC), which is determined according to ASTM E 989. The use of IIC to define the required impact sound insulation is recommended in the National Building Code of Canada, but is not mandatory.

3.3 Sound Transmission into a Room in a Building

3.3.1 ASTM E 336-10, Standard Test Method for Measurement of Airborne Sound Insulation in Buildings

This test method covers procedures for determining the sound isolation between two rooms in a building. The evaluation may be or attention may be focused only on the

dividing partition. The corresponding ISO standard is ISO 140-4. In general, this method is recommended for making measurements including all paths by which sound is transmitted, which yields the noise reduction (NR), or normalized noise reduction (NNR) or apparent transmission loss (ATL) depending on the correction for room absorption. The corresponding single number ratings determined according to ASTM E 413 are NIC, NNIC and ASTC. ASTC is recommended as the most suitable rating for specifying sound insulation between adjoining occupancies in a building.
Procedures for measuring the sound transmitted by specific flanking paths in a building are not included in ASTM E336, or in any other ASTM standard. Unfortunately these flanking paths almost always have some influence on the overall ASTC, and frequently dominate the transmission between adjacent spaces. Procedures to measure transmission via flanking paths are given in ISO 10848 Parts 1 to 4.

3.3.2 ASTM E 1007-11, Standard Test Method for Field Measurement of Tapping Machine Impact Sound Transmission through Floor-Ceiling Assemblies and Associated Support Structures

This test method is designed to measure the impact sound insulation of a floor-ceiling assembly and associated supporting structures in field situations using a standard tapping machine. Measurements may be conducted on all types of floor-ceiling assemblies, including those with floating-floor or suspended ceiling elements, or both, and floor-ceiling assemblies surfaced with any type of floor-surfacing or floor-covering materials. Measurements are made in one-third-octave bands, without taking any steps to eliminate flanking transmission along paths in addition to those through the floor-ceiling assembly. The corresponding ISO standard is ISO 140-7. The primary single-number rating determined according to ASTM E 989 is "apparent impact insulation class" (AIIC).

3.3.3 ISO 10848-2006/Parts 1 to 4, Laboratory measurement of the flanking transmission of airborne and impact sound between adjoining rooms,

ISO 10848 specifies measurement methods to be performed in a laboratory test facility in order to characterize the flanking transmission via one or several building components. The performance of the building components is expressed either as an overall quantity for the combination of elements and junction (such as Dn,f and/or Ln,f) or as the vibration reduction index Kij of a junction There are four parts:

- Part 1: Frame document
- Part 2: Application to light elements when the junction has a small influence
- Part 3: Application to light elements when the junction has a substantial influence
- Part 4: Application to all other cases

Together with the procedures of ISO 10140 (the ISO counterparts of ASTM E90 and E492), this set of procedures provide the data on acoustic performance of sub-assemblies that is required for the empirical calculation procedures of ISO 15712 Parts 1-4.

[Cette série de normes est aussi disponible en français: ISO 10848 Acoustique -- Mesurage en laboratoire des transmissions latérales du bruit aérien et des bruits de choc entre pièces adjacentes]

3.3.4 ISO 15712-2005/Parts 1 to 4, Estimation of acoustic performance of buildings from the performance of elements

Part 1 presents calculation procedures to estimate the airborne sound insulation between rooms in buildings, using measured data which characterize direct or indirect (flanking) transmission by building elements such as walls and floors, using theoretically-derived estimates of sound propagation in structural elements. A detailed model is given for calculation in frequency bands; the single number rating can be determined from the calculation results. A simplified model with a restricted field of application uses the single number ratings of the elements. This standard is intended for acoustical experts and provides the framework for the development of application documents and tools for other users in the field of building construction, taking into account local circumstances. The known limitations of the calculations and expected precision are described.
Parts 2, 3, and 4 deal with impact noise, noise from outdoors, and appliance noise.

[Cette série de normes est aussi disponible en français: ISO 15712 -- Acoustique du bâtiment -- Calcul de la performance acoustique des bâtiments à partir de la performance des éléments]

3.3.5 ASTM E 966-10, Standard Guide for Field Measurements of Airborne Sound Insulation of Building Facades and Facade Elements

This guide covers field procedures for measuring the sound level reduction or sound transmission loss of an installed building facade or facade element. Values measured in specified frequency bands may be used separately to predict interior levels or combined into the OITC single-number rating according to ASTM E 1332 to estimate the sound-insulating properties of the test element(s) in the field situation. The corresponding ISO standard is ISO 140-Part 5. The sound transmission of a building facade or facade element as measured under field conditions is dependent not only on the physical characteristics of the construction, but also on the characteristics of the incident sound field used to make the measurement. The expected variation due to source field characteristics is more pronounced than that for laboratory tests of partitions using ASTM E 90; hence this guide provides alternative test procedures for measurements of facade field-level reduction and transmission loss.

3.4 Single-Number Ratings for Sound Transmission between Dwellings

3.4.1 ASTM E 413-10, Classification for Rating Sound Insulation

This classification covers methods of calculating single-number acoustical ratings for laboratory and field measurements of sound attenuation obtained in one-third octave bands. The name given to the single-number rating depends on the test method used to obtain the one-third-octave attenuation values. If the test method is ASTM E 90, the single-number rating is called sound transmission class (STC). If the test method is ASTM E 336 and precautions are taken that include ensuring all transmission is through the common partition separating the rooms, the single-number rating is called field sound transmission class (FSTC). If the test method is ASTM E 336, with no steps to eliminate flanking transmission along paths other than those through the common partition, the

single-number rating is called apparent sound transmission class (ASTC). Other possible ratings are noise isolation class (NIC) and normalized noise isolation class (NNIC). The corresponding ISO standard is ISO 717-1. These single-number ratings are used to define the required sound insulation in architectural specifications and in building codes in Canada and the US. In particular, these ratings are referenced in the National Building Code of Canada, and in all of the provincial and municipal codes based on the NBCC.

3.4.2 ASTM E 989-06, Standard Classification for Determination of Impact Insulation Class (IIC)

This classification covers the determination of a single-figure rating that can be used for comparing floor-ceiling assemblies for general building design purposes. The rating is called "impact insulation class" (IIC). This classification is applicable only to one-third-octave band impact noise data obtained using the standard tapping machine described in ASTM E 492. This rating may be used with data obtained in the laboratory or field. The corresponding ISO standard is ISO 717-2. IIC values increasing in magnitude indicate a correspondingly increasing degree of impact sound insulation under tapping machine test. Architects, builders, and code authorities in North America commonly use the IIC rating of building constructions for acoustical design purposes. Criteria in terms of this rating are recommended in the National Building Code of Canada, but these are not mandatory requirements.

3.5 Office and Classroom Spaces

3.5.1 ASTM E 1130-08, Standard Test Method for Objective Measurement of Speech Privacy in Open Plan Spaces Using Articulation Index

This is one of a series of test methods for evaluating speech privacy in buildings. It is designed to measure the degree of speech privacy between locations in open plan spaces, where occupants are separated only by partial-height partitions and furnishings. Another test method (E2638) deals with assessing speech privacy for closed rooms. This method relies upon acoustical measurements, published information on typical speech levels, and standard methods for assessing speech communication. This test method does not measure the performance of individual open plan components which affect speech privacy; it measures the privacy which results from a particular configuration of components, such as partial height space dividers, ceiling systems and wall finishes.

3.5.2 ASTM E2638–10, Standard Test Method for Objective Measurement of the Speech Privacy Provided by a Closed Room

This test method is one of a set of standards for evaluating speech privacy in buildings. It is designed to measure the degree of speech privacy provided by a closed room, indicating the degree to which conversations occurring within are kept private from listeners outside the room. A related method (Test Method E1130) deals with assessing speech privacy in open plan spaces.

The degree of speech privacy measured by this method is that due to the sound insulation of the room structure—the walls, floor, ceiling and any other elements of the room boundaries—and to background noise at listening positions outside the closed the

room. Potential eavesdroppers are assumed to be unaided by electronic or electro-acoustic equipment, and not touching the room boundaries. The method does not set criteria for adequate speech privacy. A non-mandatory appendix provides guidance on how the results of this test method may be used to estimate the probability of an eavesdropper being able to understand speech outside a closed room, and how to set criteria for such rooms.

3.5.3 ANSI/ASA S12.60-2010, American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools,

Part 1 is applicable to classrooms and other learning spaces in permanent schools. This standard includes acoustical performance criteria, and design requirements for classrooms and other learning spaces. Part 2 is applicable to re-locatable classrooms and re-locatable modular core learning spaces, and includes siting requirements and acoustical performance criteria.

Annexes provide procedures for testing to determine conformance with the source background noise requirements and noise isolation requirements, and commentary information on various aspects.

Copies of the document may be downloaded (free of charge) through the ASA Standards Store at http://asastore.aip.org/. Users will be asked to establish a username and password and accept the End User License before downloading the standard.

3.5.4 ASTM E 596-96 (Reapproved 2009), Standard Test Method for Laboratory Measurement of Noise Reduction of Sound-Isolating Enclosures

This test method covers the reverberation room measurement of the noise reduction of sound-isolating enclosures. The enclosure to be tested is placed in a reverberation room and prepared for testing. The noise reduction in each one-third-octave band is the difference between the space-averaged sound pressure level in the reverberation room and the space-averaged sound pressure level inside the enclosure. The noise isolation class (NIC) may be determined from the noise reduction data in one-third-octave bands using the rating procedure given in ASTM E 413.

3.6 Sound Absorption

3.6.1 ASTM C 423-09a, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

This is the common method to determine the sound absorptive properties of construction materials and furnishings used to absorb airborne sound in rooms; it establishes sound absorption by measuring the change in rate of sound decay in a reverberation room when the specimen is added. Although this test method primarily covers laboratory measurements, a procedure to measure the absorption of rooms in the field is also described in an appendix. The corresponding ISO standard is ISO 354.

The sound absorption of a material or assembly depends not only on the physical properties of the material, but also on how the material is mounted relative to the surface(s) of the room. Standard specimen mountings are given in ASTM E 795; these

mountings are designated by letters, from Type A to Type L. The mountings specified are intended to provide test conditions that simulate normal installation for specific products.

3.6.2 ASTM E 1050-08 Standard Test Method for Impedance and Absorption of Acoustical Materials Using a Tube, Two Microphones and A Digital Frequency Analysis System

This test method covers the use of an impedance tube, alternatively called a standing wave apparatus, for measurement of impedance ratios and the normal incidence sound absorption coefficients of acoustical materials. It is commonly used to characterize porous or fibrous materials used for sound absorption, especially for the automotive or aerospace industry.

4 Acoustical measuring equipment and calibration / *Équipement de mesure en acoustique et calibrage*

4.1 ANSI/ASA S1.11-2004 (R2009), Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters

This standard provides performance requirements for fractional-octave-band bandpass filters, including, in particular, octave-band and one-third-octave-band filters. This standard is technically equivalent to International Standard IEC 60942:2003.

4.2 ANSI/ASA S1.15 Measurement Microphones, Parts 1 and 2

Part 1 (R2011) specifies characteristics for capacitor (condenser) microphones used as laboratory standards for sound pressure measurements of the highest attainable accuracy. The specifications are intended to ensure that primary calibration by the reciprocity method can be readily carried out. It classifies laboratory standard microphones into a number of types according to their dimensions and properties. This Standard is comparable to the International Standard IEC 61094-1 (1992),
Part 2 (R2010) specifies a primary method for the calibration of microphones by the reciprocity technique. The technical requirements of this American National Standard are identical to those of International Standard IEC 61094-2 (1992).

4.3 ANSI S1.17-2004/Part1, Microphone Windscreens - Part 1: Measurements and Specification of Insertion Loss in Still or Slightly Moving Air

This Standard specifies a test to use to determine the insertion loss of windscreens for measuring microphones over a defined frequency range. The insertion loss is determined in conditions that reflect performance in still or slightly moving air.

4.4 ANSI S1.25-1991 (R2007), Specification for Personal Noise Dosimeters

This Standard contains specifications for performance characteristics of personal noise dosimeters which measure the percentage criterion sound exposure. The Standard makes provision for three exchange rates: 3 dB, 4 dB, and 5 dB per doubling of exposure time. The Standard provides tolerances for the entire instrument including frequency response, exponential averaging (employing SLOW and FAST), threshold, dynamic range, and other characteristics; these tolerances must be attained in a random incidence sound field in

the absence of a person wearing the instrument. The corresponding international standard is IEC 61252 (2002).

4.5 ANSI/ASA S1.40-2006 (R2011), Specifications and Verification Procedures for Sound Calibrators

This standard specified performance requirements for coupler-type acoustical calibrators. For each microphone type that may be used with the calibrator, requirements include the sound pressure level in the coupler, the frequency of the sound, and the determination of the influence of atmospheric pressure, temperature, humidity, and magnetic fields on the pressure level and frequency of the sound produced by the calibrator. This Standard is comparable to the International Standard IEC 61260:1995 but differs in three ways: (1) the test methods of IEC 61260 clauses 5 is moved to an informative annex, (2) the term "band number," not present in IEC 61260, is used as in ANSI S1.11-1986, (3) references to American National Standards are incorporated.

4.6 ANSI/ASA S1.42-2001 (R2011), Design Response of Weighting Networks for Acoustical Measurements

This Standard provides the design criteria for both the frequency-domain response (amplitude and phase) and time-domain of the A- and C-weighting networks used in acoustically related measurements. Other known weighting networks that had been standardized, such as the B-, D- and E-weightings, or weightings that were published in the past, are listed in the Annexes for reference.

4.7 IEC 60318 Parts 1 to 7, Electroacoustics - Simulators of human head and ear

IEC 60318 is a series of international standards describing acoustic couplers, ear simulators, mechanical couplers, and head and torso simulators for measurements with earphones (insert, supra-aural, circumaural) and bone vibrators used in audiometry, telephonometry, hearing aids and other applications where sources are closely coupled to the ear or mastoid. Each part describes the physical construction, the acoustic/mechanical characteristics, and the use and limitations for a different coupler/simulator. There are seven parts:

- Part 1 : Ear simulator for the measurement of supra-aural and circumaural earphones (IEC 60318-1 Ed. 2.0 b: 2009)
- Part 2 : (withdrawn)
- Part 3 : Acoustic coupler for the calibration of supra-aural earphones used in audiometry (IEC 60318-3 Ed. 1.0 b: 1998)
- Part 4 : Occluded-ear simulator for the measurement of earphones coupled to the ear by means of ear inserts (IEC 60318-4 Ed. 1.0 b: 2010)
- Part 5 : 2 cm^3 coupler for the measurement of hearing aids and earphones coupled to the ear by means of ear inserts (IEC 60318-5 Ed. 1.0 b: 2006)
- Part 6 : Mechanical coupler for the measurement of bone vibrators (IEC 60318-6 Ed. 2.0 b: 2007)
- Part 7 : Head and torso simulator for the measurement of hearing aids (IEC/TS 60318-7 Ed. 1.0 b: 2011)

The IEC 60318 series of international standards is being harmonized with national standards. Part 1 relates to Section 5.4 in ANSI S3.7-1995 (R2008) and Annex C in ANSI/ASA S3.6-2010. Part 3 relates to Sections 5.2 and 5.3 in ANSI S3.7-1995 (R2008). Part 4 relates to ANSI/ASA S3.25-2009. Part 5 relates to Section 5.5 in ANSI S3.7-1995 (R2008). Part 6 relates to ANSI S3.13-1987 (R2012). Part 7 relates to ANSI S3.36-1985 (R2006).

[Cette série de normes est aussi disponible en français: CEI 60318 – Électroacoustique – Simulateurs de tête et d'oreille humaines]

4.8 IEC 61043 (1993), Electroacoustics - Instruments for the measurement of sound intensity - Measurements with pairs of pressure sensing microphones

Applies to instruments which detect sound intensity by pairs of spatially separated pressure sensing microphones and specifies performance requirements for instruments used for the measurement of sound intensity, and their associated calibrators. The purpose of this standard is to ensure the accuracy of measurements of sound intensity applied to the determination of sound power in accordance with ISO 9614. To meet the requirements of that standard, instruments are required to analyze the sound intensity in one-third octave or octave bands, and optionally to provide A-weighted band levels. The Standard is supplemented by IEC/TS 62370 (2004).

[Norme aussi disponible en français: CEI 61043 — Électroacoustique — Instruments pour la mesure de l'intensité acoustique — Mesure au moyen d'une paire de microphones de pression]

4.9 IEC 61094 Parts 3 to 7, Measurement microphones

This standard applies to laboratory standard microphones meeting requirements of IEC 61094-1, but the principles of the method are applicable to other types of microphones. It has several parts for which there are no obvious ANSI counterparts:

- Part 3 (1995): Free-field calibration of microphones by the reciprocity technique,
- Part 4 (1995): Specifications for working standard microphones,
- Part 5 (2001): Pressure calibration of working standard microphones by comparison,
- Part 6 (2004): Electrostatic actuators for determination of frequency response,
- Part 7 (2006): Values for the difference between free-field and pressure sensitivity levels of laboratory standard microphones

[Cette série de normes est aussi disponible en français: CEI 61094 – Microphones de mesure]

4.10 IEC 61672, Electroacoustics - Sound level meters - Parts 1 to 3

This standard defines the required characteristics of sound level meters. ANSI is currently preparing new drafts equivalent to this, expected to replace the obsolete ANSI SI.4 and ANSI.S1.43. It has three parts:

- Part 1 (2002), Specifications: gives electro-acoustical performance specifications for three kinds of sound measuring instruments: a conventional sound level meter that measures exponential time-weighted sound level; an integrating-averaging sound

level meter that measures time-average sound level; and an integrating sound level meter that measures sound exposure level.

- Part 2 (2003), Pattern evaluation tests: Provides details of the tests necessary to verify conformance to all mandatory specifications given in IEC 61672-1:2002 for conventional sound level meters, integrating-averaging sound level meters and integrating sound level meters.
- Part 3 (2006), Periodic Tests: Describes procedures for periodic testing of conventional, integrating-averaging, and integrating sound level meters. The purpose of periodic testing is to assure the user that the performance of a sound level meter conforms to the requirements of IEC 61672-1:2002 for a limited set of key tests and for the environmental conditions under which the tests were performed. The extent of the tests in this part of IEC 61672 is deliberately restricted to the minimum considered necessary for periodic tests.

[*Cette série de normes est aussi disponible en français: CEI 61672 – Électroacoustique – Sonomètres – Partie 1: Spécifications, Partie 2: Essais d'évaluation d'un modèle, Partie 3 : Essais périodiques]*

5 Environmental noise / *Bruit environnemental*

5.1 Introduction

This section includes standards related generally to the description measurement and assessment of Environmental Noise which should be useful to consultants and regulators. It also contains standards related to the measurement of sound from wind turbines and mobile equipment vehicles which operate in the outdoor environment, which should be useful to both equipment manufacturers and those involved in field measurement and assessment., as is a standard for blasting operations for use by the mining and aggregate industries.

The standards for environmental noise are arranged in groups, by topic:

- Sound Propagation Outdoors (Clause 5.2)
- Description, Measurement and Assessment of Environmental Noise (Clause 5.3)
- Noise from sources at fixed locations (Wind Turbines and Blasting) and a standard for design and certification of noise barriers (Clause 5.4)
- Measurement of Noise from Mobile Equipment, Vehicles and Vessels (Clause 5.5)

5.2 Sound Propagation Outdoors

5.2.1 ISO 9613-1:1993, Acoustics — Attenuation of sound during propagation outdoors — Part 1: Calculation of the absorption of sound by the atmosphere

ISO 9613 -1 is one of two standards for used to predict the environmental sound levels at locations distant from the sound source. This part of the standard specifies an analytical method of calculating the attenuation of sound as a result of atmospheric absorption as a function of four variables: the frequency of the sound, and the temperature, humidity,

and pressure of the air. Formulae are also provided suitable for ultrasonic frequencies or for lower pressures for propagation from high altitudes to the ground.

[Norme aussi disponible en français: ISO 9613-1 -- Acoustique -- Atténuation du son lors de sa propagation à l'air libre -- Partie 1: Calcul de l'absorption atmosphérique]

5.2.2 ISO 9613-2:1996, Acoustics — Attenuation of sound during propagation outdoors — Part 2: General method of calculation

This part of the standard specifies an engineering method that can be used to calculate the attenuation of sound during propagation outdoors in order to predict the levels of environmental sound at a distance from a source or collection of sources. This method is applicable to most situations concerning industrial noise sources, construction activities, and other ground-based noise sources such as road and rail traffic. It does not apply to sound from aircraft, or to blast waves. The method is used for predictions under meteorological conditions favourable for propagation downwind or under a well-developed moderate ground-based temperature inversion. Inversion conditions over water surfaces are not covered. Required parameters are the geometry of the source and environment, the ground characteristics, and source strength. The physical effects included in the prediction method are geometrical divergence; atmospheric absorption; ground effect; reflection from surfaces; and screening by obstacles. Additional information concerning propagation through housing, foliage, and industrial sites is given in an annex. The Standard does not include information on propagation over snow which is a highly variable surface.

[Norme aussi disponible en français: ISO 9613-2 -- Acoustique -- Atténuation du son lors de sa propagation à l'air libre -- Partie 2: Méthode générale de calcul]

5.3 Description, Measurement and Assessment of Environmental Noise

5.3.1 CAN/CSA-ISO 1996-1: 05, Acoustics — Description, measurement and assessment of environmental noise — Part 1: Basic quantities and assessment procedures

This part of ISO 1996 defines the basic quantities to be used for the description of noise in community environments and describes basic assessment procedures. It also specifies methods to assess environmental noise and gives guidance on predicting the potential annoyance response of a community to long-term exposure from various types of environmental noises. Specific adjustments for impulsiveness, tonality, and source type are recommended to account for differences in human response to sources even though they may have the same acoustic level.

[Norme aussi disponible en français: CAN/CSA-ISO 1996-1 -- Acoustique -- Description, mesurage et évaluation du bruit de l'environnement -- Partie 1: Grandeurs fondamentales et méthodes d'évaluation]

5.3.2 CAN/CSA-ISO 1996-2: 07, Acoustics — Description and measurement of environmental noise — Part 2: Determination of environmental noise levels

ISO 1996-2:2007 describes how sound pressure levels can be determined by direct measurement, by extrapolation of measurement results through calculation, or exclusively by calculation. It is intended as a basis for assessing environmental noise relevant to general land use. Guidance is given to evaluate the uncertainty of the result of a noise assessment. These standards have not gained a great degree of acceptance in Canada as most environmental noise is provincially regulated and many provincial jurisdictions have developed their own methods and procedures. These standards could give guidance in those jurisdictions which have not.

[Norme aussi disponible en français: CAN/CSA-ISO 1996-2 -- Acoustique -- Description, évaluation et mesurage du bruit de l'environnement -- Partie 2: Détermination des niveaux de bruit de l'environnement]

5.3.3 CAN/CSA-ISO 1996-3:05, Acoustics — Description and measurement of environmental noise — Part 3: Application to noise limits

This measurement Standard lays down guidelines for the ways in which noise limits should be specified and describes procedures to be used for checking compliance with such limits. It assumes that noise limits are established by local authorities according to these guidelines and are embodied in noise limit regulations to which reference is made. However, it should be noted that this Standard does not specify noise limits and it is important to note that this standard has been withdrawn by the ISO.

5.4 Noise from Specific Sources of Sound

For some sources of sound with fixed locations, there are specific measurement protocols suited to the specific sources. Barriers are commonly used to reduce noise impact from fixed sources, including highways and railways.

5.4.1 CAN/CSA-C61400-11-07, Wind Turbine Generator Systems Part 11: Acoustic Noise Measurement Techniques

The purpose of this part of CSA – C61400 (which is identical to IEC 61400) is to provide a uniform methodology that will ensure consistency and accuracy in the measurement and analysis of acoustical emissions by wind turbine generator systems. It presents measurement and reporting procedures expected to provide accurate results that can be replicated by others. This standard provides guidance in the measurement, analysis and reporting of complex acoustic emissions from wind turbine generator systems. It is meant to benefit those parties involved in the manufacture, installation, planning and permitting, operation, utilization, and regulation of wind turbines. The measurement and analysis techniques recommended in this document are meant to be applied by all parties to insure that continuing development and operation of wind turbines is carried out in an atmosphere of consistent and accurate communication relative to environmental concerns.

5.4.2 CAN/CSA-Z107.9-00 (R2004), Standard for Certification of Noise Barriers

This certification Standard is intended as a specification for the certification of products suitable for installation as roadway noise barriers. It is also intended to specify the requirements for noise barrier design and materials. It is broadly applicable across all engineering disciplines involved in the design of such barriers and is suitable for railway applications as well.

5.4.3 CSA CAN3-Z107.54-M85 (R2001), Procedure for Measurement of Sound and Vibration Due to Blasting Operations

This measurement procedure covers the measurement of airborne sound and ground-borne vibration from blasting such as construction and quarrying. It is somewhat dated and is currently under review.

5.5 Measurement of Noise from Mobile Equipment, Vehicles and Vessels

5.5.1 ISO 362 Parts 1 and 2, Measurement of noise emitted by accelerating road vehicles -- Engineering method

ISO 362 specifies an engineering method for measuring the noise emitted by road vehicles during normal driving under typical urban traffic conditions

- Part 1 (2007) deals with vehicles of of categories M and N. The method is designed to meet the requirements of simplicity as far as they are consistent with reproducibility of results under the operating conditions of the vehicle. The test method requires an acoustical environment that is only obtained in an extensive open space. Such conditions are usually provided for type approval measurements of a vehicle, measurements at the manufacturing stage, and measurements at official testing stations.
- Part 2 (2009) specifies an engineering method for measuring the noise emitted by road vehicles of categories L3, L4 and L5 under typical urban traffic conditions. The specifications are intended to reproduce the level of noise generated by the principal noise sources during normal driving in urban traffic, typically on roads with speed limits of 50 km/h and 70 km/h.

[Norme aussi disponible en français: ISO 362 -- Mesurage du bruit émis par les véhicules routiers en accélération -- Méthode d'expertise -- Partie 1: Catégories M et N, Partie 2: Catégorie L]

5.5.2 ISO 6393:2008, Earth-moving machinery -- Determination of sound power level -- Stationary test conditions

ISO 6393 specifies a method for determining the noise emitted to the environment by earth−moving machinery, measured in terms of the A-weighted sound power level while the machine is stationary with the engine operating at the rated speed under no-load conditions.

[Norme aussi disponible en français: ISO 6393 -- Engins de terrassement -- Détermination du niveau de puissance acoustique -- Conditions d'essai statique]

5.5.3 ISO 6395:2008 Earth-moving machinery -- Determination of sound power level – Dynamic test conditions

ISO 6395 specifies a method for determining the noise emitted to the environment by earth-moving machinery, measured in terms of the A-weighted sound power level while the machine is operating under dynamic test conditions.

[Norme aussi disponible en français: ISO 6393 -- Engins de terrassement -- Détermination du niveau de puissance acoustique -- Conditions d'essai dynamique]

5.5.4 SAE J1096-2000, Measurement of Exterior Sound Levels for Heavy Trucks under Stationary Conditions

This recommended practice establishes the test procedure, environment, and instrumentation for determining the maximum exterior sound level of highway motor trucks and truck tractors over 4540 kg gross vehicle weight rating with governed engines under stationary vehicle conditions. The basic procedure involves full throttle engine acceleration and a closed throttle deceleration with the engine inertia as the load.

5.5.5 ISO 5130:2007, Acoustics — Measurement of sound pressure level emitted by stationary road vehicles

ISO 5130 specifies a test procedure, environment and instrumentation for measuring the exterior sound pressure levels from road vehicles under stationary conditions, providing a continuous measure of the sound pressure level over a range of engine speeds. It applies only to road vehicles of categories L, M and N equipped with internal combustion engines and is designed to meet the requirements of simplicity as far as they are consistent with reproducibility of results under the operating conditions of the vehicle. It allows for the measurement of stationary A-weighted sound pressure level during type approval measurements of vehicle, measurements at the manufacturing stage, measurements at official testing stations and measurements at roadside testing. It does not specify a method to check the exhaust sound pressure level.

[Norme aussi disponible en français: ISO 5130 -- Acoustique -- Mesurages du niveau de pression acoustique émis par les véhicules routiers en stationnement]

5.5.6 ISO 14509:2008, Small craft -- Airborne sound emitted by powered recreational craft -- Part 1: Pass-by measurement procedures

ISO 14509-1 specifies the conditions for obtaining reproducible and comparable measurement results of the maximum sound pressure level of airborne sound generated during the passage of powered recreational craft of up to 24 m length of hull, including inboards, stern drives, personal watercraft (PWC) and outboard motors. It also specifies standard craft based type tests for stern drives with integral exhaust systems and for outboard motors and the procedure to be followed if, in addition to the maximum sound pressure level, the determination of the sound exposure level is desired.
[Norme aussi disponible en français: ISO 14509-1 -- Petits navires -- Bruit aérien émis par les bateaux de plaisance motorisés -- Partie 1: Méthodes de mesure pour l'essai de passage]

5.5.7 ISO 14509:2008, Small craft -- Airborne sound emitted by powered recreational craft -- Part 1: Pass-by measurement procedures

ISO 14509-1 specifies the conditions for obtaining reproducible and comparable measurement results of the maximum sound pressure level of airborne sound generated during the passage of powered recreational craft of up to 24 m length of hull, including inboards, stern drives, personal watercraft (PWC) and outboard motors. It also specifies standard craft based type tests for stern drives with integral exhaust systems and for outboard motors and the procedure to be followed if, in addition to the maximum sound pressure level, the determination of the sound exposure level is desired.

[Norme aussi disponible en français: ISO 14509-1 -- Petits navires -- Bruit aérien émis par les bateaux de plaisance motorisés -- Partie 1: Méthodes de mesure pour l'essai de passage]

5.5.8 ISO 2922:2000, Acoustics — Measurement of airborne sound emitted by vessels on inland waterways and harbours

This measurement procedure specifies the method and conditions for obtaining reproducible and comparable measurements of the noise level and the noise spectrum in the immediate vicinity of marine vessels underway.

[Norme aussi disponible en français: ISO 2922 -- Acoustique -- Mesurage du bruit aérien émis par les bateaux de navigation intérieure et portuaire]

6 Hearing measurement and protection / *Mesures et protection auditive*

6.1 CAN/CSA-Z94.2-02 (R2011), Hearing Protection Devices — Performance, Selection, Care, and Use

This Standard on personal hearing protection devices is divided into two parts. The first one (Clauses 4 to 7) deals with performance and testing requirements of hearing protectors; the second one (Clauses 8 to 12) is dedicated to the selection, care, and use of protectors as required for an effective hearing conservation program. The following types of hearing protectors are covered in the Standard: earplugs, earmuffs, communications headsets, and helmets equipped with earmuffs.

[Norme aussi disponible en français CAN/CSA-Z94.2-F02 (C2011) - Protecteurs auditifs: Performances, sélection, entretien et utilisation]

6.2 CAN/CSA-Z107.6-M90 (R2010), Pure Tone Air Conduction Threshold Audiometry for Hearing Conservation

This Standard specifies procedures and requirements for pure tone air conduction threshold audiometry, without masking, used in hearing conservation programs. . It is especially applicable to individuals whose hearing sensitivity might be adversely affected by occupational noise exposure.

6.3 ANSI/ASA S3.1-1999 (R2008), American National Standard Maximum Permissible Ambient Noise Levels for Audiometric Test Rooms

This Standard specifies maximum permissible ambient noise levels (MPANLs) allowed in an audiometric test room that produce negligible masking (less than or equal to 2 dB) of test signals presented at reference equivalent threshold levels specified in American National Standard S3.6-1996 American National Standard Specification of Audiometers. The MPANLs are specified from 125 to 8000 Hz in octave and one-third octave band intervals for two audiometric testing conditions (ears covered and ears not covered) and for three test frequency ranges (125 to 8000 Hz, 250 to 8000 Hz, and 500 to 8000Hz). The Standard is intended for use by all persons testing hearing and for distributors, installers, designers, and manufacturers of audiometric test rooms. This standard is a revision of ANSI S3.1-1991 American National Standard Maximum Permissible Ambient Noise Levels for Audiometric Test Rooms.

6.4 ANSI/ASA S3.6-2010, American National Standard Specification for Audiometers

The audiometers covered in this specification are devices designed for use in determining the hearing threshold level of an individual in comparison with a chosen standard reference threshold level. This standard provides specifications and tolerances for pure tone, speech, and masking signals and describes the minimum test capabilities of different types of audiometers. This standard revises and replaces ANSI S3.6-2004 to keep it compatible with other equivalent international standards. It is comparable to international standards IEC 60645-1 and IEC 60645-2.

6.5 ANSI/ASA S12.6-2008, American National Standard Methods for Measuring the Real-Ear Attenuation of Hearing Protectors

This standard specifies laboratory-based procedures for measuring, analyzing, and reporting the passive noise-reducing capabilities of hearing protection devices. The procedures consist of psychophysical tests conducted on human subjects to determine the real-ear attenuation measured at hearing threshold. Two fitting procedures are provided: Method A) trained-subject fit, intended to describe the capabilities of the devices fitted by thoroughly trained users, and Method B) inexperienced-subject fit, intended to approximate the protection that can be attained by groups of informed users in workplace hearing conservation programs. Regardless of test method, the attenuation data will be valid only to the extent that the users wear the devices in the same manner as during the tests. This Standard does not address issues pertaining to computational schemes or rating systems for applying hearing protector attenuation values (see ANSI/ASA S12.68), nor does it specify minimum performance values for hearing protectors, or address comfort or wearability features. Method A of this Standard corresponds to International Standard ISO 4869-1:1990 Acoustics - Hearing protectors, Part 1: Subjective method for the measurement of sound attenuation, and Method B corresponds to ISO/TS 4869-5:2006, Acoustics - Hearing protectors, Part 5: Method for estimation of noise reduction using fitting by inexperienced test subjects.

6.6 ANSI/ASA S12.42-2010, American National Standard Methods for the Measurement of Insertion Loss of Hearing Protection Devices in Continuous or Impulsive Noise Using Microphone-in-Real-Ear or Acoustic Test Fixture Procedures

This standard specifies microphone-in-real-ear (MIRE) methods for the measurement of the insertion loss of active and passive circumaural earmuffs, helmets, and communications headsets, and specifies acoustic test fixture (ATF) methods for the measurement of the insertion loss of active and passive earplugs, earmuffs, helmets, and communications headsets. The MIRE methods are appropriate for use with continuous noise whereas the ATF methods may be used with both continuous noise and high-level impulsive noise test signals. The standard contains information on instrumentation, calibration, and electroacoustic requirements, procedures for determining sound pressure levels in the ear with and without the hearing protection devices in place, and procedures for calculating the corresponding insertion loss values. The standard also describes how to combine the active contribution of insertion loss for active devices measured using the MIRE method with the passive real-ear attenuation measured in accordance with ANSI/ASA S12.6 to obtain an attenuation value for use in estimating sound pressure levels for active protectors in accordance with ANSI/ASA S12.68. Requirements for reporting of the data are also described.

6.7 ISO 1999:1990, Acoustics — Determination of occupational noise exposure and estimation of noise-induced hearing impairment

This international Standard prescribes a method to estimate the elevation in hearing thresholds in the range 0.5 to 6 kHz as a result of occupational noise exposure, given the A-weighted noise level within a normal work week, the type of noise, the number of years of exposure, the gender and age of the worker. The Standard specifies two databases according to the selection criteria of the targeted population.

6.8 ISO 11904 / Parts 1 and 2: Acoustics — Determination of sound immission from sound sources placed close to the ear.

ISO 11904 specifies methods for the determination of sound immission from sources located close to the ear and other situations for which the sound pressure level measured at the position of the exposed person (but with the person absent) does not adequately represent the sound exposure. Examples of applications are measurements with headsets and earphones used to reproduce music or transmit speech, whether in the workplace or during leisure, or from noise sources used close to the head such nail guns, and the determination of the combined exposure from a close-to-ear sound source and an external sound field. There are two parts:

- Part 1 (2002): Technique using a microphone in a real ear (MIRE technique),
- Part 2 (2004): Technique using a manikin (Manikin technique).

Both parts of ISO 11904 strive for the same result: a mean value of the free-field or the diffuse-field related level for a population of individuals. ISO 11904-1 does this by specifying the mean of miniature or probe-tube microphone measurements on a number of human subjects; ISO 11904-2 does this by using a manikin equipped with an ear simulator and microphone, reproducing the acoustical effects of an average human adult.

[Cette série de normes est aussi disponible en français: ISO 11904 -- Acoustique -- Détermination de l'exposition sonore due à des sources placées à proximité de l'oreille -- Partie 1: Technique du microphone placé dans une oreille réelle (technique MIRE), Partie 2: Technique utilisant un mannequin]

7 Human exposure to vibration / *Exposition aux vibrations chez l'humain*

7.1 CAN/CSA-M5007-03, Agricultural wheeled tractors — Operator's seat — Laboratory measurement of transmitted vibration

This international Standard specifies, in accordance with ISO 10326-1, a laboratory method for measuring and evaluating the effectiveness of the suspension of operator seats on agricultural wheeled tractors. It also specifies acceptance criteria based on the test results, while defining the input spectral classes relating to three classes of agricultural tractor with rubber tires, unsprung rear axles, and no low-frequency cab isolation: those of up to 3600 kg (Class 1); those of from 3600 kg to 6500 kg (Class 2); and those of over 6500 kg (Class 3), each of which defines a group of machines having similar vibration characteristics.

The method tests the effectiveness of the seat suspension in reducing the vertical whole-body vibration transmitted to the operator at frequencies of from 1 Hz to 20 Hz. It is not applicable to vibration reaching the operator other than through the seat (e.g., that sensed by the operator's feet on the platform or control pedals or hands on the steering wheel).

7.2 CAN/CSA-M5008-03, Agricultural wheeled tractors and field machinery — Measurement of whole-body vibration of the operator

This international Standard specifies methods for measuring and reporting the whole body vibration to which the operator of an agricultural wheeled tractor or other field machine is exposed when operating on a standard test track. The operating conditions of the machine and the ordinates of the artificial test tracks are also included.

7.3 ISO 5349-1:2001, Mechanical vibration — Measurement and evaluation of human exposure to hand-transmitted vibration — Part 1: General requirements

This international Standard specifies general requirements for measuring and reporting exposure of the hands to vibration. It is applicable to periodic, non-periodic, and random vibration, and is provisionally applicable to repeated shocks to the hands, such as those experienced when operating impact power tools (e.g., chipping hammers). Even with careful application of the procedures described, the accuracy of the daily exposure is unlikely to be better than 10%.

Symptoms of the hand-arm vibration syndrome are rare in persons occupationally exposed to an 8 h energy-equivalent vibration total value of less than 2 m/s^2, and have not been reported for persons exposed to an 8 h energy-equivalent vibration total value of less than 1 m/s^2.

The Standard is widely accepted and is used in most industrialized countries. Application of the measurement procedures to exposures in the workplace is described in ISO 5349-2. The European Union has adopted an 8 h energy-equivalent vibration total value of 2.5 m/s^{-2} as an action level, and an 8 h energy-equivalent vibration total value of 5.0 m/s^{-2} as an exposure limit for occupational exposures determined according to the provisions of ISO 5349 (Directive 2002/44/EC). A program of technical and/or organizational measures intended to reduce exposure to a minimum is to be implemented when the action level is exceeded.

[Norme aussi disponible en français: ISO 5349 -1 -- Vibrations mécaniques -- Mesurage et évaluation de l'exposition des individus aux vibrations transmises par la main -- Partie 1: Exigences générales]

7.4 ISO 5349-2:2001, Mechanical vibration — Measurement and evaluation of human exposure to hand-transmitted vibration — Part 2: Practical guidance for measurement at the workplace

This international Standard specifies procedures for measuring and reporting exposure of the hands to vibration in the workplace. It describes the precautions necessary to make appropriate vibration measurements and to characterize the daily exposure time so that the 8 h energy-equivalent vibration total value can be established. Even with careful application of the procedures described, the uncertainties associated with determining the daily exposure in an occupational setting are often as much as 20%. Guidance on the selection and mounting of accelerometers is provided in the Standard. Attention is drawn to the desirability of using a mechanical filter when measuring the vibration of a percussive or roto-percussive power tool. Potential sources of measurement error are discussed in detail. The elements required for an occupational survey of vibration exposure at a work site are described, and strategies are outlined for selecting the operations to be evaluated and for conducting the measurements. An extensive and informative series of examples for calculating daily vibration exposures is provided in Annex E in ISO 5349-2. It should be noted that instruments designed to perform automatically most of the exposure profiles described are now available commercially.

[Norme aussi disponible en français: ISO 5349-2 -- Vibrations mécaniques -- Mesurage et évaluation de l'exposition des individus aux vibrations transmises par la main -- Partie 2: Guide pratique pour le mesurage sur le lieu de travail]

8 Industrial noise / *Bruit industriel*

8.1 Introduction

The use of standards in this section is related to the use of noise declarations (Clause 8.2), as required by law in the European Union. The standards listed in this section are primarily those produced by the ISO. It should be noted that there is similar group of ANSI Standards, which in many cases are adapted from ISO counterparts with minor changes. The industrial noise standards are primarily applicable to the evaluation of industrial noise inside buildings. For industrial noise outdoors, the user is also directed to Section 5

on Environmental Noise which contains additional standards that may be useful. The standards for Industrial noise are arranged in groups, by topic:

- Occupational Sound Level Measurement and Prediction (Clause 8.2)
- Noise Emission Declarations (Clause 8.3)
- Determination of Emission Sound Pressure Levels at Specified Positions (Clause 8.4)
- Determination of Sound Power Levels using Sound Pressure (Clause 8.5)
- Determination of Sound Power Levels In Situ using Sound Intensity (Clause 8.6)

8.2 Occupational Sound Level Measurement and Prediction

8.2.1 CSA Z107.52-M1983 (R2004), Recommended Practice for the Prediction of Sound Pressure Levels in Large Rooms Containing Sound Sources

This is an old style manual graphical procedure for the prediction of sound pressure levels in a large room containing a number of sound sources. The procedure may be used to compute A-weighted, octave, or fractional octave band sound pressure levels over continuous contours, or at specific points

8.2.2 CAN/CSA Z107.56-06 (R2011), Procedures for the measurement of occupational noise exposure

This measurement procedure describes simple procedures for the determination of the occupational noise exposure level using sampling techniques. The long-term noise exposure of employees is calculated from the measurements of the equivalent sound level in the workplace. The procedures in this Standard normally form part of any occupational hearing conservation program. Users of this Standard should be proficient in noise measurement.

[Norme aussi disponible en français CAN/CSA-Z107.56-06 (C2011) - Méthodes de mesure de l'exposition au bruit en milieu de travail]

8.2.3 ISO 9612:2009 Acoustics -- Determination of occupational noise exposure -- Engineering method

This international Standard provides a comprehensive stepwise approach to the determination of occupational noise exposure from noise level measurements. This International Standard specifies and gives guidance on the selection of three different measurement strategies: task-based; job-based; and full-day measurement. This Standard also provides an informative spreadsheet to allow calculation of measurement results and uncertainties. This Standard recognizes the use of hand-held sound level meters as well as personal sound exposure meters.

[Norme aussi disponible en français: ISO 9612 -- Acoustique -- Détermination de l'exposition au bruit en milieu de travail -- Méthode d'expertise]

8.3 Noise Emission Declarations

8.3.1 CAN/CSA-Z107.58-02, Noise Emission Declarations for Machinery

This Standard is intended for manufacturers, regulators and purchasers of machinery sold in, or exported from, Canada. The Standard is intended to provide:

(a) determination and verification of noise emission declarations for machinery,
(b) guidance on application of noise emission declarations for noise control,
(c) requirements consistent with European Union Directives pertaining to machinery.
Recent changes in European Union directives and ISO standards must be considered when using this document. For example, the sound power level should be declared when the declared A-weighted emission sound pressure level is greater than 80 dBA and not 85 dBA as stated in Table 1 of Z107.58. Also, although Annex A contains useful guidance to ISO measurement standards, recent revisions of those standards could affect the selection and applicability of individual standards.

[Norme aussi disponible en français: CAN/CSA-Z107.58-F02 (C2012) - Déclaration des valeurs d'émission sonore des machines]

8.3.2 ISO 4871:1996, Acoustics — Declaration and verification of noise emission values of machinery and equipment

This international Standard prescribes the method of verification and preparation of a noise emission declaration. It is recommended for use in Canada and is incorporated within the general requirements of CAN/CSA-Z107.58. .

[Norme aussi disponible en français: ISO 4871 -- Acoustique -- Déclaration et vérification des valeurs d'émission sonore des machines et équipements]

8.4 Determination of Emission Sound Pressure Levels at Specified Positions

Emission sound pressure levels are repeatable, standardized levels that approximate the sound pressure levels that would be measured in a free field at a work station, or at other defined positions (including inside a cab). The methods are applicable outdoors or indoors. They are a complement to measures of sound power (clause 8.5) and are useful for comparing different machines as they quantify the direct noise exposure of an operator. Emission sound pressure levels are typically up to 5 dB lower than those observed under normal operating conditions because they do not include background noise and room reflections. The minimum achievable A-weighted uncertainty for precision methods is 0.5 dB; for engineering grade methods the corresponding uncertainty is 1.5 dB, and for survey grade methods this uncertainty is typically 3 dB.

8.4.1 ISO 11201:2010, Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions in an essentially free field over a reflecting plane with negligible environmental corrections

This international Standard specifies an engineering grade method for use outdoors or indoors and a precision method that requires a specialized laboratory hemi anechoic room meeting the requirements of ISO 3745. No environmental corrections are allowed, so for best results the measurement environment must approximate an ideal free field. This standard is strongly recommended for cases where the operator position is shielded from direct sound radiation from the machine. In practical terms, the method is most applicable for precision measurements of small movable sources, and engineering grade measurements of machinery that can be tested outdoors.

[Norme aussi disponible en français: ISO 11201 -- Acoustique -- Bruit émis par les machines et équipements -- Détermination des niveaux de pression acoustique d'émission au poste de travail et en d'autres positions spécifiées dans des conditions approchant celles du champ libre sur plan réfléchissant avec des corrections d'environnement négligeables]

8.4.2 ISO 11202:2010, Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions applying approximate environmental corrections

This international Standard specifies engineering and survey grade methods using an approximate method to derive the environmental correction. There are two methods in the standard, when the noise radiating area of the machinery that affects the operator is small and easily identifiable A.1 is recommended as it is robust and simple. However, method A.1 may result in levels that are higher than those obtained with other methods, and it is not appropriate when the operator is shielded from the machinery noise (i.e., behind a screen). This Standard applies in situ, outdoors or indoors and may be used in a semi-reverberant field. For users considering use of method A.2 it is recommended to use ISO 11204, which is essentially the same as method A.2.

[Norme aussi disponible en français: ISO 11202 -- Acoustique -- Bruit émis par les machines et équipements -- Détermination des niveaux de pression acoustique d'émission au poste de travail et en d'autres positions spécifiées en appliquant des corrections d'environnement approximatives]

8.4.3 ISO 11203:1995, Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions from the sound power level

This engineering grade Standard is only used when the measurement position is undefined, or variable (e.g., no operator position), and it cannot be used in a cab. It is typically used for small unattended machines. This standard differs from others in the series by estimating the emission sound pressure level using the measured sound power level (see 8.4.2 to 8.4.6). Because this standard can use any of a wide range of sound power standards it can be used in more environments than any of the other emission sound pressure level standards.

[Norme aussi disponible en français: ISO 11203 -- Acoustique -- Bruit émis par les machines et équipements -- Détermination des niveaux de pression acoustique d'émission au poste de travail et en d'autres positions spécifiées à partir du niveau de puissance acoustique]

8.4.4 ISO 11204:2010, Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions applying accurate environmental corrections

This Standard specifies engineering and survey grade methods which differ from other Standards in the series by using a measurement similar to that of sound power to obtain an environmental correction. While this standard can result in lower levels than the first 3

standards in this series, the user is cautioned that very accurate measurements are required. This Standard applies in situ, outdoors, or indoors in a semi-reverberant field, and it may be used when the operator is shielded from the noise source.

[Norme aussi disponible en français: ISO 11204 -- Acoustique -- Bruit émis par les machines et équipements -- Détermination des niveaux de pression acoustique d'émission au poste de travail et en d'autres positions spécifiées en appliquant des corrections d'environnement exactes]

8.4.5 ISO 11205:2003, Acoustics — Noise emitted by machinery and equipment — Engineering method for the determination of emission sound pressure levels in situ at the work station and at other specified positions using sound intensity

This Standard specifies an engineering grade method for use in situ. The method differs from other Standards in the series in that derives the emission sound pressure levels using specialized equipment to measure sound intensity levels. This standard is second only to ISO 11203 in terms of background noise immunity and ability to measure in any environment.

[Norme aussi disponible en français: ISO 11205 -- Acoustique -- Bruits émis par les machines et les équipements -- Méthode d'expertise pour la détermination par intensimétrie des niveaux de pression acoustique d'émission in situ au poste de travail et en d'autres positions spécifiées]

8.5 Determination of Sound Power Levels using Measurement of Sound Pressure

The ISO 3741 to ISO 3747 series of Standards specify methods for determining the sound power levels of noise sources and machinery. Sound power is used for comparison of machinery as it is independent of the environment in which the machinery is located. Sound power is also useful for the calculation of indoor noise levels. The minimum achievable A-weighted uncertainty for precision methods is 0.5 dB; for engineering grade methods the corresponding uncertainty is 1.5 dB, and for survey grade methods this uncertainty is typically 3 dB.

These standards are applicable for specific environments:

- A reverberant environment can be used to characterize sound power from small sources near one or more reflecting planes. Compared to free field methods it is quick and efficient since as few as 3 measurement positions may be required. Reverberant rooms are not suitable for equipment which cannot be readily moved. Quantities that cannot be determined are the directivity of the source and the temporal pattern for sources emitting non-steady sound.
- An environment approximating a free field may be outdoors or indoors in a large room near one or more reflecting planes. Unlike measurements in a reverberant field, directivity and temporal characteristics of the sound source can be determined, and measurements are less affected by background noise. Sound pressure levels are measured over a measurement surface enveloping the sound source and the measurement grade is primarily determined by an evaluation of the measurement environment. Source dimensions may be up to 10 meters, but the

method is impractical for very tall or very long sources such as chimneys, ducts, conveyors, and multi-source industrial plants.

- In situ measurements of a sound source in its actual operating environment can be made for some indoor and outdoor cases.

8.5.1 ISO 3741:2010, Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Precision methods for reverberation test rooms

ISO 3741 is used in a specialized laboratory reverberation room to characterize equipment with size less than 2% of room volume. Results are obtained in one-third-octave frequency bands, from which octave-band values and A-weighted levels can be computed. Use of this standard requires greater effort for a source emitting sound in narrow bands of frequency.

[Norme aussi disponible en français: ISO 3741 -- Acoustique -- Détermination des niveaux de puissance acoustique et des niveaux d'énergie acoustique émis par les sources de bruit à partir de la pression acoustique -- Méthodes de laboratoire en salles d'essais réverbérantes]

8.5.2 ISO 3743-1:2010, Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering methods for small, movable sources in reverberant fields — Part 1: Comparison method for a hard-walled test room

This method is used in a hard-walled test room with prescribed acoustical characteristics. It is based on a comparison with a specialized calibrated reference sound source. Results are obtained in octave frequency bands, from which A-weighted sound power levels or sound energy levels can be computed.

[Norme aussi disponible en français: ISO 3743-1 -- Acoustique -- Détermination des niveaux de puissance acoustique et des niveaux d'énergie acoustique émis par les sources de bruit à partir de la pression acoustique -- Méthodes d'expertise en champ réverbéré applicables aux petites sources transportables -- Partie 1: Méthode par comparaison en salle d'essai à parois dures]

8.5.3 ISO 3743-2:1994, Acoustics — Determination of sound power levels and noise sources using sound pressure — Engineering methods for small, movable sources in reverberant fields — Part 2: Methods for special reverberation test rooms

ISO 3743-2 is used for specified applications in a specially constructed hard-walled reverberant test room. Unless there is a specific application for this method it is recommended to use ISO 3743-1, which is similar.

[Norme aussi disponible en français: ISO 3743-2 -- Acoustique -- Détermination des niveaux de puissance acoustique émis par les sources de bruit à partir de la pression acoustique -- Méthodes d'expertise en champ réverbéré applicables aux petites sources transportables -- Partie 2: Méthodes en salle d'essai réverbérante spéciale]

8.5.4 ISO 3744:2010, Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering method for an essentially free field over a reflecting plane

This international Standard can be used in a machinery room where the tested equipment must have typical dimensions one fifth of the typical dimensions of the room. Measurements can also be made in a flat clear area outdoors e.g., a parking lot. A minimum of 9 measurement positions are required. Results are obtained in one-third-octave frequency bands, from which octave-band values and A-weighted sound power levels or sound energy levels can be computed.

[Norme aussi disponible en français: ISO 3744 -- Acoustique -- Détermination des niveaux de puissance acoustique et des niveaux d'énergie acoustique émis par les sources de bruit à partir de la pression acoustique -- Méthodes d'expertise pour des conditions approchant celles du champ libre sur plan réfléchissant]

8.5.5 ISO 3745:2012, Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Precision methods for anechoic and hemi-anechoic rooms

This standard is used indoors in a laboratory room with sound absorbing walls and no more than one reflecting plane i.e., the floor. The method is suited for small movable machines with a maximum dimension no more than one third the minimum dimension of the laboratory room. A minimum of 20 measurement positions are required. Results are obtained in one-third-octave frequency bands, from which octave-band values and A-weighted levels can be computed.

[Norme aussi disponible en français: ISO 3745 -- Acoustique -- Détermination des niveaux de puissance acoustique et des niveaux d'énergie acoustique émis par les sources de bruit à partir de la pression acoustique -- Méthodes de laboratoire pour les salles anéchoïques et les salles semi-anéchoïques]

8.5.6 ISO 3746:2010, Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Survey method using an enveloping measurement surface over a reflecting plane

This international Standard specifies a free field method for in situ A weighted measurement of sound power levels. It may also be used in semi reverberant environments, and is less affected by background noise than ISO 3747. A minimum of 4 measurement positions are required. Measurements may be made indoors or outdoors near one or more reflecting planes

Norme aussi disponible en français: ISO 3746 -- Acoustique -- Détermination des niveaux de puissance acoustique et des niveaux d'énergie acoustique émis par les sources de bruit à partir de la pression acoustique -- Méthode de contrôle employant une surface de mesure enveloppante au-dessus d'un plan réfléchissant]

8.5.7 ISO 3747: 2010, Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering/survey methods for use in situ in a reverberant environment

This international Standard specifies a method for in situ measurement of sound power levels in a reverberant environment. Measurements can be made indoors in most ordinary rooms without sound absorbing material on the walls or ceiling. This standard is based on a comparison of the sound pressure levels of a noise source with those of a specialized calibrated reference sound source. It is suitable for larger pieces of stationary equipment which, due to their manner of operation or installation, cannot readily be moved. A minimum of 3 measurement positions are required. To use this method, the noise of the machinery under test must dominate the noise in the test environment. Results are obtained in octave frequency bands, from which A-weighted sound power levels or sound energy levels can be computed.

[Norme aussi disponible en français: ISO 3747 -- Acoustique -- Détermination des niveaux de puissance acoustique et des niveaux d'énergie acoustique émis par les sources de bruit à partir de la pression acoustique -- Méthode d'expertise et de contrôle pour une utilisation in situ en environnement réverbérant]

8.5.8 ISO 6926:1999, Acoustics — Requirements for the performance and calibration of reference sound sources used for the determination of sound power levels

This international Standard is used only by testing laboratories. It specifies the acoustical performance requirements for temporal steadiness, spectral characteristics, and directivity index for reference sound sources used in "comparison methods" for determining the noise emissions of other sound sources. For calibration of reference sound sources with more than one reflecting plane, ISO3741 must be used.

8.6 Determination of Sound Power Levels In Situ using Sound Intensity

The use of sound intensity allows measurements in the widest range of environments and background noise levels. However, the required equipment is specialized and can be expensive. Sound power standards that use sound intensity require many measurement positions, so that they can take more total measurement time than other standards based on sound pressure. This is true even for those sound intensity standards that allow scanning movement between measurement positions.

8.6.1 ISO 9614-1:1993, Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 1: Measurement at discrete points

This international Standard specifies methods to determine sound power levels based on discrete point measurements. This method often requires dozens of measurement positions. The measurement grade, precision, engineering or survey can only be determined on completion of the test measurements.

[Norme aussi disponible en français: ISO 9614-1 -- Acoustique -- Détermination par intensimétrie des niveaux de puissance acoustique émis par les sources de bruit -- Partie 1: Mesurages par points]

8.6.2 ISO 9614-2:1996, Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 2: Measurement by scanning

This standard uses measurements made by continuously scanning a moving probe around the equipment. This results in decreased measurement time compared to discrete point sampling. The measurement grade, engineering or survey, is verified on completion of the test measurements. Consideration should be given to first attempting precision measurements using ISO 9614-3 since the precision method is compatible with ISO 9614-2 and a determination of engineering or survey grade may be possible without the need for additional measurements.

[Norme aussi disponible en français: ISO 9614-2 -- Acoustique -- Détermination par intensimétrie des niveaux de puissance acoustique émis par les sources de bruit -- Partie 2: Mesurage par balayage]

8.6.3 ISO 9614-3:2002, Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 3: Precision method for measurement by scanning

This international Standard specifies an in situ precision grade method to determine sound power levels by scanning an intensity probe continuously over a measurement surface enveloping the noise source. The measurement grade is verified on completion of the test measurements. The method is compatible with ISO 9614-2 so measurements that do not meet precision grade may qualify for engineering or survey grade.

[Norme aussi disponible en français: ISO 9614-3 -- Acoustique -- Détermination par intensimétrie des niveaux de puissance acoustique émis par les sources de bruit -- Partie 3: Méthode de précision pour mesurage par balayage]