AMERICAN NATIONAL STANDARD

Quantities and Procedures for Description and Measurement of Environmental Sound – Part 3: Short-term Measurements with an Observer Present

ANSI/ASA S12.9-2013/Part 3

Accredited Standards Committee S12, Noise

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ANSI/ASA S12.9-2013/Part 3
(Revision of ANSI S12.9-1993/Part 3)

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Quantities and Procedures for Description and Measurement of Environmental Sound — Part 3: Short-term Measurements with an Observer Present

Secretariat:

Acoustical Society of America

Approved on January 15, 2013 by:

American National Standards Institute, Inc.

Abstract

This standard is the third in a series of parts concerning description and measurement of outdoor environmental sound. The standard describes recommended procedures for measurement of short-term, time-average environmental sound outdoors at one or more locations in a community for environmental assessment or planning for compatible land uses and for other purposes such as demonstrating compliance with a regulation. These measurements are distinguished by the requirement to have an observer present. Sound may be produced by one or more separate, distributed sources of sound such as a highway, factory, or airport. Methods are given to correct the measured levels for the influence of background sound.

AMERICAN NATIONAL STANDARDS ON NOISE

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FOREWORD

[This Foreword is for information only and is not a part of the American National Standard ANSI/ASA S12.9-2013/Part 3 American National Standard Quantities and Procedures for Description and Measurement of Environmental Sound – Part 3: Short-term Measurements with an Observer Present. As such, this Foreword may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the standard.]

This standard comprises a part of a group of definitions, standards, and specifications for use in noise. It was developed and approved by Accredited Standards Committee S12, Noise, under its approved operating procedures. Those procedures have been accredited by the American National Standards Institute (ANSI). The Scope of Accredited Standards Committee S12 is as follows:

> *Standards, specifications, and terminology in the field of acoustical noise pertaining to methods of measurement, evaluation, and control, including biological safety, tolerance, and comfort, and physical acoustics as related to environmental and occupational noise.*

This standard is a technical revision of ANSI/ASA S12.9-1993/Part 3. The applications of this Standard have been clarified, the microphone position and correction for nearby reflecting surfaces has been expanded, and the equation for day-night sound level as a function of population density in the United States has been corrected. The prediction in the previous edition was 3 dB too high, and all associated tables have been adjusted down by 3 dB.

This standard is the third in a series of six parts concerning description and measurement of outdoor environmental sound. This Part describes recommended procedures for measurement of short-term, average environmental sound pressure levels outdoors in a community with an observer present. Part 1 deals largely with definitions for standard quantities. Part 2 addresses measurement of long-term, wide-area sound. Part 4 deals with noise assessment and noise assessment metrics. Part 5 deals with noise-zone compatible land use planning. Part 6 deals with the probability of awakening by a set of discrete noise events; typically, the set encompasses the whole nights (e.g., all the nighttime operations at a busy commercial airport).

The subject matter in ANSI/ASA S12.9-2013/Part 3 is not considered in corresponding ISO documents.

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Suggestions for improvements of this standard will be welcomed. They should be sent to Accredited Standards Committee S12, Noise, in care of the Standards Secretariat of the Acoustical Society of America, 35 Pinelawn Road, Suite 114E, Melville, New York 11747-3177. Telephone: 631-390-0215; FAX: 631-390-0217; E-mail: asastds@aip.org.

INTRODUCTION

This standard is the third part of a series related to quantities and procedures for description and measurement of environmental sound. Part 1 lists definitions for basic quantities that can be used separately or in combination to describe community sound and basic procedures for measurement of these quantities. Part 2 provides procedures for measurement of long-term, wide-area time-average descriptors such as day-night sound exposure and yearly day-night average sound level; Part 2 also establishes spatial and temporal sampling requirements so as to measure these time-average sound levels with a specified degree of precision and confidence. Long-term wide-area measurements take days or weeks or months to accomplish with the desired degree of accuracy and confidence. Normally, long-term sound level measurements are not made by an operator at a measurement site; they are measured by unattended instruments.

This standard, Part 3, deals with basic measurements of sound with an observer present. Typically, the duration of these measurements ranges from several minutes to several hours. The purpose of this part is to provide the method(s) to measure the sound of a specific source at a specified location, such as the noise from a specific power plant in some specified person's backyard. The method is to measure the total sound and then to subtract the background, which is all sound at the location in question except for the sound from the specific source in question.

NOTE As an example, one hour (1 h) is used as the basic measurement duration in Part 3. One hour is not a measurement duration required by this standard; it is only an example of a basic measurement duration, though a common one.

American National Standard

Quantities and Procedures for Description and Measurement of Environmental Sound — Part 3: Short-term Measurements with an Observer Present

1 Scope

The scope of this standard includes the measurement, with an observer present, of quantities such as equivalent-continuous sound pressure level or sound exposure from a specific source or sources at a specified location. These measurements require several minutes to several hours to perform; they take less than one day to perform. Measurements may be obtained with a standard frequency weighting, may be frequency filtered in a defined manner, or may be frequency filtered by octave band or fractional octave band filters. This standard specifies procedures to effectively eliminate, to the extent possible, the contributions of extraneous background sound from the source-specific measurements. Measurement procedures in this standard require the presence of an instrument operator and are not applicable to measurements by unattended instruments. This standard does not define specific measures or limits for environmental sounds or recommend measurement locations or durations.

The purposes of this standard are to (a) specify procedures for measurement of environmental sound from a specific source or sources at a specified location, and (b) to specify procedures to effectively eliminate the contributions of extraneous background sounds from the source-specific measurements. Sound pressure levels are measured with an observer present to record the data described in this part.

This standard is applicable to the measurement of quantities such as equivalent-continuous sound pressure level or sound exposure level from a specific source or sources with an observer present. Major applications of this Standard include:

1. Assessment of environmental sound
2. Measurement of source emissions as equivalent-continuous sound pressure level (LEQ), or as sound exposure level (SEL)
3. Measurement of received sound as LEQ
4. Correction of LEQ measurements for the background sound

NOTE Source emissions typically are measured only when the direct measurement of the received sound is not practical or when the source is not yet in operation. In either case, the received sound must be predicted using the measured source emissions. Annex A contains an informative discussion regarding source emissions and received sound, and clause 7.4 discusses, in general terms, moving closer to the source when the source cannot be turned off, and, as a result of not being able to be turned off, correction for the background is problematic.

2 Normative references

The following referenced documents are indispensable for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ANSI S1.4-1983 (R 2006) *American National Standard Specification for Sound Level Meters*; and Amendment No. 1 in ANSI S1.4A-1985

ANSI/ASA S1.11-2004 (R 2009) *American National Standard Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters*

ANSI/ASA S1.13-2005 (R 2010) *American National Standard Measurement of Sound Pressure Levels in Air*

ANSI/ASA S1.40-2006 (R 2011) *American National Standard Specifications and Verification Procedures for Sound Calibrators*

ANSI/ASA S1.43-1997 (R 2012) *American National Standard Specifications for Integrating-Averaging Sound Level Meters*

ANSI S12.9-1988/Part 1 (R 2003) A*merican National Standard Quantities and Procedures for Description and Measurement of Environmental Sound, Part 1*

ANSI/ASA S12.18-1994 (R 2009) *American National Standard Procedures for Outdoor Measurement of Sound Pressure Level*

SAE J184-1998 *Qualifying a Sound Data Acquisition System*

IEC 60942 Ed. 3.0 b:2003 *Electroacoustics - Sound calibrators*

IEC 61260 Ed. 1.0 b:1995 *Electroacoustics - Octave-band and fractional-octave-band filters*

IEC 61672-1 Ed. 1.0 b:2002 *Electroacoustics - Sound level meters - Part 1: Specifications*

3 Terms and definitions

For the purposes of this standard, the terms and definitions given in ANSI S12.9/Part 1 and the following apply:

3.1
background sound
all-encompassing sound associated with a given environment without contributions from the source or sources of interest

NOTE 1 In this standard, background sound is described as a combination of (1) continuous background sound, and (2) transient background sounds, with the durations for continuous and transient defined according to application and situation. Continuous relates to the constant nature of the background, not to any measurement duration.

NOTE 2 Subclause 5.2 contains a discussion and examples of continuous and transient background sound.

3.2
continuous background sound
background sound measured during a measurement period specified in this Standard, after excluding the contribution of transient background sounds in accordance with one of the methods specified in this standard

NOTE 1 Continuous background sound is sound that occurs repeatedly, minute after minute and day after day. It is assumed to be approximately stationary in a statistical sense, over the measurement duration, and it is described solely by its sound exposure per unit time (in each frequency-weighted or frequency-filtered band of interest).

NOTE 2 As a general rule, sound events from a single source (e.g., aircraft flyovers, heavy truck pass-bys) that occur at a rate of at least 12 times per hour (at least once every five minutes) should be considered part of the continuous background sound.

3.3
transient background sound
background sound associated with one or more sound events which occur infrequently during the basic measurement period, a measurement interval with or without the source operating, and measured in accordance with one of the methods in this standard

NOTE The sound exposure level and time of occurrence of transient background sounds cannot be described statistically during the basic measurement period. Examples of transient background sounds include sounds from such sources as a nearby barking dog, accelerating motor vehicle, radio music, siren, or an aircraft flyover, etc.

3.4
basic measurement period
planned duration and time of occurrence in a day, day of week, or time of year for measurement of the sound from a source, stated as a condition of measurement appropriate to the source and the associated background sound

NOTE 1 For example, an air-conditioning system is best measured when the ambient temperature is warm and it is in normal use.

NOTE 2 As described in 6.8, the actual measurement duration may take longer than planned (i.e., the basic measurement period) because too many measurements were corrupted by background sound.

3.5
corrected measurement period equivalent-continuous sound pressure level
Measurement period data which has been corrected for transient background sound by the transient sound having been inhibited from being collected with or having been removed from the measurement period data

3.6
dominant sound
sound, when heard among other sounds, that is audibly louder than all other sounds combined, and that causes a change of the indicated sound pressure level (measured using approximately a 0.1 s time average or a fast time weighting) of at least 6 decibels (dB) with the audible fluctuations corresponding to the visible fluctuations of the indicated sound pressure levels

3.7
source sound pressure
equivalent-continuous frequency-weighted or frequency-filtered sound pressure measured with the source in operation, P_S, and in accordance with the procedures described in this Standard, and after making all required corrections

3.8
source sound pressure level
equivalent-continuous frequency-weighted or filtered pressure level of the source sound, L_S, i.e.,

$$L_S = 10 * \log(P_S/P_0)^2,$$

where P_0 equals the reference sound pressure of 20 μPa.

NOTE In the case of filtered sound pressures, there may be one source sound pressure level for each filter frequency bandwidth (e.g., octave band or one-third octave band sound pressure levels).

3.9
equivalent-continuous sound pressure
square root of the time average of the integral of the squared sound pressure over a specified time. Units: pascal, Pa

NOTE Equivalent-continuous sound pressure is also termed time-mean-squared sound pressure.

4 Instrumentation

4.1 Sound measuring instrument

Measurements shall be made with an integrating-averaging sound level meter, or equivalent instrument, that complies with the requirements of ANSI/ASA S1.43-1997, or IEC 61672-1 Ed. 1.0 b:2002, for Type 1 accuracy grade. Measurements, when permitted by cognizant authorities, may be made with an integrating-averaging sound level meter that at least complies with the requirements of ANSI S1.4 and ANSI S1.4A for Type 2 accuracy grade, but Type 1 accuracy grade is preferred. The type or accuracy grade of the sound level meter shall be stated in the measurement report.

NOTE 1 A GPS device is sometimes useful for noting the position of noise sources and measurement locations.

NOTE 2 Headphones are useful for listening to the sound being measured and detecting the “popping” sound that is characteristic of wind-induced pseudo-noise at the microphone, or overload conditions, etc. The acoustic signal can be obtained through the “AC out” that is available on most sound level meters or headphones and/or line out that is available on most recorders.

4.2 Acoustical calibrator

The overall acoustical sensitivity of the measuring instrument shall be checked before and after a series of measurements with an acoustical calibrator meeting the requirements of ANSI/ASA S1.40-2006 (R 2011) or IEC 60942-2003. The class of the calibrator shall be the same as or better than the class of the sound level meter.

4.3 Spectrum analyzer

When required, the frequency spectrum of the sound generated by the source shall be measured by octave band or one-third octave band filters complying at least with the requirements of ANSI/ASA S1.11-2004 (R 2009) or IEC 61260 for a Class 1 accuracy grade. The nominal midband frequencies of the filters shall be a set of the preferred frequencies given in ANSI/ASA S1.11-2004 or IEC 61260. The filters may be an accessory to an integrating-averaging sound level meter or may be those in a real-time spectrum analyzer that provides the functions of an integrating-averaging sound level meter and bandpass filters and which also complies with the Class 1 accuracy requirements of ANSI/ASA S1.11-2004 or IEC 61260.

4.4 Recording equipment

A digital recording device or magnetic tape recorder, analog or digital, used to store the time waveform of the sound pressure signals shall comply with the requirements of SAE J184-1998 and ANSI/ASA S1.13-2005 (R 2010).

4.5 Windscreen

The windscreen, when used, should be clean, dry, in good condition, and of a type recommended by the manufacturer of the meter. The manufacturer's instructions for installation of the windscreen around the microphone should be followed closely. A windscreen shall be used when the wind-induced noise is

within 10 dB of the source sound pressure level in any frequency band being measured. The insertion loss caused by the windscreen as stated by the manufacturer shall not exceed 2 dB at any frequency of interest for sound incidence angles from 0° to ±180°.

4.6 Meteorological equipment

(a) An anemometer accurate to ±10% of full scale and a compass accurate to ±3° or other suitable, equally accurate devices for measuring wind speed and direction.

(b) A thermometer accurate to ±5% of full scale, suitable for measurement of ambient temperature.

(c) A hygrometer accurate to ±10% of full scale, suitable for the measurement of relative humidity.

(d) A barometer accurate to ±5% of full scale, suitable for the measurement of barometric pressure (optional).

5 General data collection concepts

5.1 Introduction

Background sound varies widely from rural remote to heavily populated urban environments. The sound is made up of a steady unidentifiable residual source or sources usually associated with far-off traffic or industrial emissions. Background sound also contains both identifiable steady and sporadic sounds. Identifiable steady sources may be songbirds and/or insect activity, while sporadic events are passing local traffic, aircraft activity, barking dogs, etc.

5.2 Background sound

Background sound affects measurements by directly adding extraneous sound energy to the sound produced by the specific source or sources under measurements. For the purpose of this standard, the background sound of concern is that which exists during the time when the sound from a source is being measured, and is sufficiently loud to materially affect the measurement, where "materially" depends on the measurement precision required. The background sound shall be quantified so that measured sound levels of the source may be corrected, when necessary, by removing the extraneous effect of the background sound from the data.

Background sound can be divided into two categories: (1) transient background sounds and (2) continuous background sound. Transient background sounds can be caused by such sources as a barking dog, an accelerating motor vehicle, or an aircraft flyover. The time of occurrence and sound exposure level of transient background sounds cannot be statistically described during the basic measurement period. Continuous background sound includes the composite of all sounds from sources far and near which are (1) not transient background sounds and (2) not sound from the specific noise source under study. Continuous background sound is more or less constant and is considered in these procedures to be statistically stationary over the basic measurement period (e.g., one hour). The measurement procedures described herein provide a systematic method to remove the effects of transient background sounds and continuous background sound in the measurement of the noise emissions from a specific source or sources.

NOTE 1 The sound from any specific background source such as a truck pass-by or aircraft flyover may be part of the transient or continuous background sound depending on the situation. In a quiet neighborhood, infrequent loud trucks generally cause transient background sounds. However, near a busy highway or freeway, these same sounds would be part of the continuous background, because they can occur frequently (several per minute) and their time of occurrence can be described statistically as a stationary process. Similarly, infrequent aircraft flyovers cause transient background sounds, but the regular occurrence of flyovers resulting from aircraft taking off from a busy runway every

few minutes would be part of the continuous background sound. It is recommended that sounds that occur more than 12 times per hour be considered part of the continuous background.

NOTE 2 In the procedures of this Standard, the background sound energy is considered to be uncorrelated with the sound energy of the source, so the influence of continuous background sound is removed by simple subtraction.

NOTE 3 This Standard is focused on correcting measurements for background measurements that are made with an observer present. Other factors such as the time of day, day of the week, repetition of measurements, duration of measurements, etc., are the subject matter of other standards, regulatory agencies, and/or good engineering practice.

5.3 General data collection methods for measurement of the LEQ of a source corrected for the continuous LEQ of the background and for transient background sound

The general measurement procedure conceptually requires the measurement of source sound pressure levels for the basic measurement period with the contribution of transient background sounds removed. Then, if the sound from the specific source is not dominant, the data are further corrected for contribution of continuous background sound. Two methods are presented to remove the contribution of transient background sounds from the measured sound pressure levels. In the first method, the required measurement period is broken up into many, regular-sized, small blocks of time. For each small block, the data corrupted by transient background sounds are deleted. The equivalent-continuous sound pressure level is calculated using only the remaining blocks of data. In the second method, data collection is inhibited any time that a transient background sound occurs, or the data that occur during the time that a transient background sound occurs are subtracted and totally removed by the meter. In this case, the equivalent-continuous sound pressure level is corrected by the meter for the time during which data collection was inhibited or the data were removed because of background transient sound. If the meter does not do this correction automatically, then the user shall perform this correction. With either method, if the sound from the source is not dominant, the measurement period data directly from the meter are then corrected for the influence of continuous background sound.

The first method, dividing the basic measurement period into many regular-sized small blocks of equivalent-continuous sound pressure levels, is applicable to all situations. The person performing the measurements observes activity at the site, and transient background sounds may be removed from the results during subsequent analysis. The second method, data inhibition, is applicable primarily when there are few, if any, transient background sounds and the general background sound level is 10 dB or more below the level of the sound from the source or sources being measured.

6 Source(s) data collection

6.1 Site selection

(a) Measurements shall be taken at one or more microphone positions at the designated receiving location and shall be consistent with the general requirements of ANSI/ASA S1.13-2005 (R 2010). However, when more controlled sound pressure level measurements from a specific source are required, the procedures of ANSI/ASA S12.18-1994 (R 2009) shall also be used.

NOTE The specific requirements that follow, including the 6- and 3-dB positions, the distance from various size reflecting surfaces, the meteorological sensing, etc., generally follow the requirements in ISO 1996-2:2006.

(b) Microphones shall be located at least 7.5 m from any surface where reflections may influence the measured sound pressure levels, or microphones shall be located at one of the following two positions:

(1) The 6-dB position—To approximate measurements made in a free field with only the ground as a nearby reflecting surface, 6 dB shall be subtracted from measurements made with the microphone flush against a hard reflecting surface.

(2) The 3-dB position—To approximate A-weighted broadband measurements made in a free field with only the ground as a nearby reflecting surface, 3 dB shall be subtracted from A-weighted measurements made with the microphone 1 to 2 m from a hard reflecting surface. This approximation shall not be used if the signal contains prominent discrete tones.

NOTE 1 Reflecting objects with small dimensions (trees, posts, bushes, etc.) should not be within 1.5 m of the microphone position. If sound pressure levels are measured within 1.5 m of such objects, the effect, if any, on the measured data should be determined from measurements made at another location where the objects are at a greater distance, or by an equivalent procedure.

NOTE 2 Reflecting surfaces refer to those other than the ground.

NOTE 3 Normally, a microphone position that is at least 7.5 m from the nearest reflecting surfaces is preferred. The main alternative is a microphone that is flush-mounted on a reflecting plane, the 6-dB position. For A-weighted data, the 3-dB position is a second alternative. Other positions between flush-mounting and 7.5 m should be avoided because the effects of reflecting surfaces are frequency-dependent and difficult to determine.

NOTE 4 Nearby reflecting objects also should be avoided since they may increase the level of the background sound (e.g., sound produced by the rustling of leaves).

6.2 Instrument setup

(a) Except for multi-story structures, microphone height shall be between 1 and 2 m above ground. For multi-story buildings, and especially high-rise buildings, the microphone may be at multiple stories above ground. Flush-mounting on a reflecting plane, such as the building wall, is recommended. Alternatively, the microphone can be mounted on a pole extending from a window, 1 to 2 meters (i.e. the 3-dB position).

(b) The microphone shall be oriented so as to provide a sound incidence angle for the primary source of sound that yields the flattest frequency response for sound incident on the microphone in accordance with information in the sound level meter's or microphone's Instruction Manual, as applicable.

(c) While sound measurements are being taken, the operator shall be far enough from the microphone so as to minimize any influence on the measurements.

NOTE Normally, this is accomplished by placing the microphone on a tripod or other support and connecting it to the sound level meter by an extension cable that is at least 1.5 m long. If a microphone extension cable is not available, the operator should position the microphone and sound level meter in accordance with the manufacturer's instructions for the measurement of sound pressure levels with minimum reflections from the observer.

(d) Exceptions, such as measurements outside an upper level window or having the operator in close proximity to the meter, shall be noted in the report of the data collection.

6.3 Measurement site operation and checking instrument sensitivity

(a) Wind speed and direction, ambient air temperature, and dew point or relative humidity shall be measured and recorded (near the measurement site) at the onset of measurements and approximately hourly thereafter, and after completion of the measurements. Any sudden changes in weather shall be noted and recorded. Hourly readings from a local National Weather Service station or an airport's weather advisory service may be used to satisfy this requirement in lieu of

measurement on site, unless the weather conditions at the measurement site are not similar to those at the weather station. In addition, the occurrence of precipitation and its approximate rate shall be recorded at the site whenever it occurs. Measurements shall not be made during periods of rain or ice that are heavy enough to significantly increase the ambient level and significantly increase background noise issues, or are heavy enough to adversely affect the electrical functioning of the meter or likely may damage the instruments or microphone.

(b) To minimize the effects of wind on the microphone, sound measurements should not be taken when the wind velocity is greater than 5 m/s (11 mph or 10 knots) at the microphone position when measured at a height of 2 m above the ground.

NOTE At source-to-receiver distances greater than 30 m and at elevation angles smaller than 20° from the source-to-measurement location, measurements not made under essentially calm wind conditions with a temperature inversion or with the measurement location downwind of the source almost always will have significantly altered spectra and generally lower sound pressure levels. To avoid these altered spectra or generally lower sound pressure levels, the procedures of ANSI/ASA S12.18-1994 (R 2009) should be considered.

(c) The acoustical sensitivity of the measuring system shall be checked ("calibrated") according to the procedure given in the sound level meter's Instruction Manual. This checking shall occur before and after the data collection period, and at approximately hourly intervals during the measurements. If the measuring system's acoustical sensitivity varies by more than ±0.5 dB from the most recent field check, then the sound pressure levels measured after that most recent check shall not be used.

NOTE Checking the acoustical sensitivity of a sound level meter or analyzer is commonly termed "calibration."

6.4 Initial data collection

(a) The duration of the basic measurement, together with any conditions related to the time of day, day of week, and season for the measurement, shall be established prior to the beginning of measurements.

(b) The characteristics of the source(s) and type of operation shall be examined to determine if:

(1) the sound pressure level of the source is essentially steady with time (e.g., cooling tower, electric power transformer, or diesel generator), or

(2) the sound pressure level of the source varies with time (e.g., cycling window air-conditioner, steam over-pressure valves, jet engine test cell, construction cranes, bulldozers, and forklift trucks).

6.5 Simplified procedure 1 for the accelerated measurement of equivalent-continuous sound pressure level

(a) Simplified data collection procedure 1 may be used to reduce the on-site measurement time when the following conditions are met:

(1) The measurements are being obtained with a standard frequency weighting (e.g., A-weighting) or are frequency filtered in a defined manner to yield only one sound pressure level;

(2) The source(s) sound pressure level is essentially steady with time and the source can be turned on and off; or

(3) The source is intermittent, consisting of definite on and off cycles and the sound pressure level during each "source-on" period is virtually constant.

(b) The following is the method of simplified procedure 1:

(1) Set the sound level meter to measure approximately 0.1 s time-average or *fast* time-weighted sound pressure levels. Observe the changes in indicated level when the source(s) of a steady sound are turned on or off, or when the source(s) of an intermittent sound are on or off, and determine if each source constitutes a dominant sound.

- *For a steady sound,* observe the indicated sound level for a 5-min period with the source(s) in operation and determine the frequency-weighted or frequency-filtered sound pressure level. For the sound to be essentially steady, the difference between the maximum sound pressure level and the minimum sound pressure level measured during the 5-min observation period shall be less than or equal to 3 dB. If there are transient background sounds that cause the indicated sound pressure level to rise by 3 dB or more, discard the sound pressure level measurements and repeat the 5-min observation. If interruptions persist, use the methods of 6.7.2 or 6.7.3 to eliminate the contribution of transient background sounds from the measurements of sound pressure levels as measured in the field.

- *For an intermittent sound,* measure the sound pressure level for 5 min or for the time necessary to observe at least three repetitions of a normal on-off cycle, whichever is longer, but not exceeding the duration of the basic measurement period (see 6.7). Determine the frequency-weighted or frequency-filtered sound pressure level with the "source on" from the arithmetic average of the sound pressure levels observed during "source-on" cycles. Determine the frequency-weighted or frequency-filtered sound pressure level with the "source off' from the arithmetic average of the minimum sound pressure level observed during "source-off" cycles. For the source to be virtually constant, the difference between the maximum sound pressure level and the minimum sound pressure level measured during the “source on” portion of any source cycle, using the *fast*-time weighting, shall be less than or equal to 2 dB; the difference between the highest sound pressure level found for a “source on” time period and the lowest level found for a “source on” time period shall be less than or equal to 1.5 dB. If transient background sounds increased any of the "source-on" sound pressure level measurement by 3 dB or more, discard the measured sound pressure levels and repeat the observations. If interruptions persist, use the methods of 6.7.2 or 6.7.3 to eliminate the contribution of transient background sounds from field measurements that constitute the total sound pressure levels. Determine the duty cycle which is the ratio of a typical source "on-time" to the total duration of a cycle.

NOTE 1 This procedure can be used with instruments that make multiple simultaneous measurements such as sound analyzers that measure octave band or fractional-octave-band sound pressure level. The basic requirement is that the operator be able to watch all the bands simultaneously, repeating the 5-min measurement enough times to have watched all the individual bands. With the potential for 40 bands there is a point where the long procedure is faster than the short procedure.

NOTE 2 The provision for frequency filtering is largely a moot point with modern instruments. It goes back to the days when an octave band filter set or sound level meter might have provisions for an external filter. In principle, however, this remains a possibility. For example, in principle, one could fit sound level meters with filters that would reduce the influence of insect noise in A-weighted measurements.

(2) Correct for background sound and duty cycle:

- *For steady sound,* if the measured and audible changes in the sound pressure level during source turn-on and turn-off meet the requirements for a dominant sound, subtract the approximate time-mean-square sound pressure measured during the 5-min measurement of the background sound from the approximate time-mean-square sound pressure measured during the 5-min measurement of the background plus the source-on sound.

NOTE 1 The time-mean-square sound pressure is the square of the equivalent-continuous sound pressure.

NOTE 2 Time-mean-square sound pressure, p^2 (in pascals squared), is calculated from the equivalent-continuous sound pressure level, L_p, in decibels by

$$p^2 = p_1^2 10^{0.1(L_p - 94)} \tag{1}$$

where 94 dB is the level of a sound pressure defined by p_1 = 1 Pa.

NOTE 3 Sound exposure in pascals-squared seconds is calculated from the sound exposure level, L_E, in decibels by

$$E = E_1 10^{0.1(L_E - 94)} \tag{2}$$

where 94 dB is the level of a sound exposure defined by E_1 = 1 Pa^2 s. Corresponding to E, the time-mean-square sound pressure in pascals squared is

$$p^2 = (1/T)E_1 10^{0.1(L_E - 94)} = E/T \tag{3}$$

where T is the duration of the measurement in seconds.

NOTE 4 The equivalent-continuous sound pressure level corresponding to a measured sound exposure may be determined from

$$L_p = 10 \lg (E / E_0) - 10 \lg (T / t_0) = L_E - 10 \lg (T / t_0) \tag{4}$$

where E_0 is the reference sound exposure of $(20\ \mu\text{Pa})^2$ s and t_0 is the reference time of 1 s.

- *For intermittent sound,* if the measured and audible changes in the sound during source-on and source-off meet the requirements for a dominant sound, subtract the approximate time-mean-square frequency-weighted or frequency-filtered sound pressure measured with the "source off" from the approximate time-mean-square sound pressure measured with the source on. Subtract ten times the base ten logarithm of the duty cycle from the corrected equivalent-continuous sound pressure level to account for the influence of the duty cycle of the source.

6.6 Simplified procedure 2 for the accelerated measurement of equivalent-continuous sound pressure level

(a) Simplified data collection procedure 2 may be used to reduce the on-site measurement time when the following conditions are met:

(1) The measurements are being obtained with a standard frequency weighting (e.g., A-weighting) or are frequency filtered in a defined manner to yield only one sound pressure level.

(2) The source(s) sound pressure level is essentially steady with time and the source can be turned on and off.

(b) The following is the method of simplified procedure 2:

(1) Set the sound level meter to measure approximately 0.1-s time-average or *fast* time-weighted sound pressure levels. Observe the changes in indicated level when the source of the steady sound is turned on or off, and determine if this source constitutes a dominant sound.

(2) Measure the L-90 sound level for a 5-min period with the source(s) in operation and determine the frequency-weighted or frequency-filtered sound pressure level. Use of the L-90 will automatically remove transient background sounds from the result.

(3) Correct for background sound: If the measured and audible changes in the sound pressure level during source turn-on and turn-off meet the requirements for a dominant sound, subtract the L-90 measured during the 5-min measurement of the background sound from the L-90 measured during the 5-min measurement of the background plus the source-on sound. As with the measurement of the background plus the source-off sound, use of the L-90 will automatically remove transient background sounds from the result.

6.7 Basic procedure for measurement of equivalent-continuous sound pressure level

6.7.1 Introduction

The basic data collection procedure requires measurement of the continuous background sound for 10 min or more and measurement of the sound with the source(s) in operation for the basic measurement period (e.g., 1 h). For both of these required measurements, the measured sound pressure level data directly from the meter shall be corrected for the contribution of transient background sounds using the method of either 6.7.2 or 6.7.3 in accordance with the minimum data requirements of 6.8. The source sound pressure level shall be obtained from the corrected data directly from the meter by using the method in 6.7 and reported, together with the other items required in Clause 8. If difficulty is encountered with measuring the continuous background sound, use the alternative approach selected from the approaches in Clause 7 that results in the smallest correction to the measured time-average frequency-weighted or filtered sound pressure level.

6.7.2 Data collection using small blocks of time

(a) The basic measurement period shall be divided into many small blocks of time. The block duration in seconds, ΔT , which shall remain fixed for any measurement period, shall divide (exactly without remainder) into 3600 s and shall be neither less than 1 s nor greater than 60 s.

NOTE 1 Small blocks of time are used so that if a transient background sound occurs during some block, then only a small part of the total measurement period is lost.

NOTE 2 For example, if the block duration is chosen to be 30 s, and the basic measurement duration is chosen to be 1 h, then the data collection consists of 120 30-s block measurements.

NOTE 3 For very short blocks, e.g., 1 s, a computerized log of blocks corrupted by background and acceptable blocks may be required.

(b) The measurements may be obtained with a standard frequency weighting (e.g., A-weighting), may be frequency filtered in a defined manner, or may utilize standard octave band or fractional octave band filters.

(c) Measure the frequency-weighted or filtered equivalent-continuous sound pressure levels for each block duration. Omit the sound pressure levels for any block corrupted by transient background sounds.

(d) After deleting measurements that are "corrupted" by the influence of transient background sounds, there will be some number of "good" data blocks remaining. This number of "good" data blocks shall be designated as N_g where g stands for "good." These remaining blocks are numbered consecutively with subscript “i” denoting the time sequence of the good data blocks.

(e) The equivalent-continuous sound pressure levels for these N_g remaining blocks shall be averaged by application of Equation (5). Also, when the measurement is of octave band or fractional octave band sound pressure level, the subscript “j” in Equation (5) designates the frequency band.

For measurements of octave band or fractional octave band sound pressure level, the measurement period equivalent-continuous sound pressure level (in the jth frequency band) is given by

$$L_{eqj} = 10 \lg \left(\frac{1}{N_g} \sum_{i=1}^{N_g} 10^{\left(0.1 L_{eqij}\right)} \right), \tag{5}$$

Where, L_{eqij} is the equivalent-continuous sound pressure level data directly from the meter in the *j*th frequency band for the *i*th data block.

For measurements of a single frequency-weighted or frequency-filtered sound pressure level, the measurement period equivalent-continuous sound pressure level also is given by Equation (5), but with the subscript “j” omitted.

6.7.3 Data collection using large, continuous blocks of time

(a) The measuring instrument shall be adjusted to continuously measure equivalent-continuous sound pressure level(s).

(b) A means shall be available to inhibit data collection whenever a transient background sound occurs. On some instruments similar means may be available to delete the most recent previous measurement. These means shall be used to eliminate the contribution of transient background sounds.

(c) Data collection shall proceed for the entire required measurement period, or for several large subdivisions. Each result is the corrected measurement period equivalent-continuous sound pressure level data directly from the meter for the entire period or for one of its subdivisions. If the required measurement period is subdivided into blocks, each block should have an equal duration as given in 6.7.2(a), and data for any blocks that are irretrievably corrupted by transient background sounds shall be omitted. The remaining blocks shall be numbered consecutively. The subscript “i” denotes the time sequence of the good data blocks.

NOTE If the source or environmental conditions (e.g., wind speed or direction) change during the required measurement period, the measurement period can be divided into a few large, equal-length blocks. For example, one hour could be divided into four 15-min blocks to allow correlation of any changes in the measured sound pressure levels with variations in the observed source or environmental conditions.

(d) For measurements of octave band or one-third octave-band sound pressure levels, the measurement period equivalent-continuous sound pressure level (in the *j*th frequency band) is given by

$$L_{eq\mathrm{j}} = 10 \lg \left[\frac{1}{T_\mathrm{g}} \sum_{i=1}^{N_\mathrm{g}} T_{\mathrm{gi}} 10^{\left(0.1 L_{eq\mathrm{ij}}\right)} \right], \tag{6}$$

where $L_{eq\mathrm{ij}}$ is the equivalent-continuous sound pressure level data directly from the meter in the *j*th frequency band for the *i*th large block (typically 10–30 min), T_{gi} is the number of non-inhibited seconds of good data during the *i*th large block, and T_g is the total number of non-inhibited seconds *of good* data [see Equation (7)].

For measurements of a single frequency-weighted or frequency-filtered sound pressure level, the measurement period equivalent-continuous sound pressure level as measured in the field is given by Equation (6), but with the subscript "j" omitted. For Equation (6),

$$T_\mathrm{g} = \sum_{i=1}^{N_\mathrm{g}} T_{\mathrm{gi}}. \tag{7}$$

6.8 Minimum data collection requirements for basic measurement data collection

The measurement period for basic measurement data collection of 6.7.2 shall proceed initially for the required measurement period, either the basic measurement period (e.g., 1 h) or a 10-min period for the measurement of continuous background sound. Because of corrections for transient background sounds, the actual reported data collection time, T_g, in seconds, may be less than the basic measurement period, but shall not be less than half of the required measurement period.

(a) If small blocks of time are used for data collection, then the total measurement duration in seconds, T_g, is given by $N_\mathrm{g} T_\mathrm{b}$, where T_b is the duration of each block in seconds and N_g is the number of good data blocks. If the data inhibition procedure of 6.7.3(b) is used for data collection, then T_g is the number of non-inhibited seconds of good data during the measurement period.

(b) If T_g is less than half the basic measurement period (e.g., less than 1800 s for a basic measurement period of 1 h), two alternative procedures are provided, as follows:

(1) The duration of the data collection measurements shall be extended for an additional required measurement period (e.g., an additional hour or an additional 10 min).

(2) If T_g for the combined first and second periods of measurement is less than half the basic measurement period, then data collection procedures shall be appropriately modified and a new measurement period shall be initiated.

(3) If the duration of good data for a new measurement period is less than half the basic measurement period, then one of the two alternatives described above shall be selected again and the measurements repeated.

NOTE The following are possible remedies if the total duration of good data is too short:

- The duration of each small data block may be too long. Repeat the measurements with a shorter block duration.

- For either data collection method, sounds considered to be short term actually may be part of the continuous background and should be so redefined.

(c) If the measurement conditions do not allow the collection of the required minimum number of good samples of sound pressure level after repeated attempts, the problems encountered should be carefully reviewed and the test plan should be altered in accordance with the findings (e.g., by rescheduling to obtain better weather conditions, relocating the measurement location, or altering the time of day, week, or season) to improve the probability of successful measurements.

6.9 Correction for continuous background sound

(a) One purpose of this standard is for an observer to properly measure and to derive measured sound emissions from a subject source of sound or noise, exclusive of the continuous background. This requires a valid measurement of both operational and background sound. This is not an easy task when the source level, if properly designed acoustically, will be very close to or even below the background sound. The ideal and straightforward procedure is to measure both before and after an operational run to acquire an average background spectra presumed present during the operational time. This level may be subtracted from operational (or total) measurements. The task is exacerbated for sources, such as large fossil and nuclear power plants, and industrial and petrochemical complexes, that cannot be turned on and off readily if at all. Clause 7.0 discusses measurement techniques to acquire background levels for both scenarios; i.e., when a source can be turned off and when it cannot.

(b) If the measurements are of spectra, and when valid operational and background level spectra are acquired, the following corrections in clause 6.9(d), *or the exact equation solution values*, shall be applied to each frequency band selected for measurement. Overall A- and C-weighted levels shall not be corrected for background by using Table 1 nor by using the exact equation solution values. Rather, they shall be recalculated from corrected octave band data. The recalculation shall exclude the octave bands from 2 kHz thru 8 kHz if there is audible insect, bird, or leaf rustle noise in the measurements.

(c) If the measurements are of just A-, C- or Z-weighted levels, and when valid operational and background levels are acquired, the following corrections in clause 6.9(d), *or the exact equation solution values*, shall be applied to the weighted level selected for measurement. Weighted levels shall never be considered valid if there is audible insect, bird, or leaf noise.

(d) Mathematical correction procedure

(1) If the difference between the measurement period equivalent-continuous total sound pressure level (sound that is the sum of source in question and the continuous background sound) and the corresponding continuous background sound pressure level is less than 3 dB, then the reported source sound level shall be set equal to -99 dB for subsequent calculations, or to n/a for written presentations.

(2) If this difference is larger than 10 dB, then the correction for background sound shall be set to 0, and the corrected measurement period equivalent-continuous sound pressure level shall be just the source sound level reported (in the jth frequency band for a measurement of frequency band sound pressure level).

(3) If this difference is between 3 and 10 dB, then the correction given in Table 1, shall be subtracted from the unadjusted measurement period equivalent-continuous sound pressure level. The resulting corrected level shall be the source sound level reported (in the jth frequency band for a measurement of frequency band sound pressure level).

Table 1 — Corrections to measured equivalent-continuous sound pressure levels for contributions of continuous background sound

Δ, difference (dB)	3–4	4–5	5–6	6–7	7–8	8–9	9–10
K, correction (dB)	3	2.2	1.7	1.3	1.0	0.7	0.6
NOTE From Equation (8)							

NOTE 1 Corrections for continuous background sound can yield a spectrum that appears to possess discrete frequency components or "tones." The test for the presence of prominent discrete tones should be performed without correcting for background sound as described in Clause B.2. After correction for continuous background sound, a test for the presence of prominent discrete-frequency components may incorrectly infer the presence of a discrete frequency because some one-third octave band equivalent-continuous sound pressure levels may have been set to 0 or to some unusually small level. Annex B provides one procedure to test for the presence of prominent discrete tones.

NOTE 2 In Table 1, the correction, K, in decibels is given in terms of the sound pressure level difference in decibels, Δ, by

$$K = 10 \lg \left\{ 1 + \left[1 / \left(10^{0.1\,\Delta} - 1 \right) \right] \right\}. \quad (8)$$

7 Determining the background sound

7.1 Introduction

Ideally, when correcting for the contribution of continuous background sound, it is assumed that this quantity is statistically stationary, at least over a period of a few hours. Therefore, the continuous background sound should be measurable over a time period which is much shorter than 1 h, for example, a 10-min period. As in the screening method of 6.5, one would turn off the source(s) under study for 10 min preceding the actual source measurements and, during this period, measure the equivalent-continuous background sound pressure level(s). However, since one may not be able to turn off the source(s) under study or transient background sounds may occur during this 10-min period, one of the following procedures shall be used for the measurement of the continuous background sound.

7.2 Background sound measurement method

The same measurement method used to measure source plus background equivalent-continuous sound pressure levels shall be used to measure the continuous background sound pressure levels (i.e., the method in 6.5, 6.6, 6.7.2, or 6.7.3). If the method in 6.7.2 or 6.7.3 is used, then the period for the measurement of continuous background sound pressure level (without source) shall be at least 10 min. The requirements of 6.8 shall also apply. In applying the method of 6.7.2 or 6.7.3 and 6.8, the symbol T_B shall be used to designate the total measurement duration for the continuous background sound not corrupted by transient background sound, and the symbol N_g shall be used to designate the number of good data blocks.

7.3 Background sound measurement alternatives for sources that can be turned off

7.3.1 Introduction

The following are a hierarchical order of four procedures for determining the equivalent-continuous background sound pressure levels. These four procedures require that source(s) of sound be turned off

and involve direct measurement. These are not equivalent procedures but are ordered from what is considered to be the most accurate to what is considered to be the least accurate procedure.

NOTE Annex C contains a method to roughly estimate background levels in special circumstances when such estimates are prudent. The method given in Annex C is not a substitute for any of the four procedures in this section.

7.3.2 When determining compliance with or violation of a noise law, regulation, ordinance or criterion, etc., the only methods used to determine the continuous background shall be the methods of clause 7.3.3. The method of Annex C shall not be used when determining compliance with or violation of a noise law, regulation, ordinance or criterion, etc. However, when determining compliance with or violation of a noise law, regulation, ordinance or criterion, etc., the provisions of the following two clauses shall apply, and the tolerances given in clause 7.3.3 shall be added to or subtracted from the measured ambient according to the following schedule:

(a) If one's purpose in making measurements is to demonstrate compliance then the tolerance shall be subtracted from the measured background levels for their use in clause 6.9.

(b) If one's purpose in making measurements is to demonstrate a violation, then the tolerance shall be added to the measured background levels for their use in clause 6.9.

NOTE In two circumstances, determination of the ambient can be simplified as given in the following two clauses. The first circumstance is when the sound from some activity is significantly below the criteria, and one needs to demonstrate compliance. In this circumstance, any quieter time-period can be used to measure the ambient and demonstrate compliance. The second circumstance is when the sound from some activity is significantly above the criteria, and one needs to demonstrate a violation. In this circumstance, any louder time-period can be used to measure the ambient and demonstrate a violation.

7.3.2.1 If this standard is used for determining a violation of a noise law, regulation, ordinance or criterion**,** etc. (but not compliance), any clearly noisier period for the continuous background sound may also be used to demonstrate a violation of the rules. This period might be rush-hour traffic during evening hours instead of mid-afternoon traffic, or daytime traffic instead of nighttime traffic. Consistent with this requirement, the applicable uncertainty factor given in 7.3.3 shall be added to the measured continuous background sound if the result is to be used to determine a violation of a noise law, regulation, ordinance or criterion, etc., and the time period for the background sound measurement is not clearly noisier.

7.3.2.2 If this standard is used to show compliance with a noise regulation (but not a violation), any clearly quieter period for the continuous background sound [without the source(s) present] may also be used to determine the continuous background sound to demonstrate compliance with the rules. This period might be a night or weekend instead of mid-afternoon. Consistent with this requirement, the applicable uncertainty factor given in 7.3.3 shall be subtracted from the measured continuous background sound if the result is to be used to show compliance with a noise law, regulation, ordinance or criterion, etc., and the time period for the background sound measurement is not clearly quieter. However, no measurement of continuous background sound is required if the corrected measured equivalent-continuous frequency-weighted or filtered sound pressure level as measured in the field with the source operating plus the contribution of the background sound meets the requirements for compliance.

7.3.3 Direct measurement of the equivalent-continuous background sound pressure level

(a) With the source(s) off, measure the equivalent-continuous sound pressure level of the background sound just before *and* just after measurement of the source of sound of interest at the location of the source(s) measurements, with the same sound pressure level measuring instruments and with the same instrument settings. Average the two sets of background measurements to determine the background data to be used for clause 6.9. The uncertainty factor to be used in 7.3.2 for this clause is 1 dB.

(b) With the source(s) off, measure the equivalent-continuous sound pressure level of the background sound within the hour before or within the hour after measurement of the source at the location of the source(s) measurements, with the same sound pressure level measuring instruments, and with the same instrument settings. The uncertainty factor to be used in 7.3.2 for this clause is 1.5 dB.

(c) With the source(s) off, measure the equivalent-continuous sound pressure level of the background sound during a similar time period within the 1–3 h before or within the 1–3 h after measurement of the source(s) sound pressure levels at the location of the source(s) measurements, with the same sound pressure level measuring instruments, and with the same instrument settings. For example, for daytime measurements at a plant or factory that operates only during daytime hours, measurement of the background sound might occur just before work begins, during lunch, or just after work ends. In this type of situation, the "source plus background" measurements and the background alone measurements shall be as close together in time as practicable, consistent with the requirement that these two measurements be at two times when the background levels would be similar. That is, one should not have one of these two measurements during rush hour and the other at 2 a.m., etc. The uncertainty factor to be used in 7.3.2 for this clause is 3 dB.

(d) With the source(s) off, measure the equivalent-continuous sound pressure level of the background sound during some other acoustically similar period within 1–30 days before or within 1–30 days after measurement of the source(s) sound pressure levels. This alternative continuous background measurement time might be any scheduled or unscheduled downtime for the source(s). These measurements shall be made at the location of the source(s) measurements, with the same measurement instruments and instrument settings (or equivalent instruments and instrument settings) used to measure the sound pressure levels produced by the source(s). The uncertainty factor to be used in 7.3.2 for this clause is 5 dB.

(e) If the background cannot be measured within the 60-day window of clause (d) above, then it shall be considered to be a situation where the source cannot be turned off.

7.4 Background sound measurement alternatives for sources that cannot be turned off

7.4.1 Two general procedures are described for determining the background when the source cannot be turned off. These two procedures are generalized and, as such, they are not intended to specify a detailed procedure that is applicable to any case or site. In any adversarial situations, the sides jointly shall develop a test protocol tailored for conditions of that specific case. At a minimum, the protocol shall address the following:

- Test locations
- Acceptable testing time of day
- Acceptable weather conditions
- Operating scenario of the equipment under test
- Minimum instrumentation standards and suitable calibration data
- Description of all proposed analyses of data to arrive at sound or noise emissions
- Allowance or not for measurement tolerances
- Clear definition of what constitutes a pass or failure of test.

7.4.2 The two general procedures are given below.

(a) Proxy test location method. This method involves going to a proxy location just before or just after the "source plus background" measurements. This proxy location shall be far enough from the source such that the background is dominant. Figure 1 illustrates the minimum distance for the proxy site from the source for large, distributed source areas. This distance shall be greater than 5 times the longest length of the distributed source area envelope.

NOTE The distance for a proxy background measurement is given in terms of the longest length of the envelope; the length of the envelope section "facing" the measurement (in this case section *"a"*) is not utilized.

(b) Closer-in measurement location method. This method involves measuring at a closer distance to the sound source compared to the distance of the source plus background measurement location from the sound source location. Normally, calculations for the attenuation of sound with distance will differ depending on whether one is close to the sources, far from the sources, or at an "in between" distance. For this determination, one is interested in the longest length of envelope*, E*, that faces the closer-in measurement position.

(1) When the measurement position is less than the distance *E* from the envelope section having length *E*, then the distributed source may behave more like a line source than a point source, and the attenuation of sound with distance may fall as low as 3 dB per doubling of distance. Clause 8.1 defines these three regions for a generalized measurement site.

NOTE At measurement distances that also are less than the height of the source and the sources are distributed vertically, the source may appear to be a plane with no decay with distance.

(2) When the measurement position is greater than the distance 2***E* from the envelope section having length *E*, then the distributed source should behave nearly like a point source, and the attenuation of sound with distance will be nearly 6 dB per doubling of distance.

(3) When the measurement position is in between the distances *E* and *2*E* from the envelope section having length *E*, then the attenuation of sound with distance should transition from the *close* region attenuation rate that can be as low as 3 dB per doubling of distance, to the *far* region attenuation rate that normally will approach 6 dB per doubling of distance.

Figure 1 illustrates these three regions for a generalized measurement site. In this case the measurement positions "face" the longest length of envelope; if the measurement positions were "facing" another segment such as "*d*," then the criteria for a measurement position being close or far from the sources would be given in terms of the length of segment *d*.

8 Data to be reported

8.1 Source data

(a) The reported measurement period equivalent-continuous sound pressure levels shall be those described in Clauses 5 and 6 and shall be reported rounded to the nearest whole decibel.

(b) The number of measurement seconds not corrupted by transient background sounds shall also be reported.

NOTE 1 If the source(s) measurement period is divided into small measurement time blocks, then the total duration of the good measurements is given by the number of non-discarded measurement blocks multiplied by the duration of each block in seconds.

NOTE 2 If data collection is inhibited when transient background sounds occur, then the duration of good measurements is the total non-inhibited measurement duration during the source(s) measurement period (see 6.7.3).

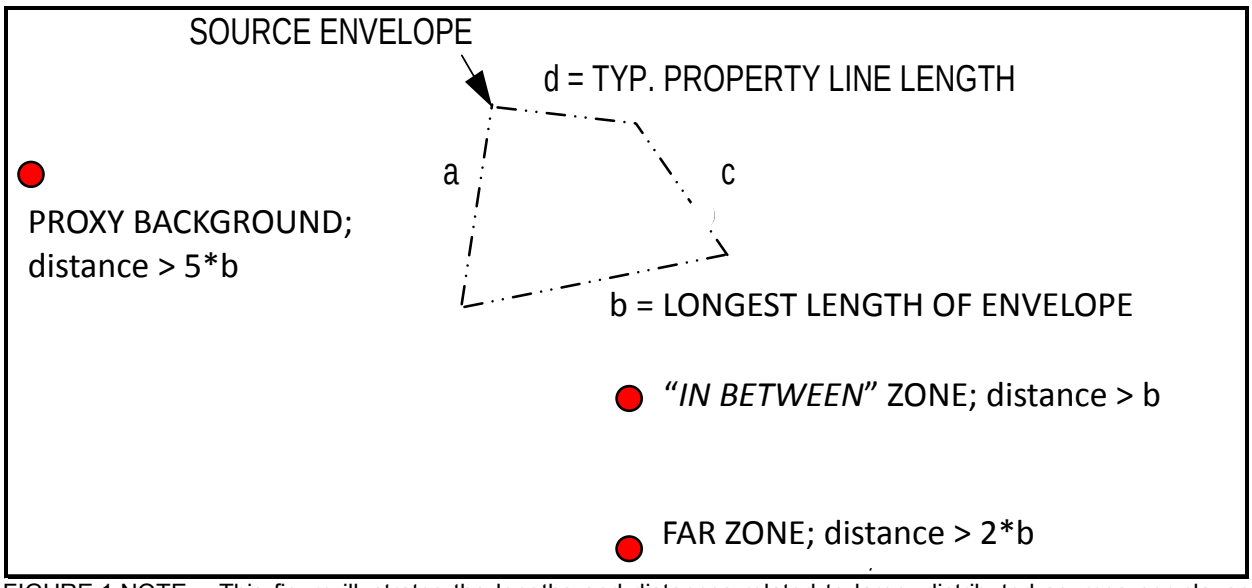

FIGURE 1 NOTE This figure illustrates the lengths and distances related to large, distributed sources per clause 7.4. As per clause 7.4.2 (a), the proxy distance is given as >5*b even though it is in the "a" direction, since b is the longest length to the source envelope. As per 7.4.2 (b), the three zones used for close-in measurements are: (1) the near zone with distance d<b, and where decay with distance is likely to be 3 dB or less; (2) the in between zone where distance d is >b and <2b, and where the decay with distance likely transitions from 3 to 6 dB per doubling of distance; and (3) the far zone where d>2*b, and where the decay with distance is 6 dB per doubling of distance.

Figure 1 - Lengths and distances related to large, distributed sources

8.2 Background sound

(a) The clause under which the background was determined shall be reported.

(b) Background sound data to be reported shall be the equivalent-continuous background sound pressure levels used to correct the measured source(s) data. The report shall indicate what tolerance, if any, was added or subtracted from the measured data.

(c) The several most important sources of sound contributing to the continuous background sound shall be listed and briefly described.

(d) The number of measurement seconds not corrupted by transient background sounds shall also be reported.

NOTE 1 If the 10-min continuous background sound measurement is divided into small measurement time blocks, then the total duration of good measurements is given by the number of non-discarded measurement blocks multiplied by the duration of each block in seconds.

NOTE 2 If data collection is inhibited when transient background sounds occur, then the duration of good measurements is the total non-inhibited measurement duration during the 10-min continuous background sound measurement.

(e) While source(s) of continuous background sound data are being measured, transient background sounds may interfere. The specific nature of these interfering sounds and their time of occurrence shall be recorded.

8.3 General site and procedural information

8.3.1 Acoustical measurement instrumentation

The report shall include the manufacturer, model number, and serial number of each instrument used in the measurements, and, if a wind screen was used, it shall include the insertion loss of the windscreen as stated by the manufacturer, either A-weighted or in fractional octave bands as appropriate to the measurements, and whether or not these insertion loss values in dB have been applied to the reported data.

8.3.2 Acoustical sensitivity checks (calibration)

The report shall include the results of the checks of the acoustical sensitivity of the measuring instruments before and after the data collection period, and at approximately hourly intervals during the measurements, as required.

8.3.3 Meteorological conditions (outdoor measurements)

The report shall, as a minimum, include the meteorological conditions that prevailed during the measurement period, consisting of:

(a) average wind speed and direction,

(b) ambient air temperature, and

(c) relative humidity (or dew point).

For short-term measurements of more than 1-h duration, additional meteorological data shall be reported at approximately hourly intervals.

8.3.4 Site description

The report shall include:

(a) A physical and topological description of the measurement surface in the vicinity of the measurement site.

(b) A map indicating the measurement site location(s) and a map (possibly more detailed) indicating the approximate location of the noise source(s) relative to the microphone positions. The measurement site location map shall identify the direction to North. Both maps shall include an appropriate length scale, preferably in meters.

(c) A diagram and photographs of the measurement site area including the location of the operator of the sound-measuring instruments, any observers, and large reflective surfaces near the microphone position(s).

(d) A description of the source(s) of sound.

Annex A

(informative)

Source and receiver sound

When addressing environmental noise problems, one generally has a specific source under study or evaluation such as an airport, a highway, a plant or factory, a restaurant or tavern with outdoor music, a specific ventilation fan, a kennel, a neighbor's air-conditioning condenser, a neighbor's dog, etc. These sources emit sound that varies with direction, frequency, and time. If one adopts a geometric viewpoint, then there are set of paths that the sound can follow from the source (the emitter) to the designated point (or points) in the community where the sound is a problem. These are the point or points at which the sound is received. The source sound that reaches a designated community point is commonly termed the received sound at that point. That is, the source emits sound and the designated point in the community receives the sound; hence the terms "emitter" and "receiver." Sound leaving the emitter is emitted sound, and sound reaching the receiver is received sound. The sound leaving the emitter is known as the source emission, and from the Latin, sound arriving at the receiving points should be termed the receiving point immissions. However, this term is not common in the United States. Rather, the term "received sound" is used.

Most environmental noise measurements are made directly at the designated receiving points in the community. However, sometimes one is called upon to predict what the sound will be from a source that is not yet in place. Sometimes the source is well defined and sound power data are available such that one can use standard equations to predict the sound pressure levels received in the community. Usually this is not the case and one must measure the source emissions at a known distance from the assumed center of the source, and then use standard equations to work backwards and establish a sound power that, in turn, is used to predict the received levels in the community.

Annex B

(informative)

Determination of the presence of prominent discrete tones

B.1 Test for the presence of a prominent discrete tone

A test for the presence of a prominent discrete-frequency spectral component (tone) typically compares the equivalent-continuous sound pressure level in some one-third octave band with the equivalent-continuous sound pressure levels in the adjacent two one-third octave bands. For a prominent discrete tone to be identified as present, the equivalent-continuous sound pressure level in the one-third octave band of interest is required to exceed the arithmetic average of the equivalent-continuous sound pressure level for the two adjacent one-third octave bands by some constant level difference, K_T.

NOTE This constant may vary with frequency. Possible choices for the level differences are: 15 dB in low one-third octave bands (25–125 Hz), 8 dB in middle-frequency bands (160–400 Hz), and 5 dB in high-frequency bands (500–10,000 Hz).

B.2 Determination of the presence of a prominent discrete tone

Determine if a prominent discrete tone is present according to the criteria in B.1 without applying background corrections. Background sound can affect the determination of a prominent discrete tone in two ways: it can mask a tone that would otherwise be prominent in the absence of the background sound or the background sound can be the source of a prominent discrete tone. Therefore, the masking in the presence of typical background sound should be considered when determining the presence of a prominent discrete tone, and if a prominent discrete tone is present, it should be determined if background sound is sufficient to cause the "prominence."

If there is a prominent discrete tone without correcting for background sound, perform the following test to determine if the background sound could have caused the prominent discrete tone.

Because it is possible for the equivalent-continuous sound pressure level in some one-third octave bands to be very small after correcting for continuous background sound, the test for a prominent discrete tone in any one-third octave band needs to be performed not only on the adjacent continuous and transient background-corrected equivalent-continuous one-third *j* octave band sound pressure levels (see 6.9), but also on the corresponding equivalent-continuous one-third octave band sound pressure levels which were only corrected for transient background sounds [see 6.7.2(e) and 6.7.3(d)].

Let $\left\{L_{B(j)}\right\}$ be the set of continuous and transient background corrected one-third octave band equivalent-continuous sound pressure levels, and let $\left\{L_{S(j)}\right\}$ be the set of one-third octave band equivalent-continuous sound pressure levels which were only corrected for transient background sounds by eliminating corrupted data, where the subscript "*j*" indicates *j*th one-third octave band. Then the test for the presence of a prominent discrete tone is given by the following expression:

$$L_{S(j)} - \left\{\max\left(L_{S(j+1)}, L_{B(j+1)}\right) + \max\left(L_{S(j-1)}, L_{B(j-1)}\right)\right\} / 2 > K_T, \qquad \text{(B.1)}$$

where $\max\left(X, Y\right)$ denotes the maximum value of two quantities X and Y, and K_T is the criterion level difference applicable to the one-third octave band with mid-band frequency index j.

NOTE The criterion level difference is determined by the one-third octave band sound pressure level being evaluated even though one of the two adjacent one-third octave bands may fall within a range of bands for which there is a different criterion.

Annex C

(informative)

Table look-up method to determine the continuous background sound level

Clause 7.3.2 states: "THE METHOD OF ANNEX C SHALL NOT BE USED WHEN DETERMINING COMPLIANCE WITH OR VIOLATION OF A NOISE LAW, REGULATION, ORDINANCE OR CRITERION, ETC." The table look-up method in this annex provides a very approximate alternative method for estimating the contribution of continuous background sound. In any specific situation, the 95% prediction interval is on the order of ±10 dB.

These tables are organized by predominant land use and time of day (daytime or nighttime). There are separate tables for octave band and one-third octave band sound pressure levels. These background environments are taken from a variety of sources (see Bibliography) and are divided into the six categories given below. Categories 1, 2, and 3 are applicable, respectively, to noisy, moderate (in this subclause, "moderate" means "in between noisy and quiet"), and quiet commercial or industrial areas. Categories 2, 3, 4, and 5 are applicable, respectively, to noisy, moderate, quiet, and very quiet urban residential (or other noise sensitive) areas, and Categories 3, 4, 5, and 6 are applicable, respectively, to noisy, moderate, quiet, and very quiet suburban areas. Category 6 is also applicable to sparsely populated rural areas. These six categories are intended only for the land uses indicated in italics, and no others.

The following are descriptions of these six categories of land use:

(a) *Noisy commercial and industrial areas, and very noisy residential areas* (Category 1)*:* Very heavy traffic conditions such as in busy "downtown" commercial areas; at intersections for mass transportation or for other vehicles including elevated trains, heavy motor trucks, and other heavy traffic; and at street corners where many motor buses and heavy trucks accelerate.

(b) *Moderate commercial, industrial, and noisy residential areas* (Category 2)*:* Heavy traffic areas with conditions similar to (a) above, but with somewhat less traffic; routes of relatively heavy or fast automobile traffic and motor bus routes, but where heavy truck traffic is not extremely dense.

(c) *Quiet commercial, industrial, and normal urban and noisy suburban residential areas* (Category 3)*:* Light traffic conditions where no mass transportation vehicles and relatively few automobiles and trucks pass, and where these vehicles generally operate at moderate speeds. Residential areas and commercial streets and intersections with little traffic comprise this category.

(d) *Quiet urban and normal suburban residential areas* (Category 4)*:* These areas are similar to (c) above, but for this group the background sound either is distant traffic or is unidentifiable. Typically, the population density is one-third the density in (c) above.

(e) *Quiet residential areas* (Category 5)*:* These areas are isolated, far from significant sources of sound, and may be situated in shielded areas such as a small wooded valley.

(f) *Very quiet, sparse suburban or rural residential areas* (Category 6)*:* These areas are similar to those in (d) above but are usually in sparse suburban or rural areas and for this group there are few if any near sources of sound.

Table C.1 provides day, night, and day-night average sound levels for these six types of land use categories, ranging from "very noisy urban" to "very quiet rural residential." Table C.1 includes a column

which indicates the approximate population density in people per square kilometer for each zone of day-night average sound level.

Table C.1 — A-weighted day, night, and day-night average sound levels in decibels and corresponding approximate population densities as indicated

Residential land use category	DNL range (dB)	Typical DNL (dB)	Day level (dB)	Night level (dB)	People per square mile	People per square km
1. Very noisy urban residential	>65	67	66	58	63,840	24,650
2. Noisy urban residential	60 to 65	62	61	54	20,000	7,722
3. Urban and noisy suburban residential	55 to 60	57	55	49	6,384	2,465
4. Quiet urban and normal suburban residential	50 to 55	52	50	44	2,000	772
5. Quiet suburban residential	45 to 50	47	45	39	638	247
6. Very quiet suburban and rural residential	<45	42	40	34	200	77

NOTE Use of this table and Equation (C.1) is only recommended when the predicted DNL is between 50 and 70 dB. Residential land use categories 1 through 4 constitute the extent of this range, and in this range, the 95-percent prediction interval is approximately +10 dB. Outside of this range, 50 to 70 dB, predictions are not recommended. The levels indicated for categories 5 and 6 show approximately what range of DNL they might span. If referencing this standard, then Equation (C.1) should not be used to predict DNL that are outside the range of 50 to 70 dB, and the descriptions of the noise in land uses that fit in categories 5 and 6 should not be used to estimate the DNL in those areas.

These data come from Bibliographic reference [6]. The basic formula relating population density, ρ, to day-night average sound level, L_{dn}, is

$$L_{dn} = 10 \lg \left(\rho \right) + k_{\rho} \tag{C.1}$$

where k_{ρ} = 23.1 when ρ is measured in people per square kilometer, and k_{ρ} = 19 when ρ is measured in people per square mile.

NOTE Equation (C.1) is based, primarily, on day-night average sound levels (DNL) in the range from 50–70 dB. Extrapolation of Equation (C.1) to day-night average sound levels below 50 dB or above 75 dB is not recommended.

Tables C.1 and C.2 are used to calculate the entries in Tables C.3, C.4, C.5, and C.6. Table C.2 provides offsets to be added to A-weighted background levels to calculate octave band and one-third octave band background sound pressure levels. These offsets from Table C.2 are added to the day-average and night-average sound levels in Table C.1 to generate Tables C.3, C.4, C.5, and C.6.

Tables C.3 and C.4 provide background octave band sound pressure levels for daytime and nighttime, respectively. These tables also include A- and C-weighted levels. In general, the C-weighted level is

12 dB above the A-weighted level. Similarly, Tables C.5 and C.6 provide background one-third octave band sound pressure levels for daytime and nighttime, respectively.

NOTE Time-mean-square sound pressure is calculated from the sound pressure levels in these tables by Equation (1).

Table C.2 — Offsets to be added to A-weighted background sound pressure levels to calculate octave band and one-third octave band background sound pressure levels[a]

Nominal mid-band frequency (Hz)	One-third octave-band offset (dB)	Octave band offset (dB)
25	+4	
31.5	**+4**	**+9**
40	+4	
50	+4	
63	**+4**	**+9**
80	+3	
100	+2	
125	**+1**	**+6**
160	0	
200	-1	
250	**-3**	**+2**
315	-5	
400	-6	
500	**-7**	**-2**
630	-8	
800	-10	
1000	**-12**	**-7**
1250	-14	
1600	-15	
2000	**-16**	**-11**
2500	-17	
3150	-18	
4000	**-19**	**-14**
5000	-20	
6300	-21	
8000	**-23**	**-18**
10,000	-24	
12,500	-25	

NOTE [a] After entry [7] in Bibliography.

Table C.3 — Daytime equivalent-continuous background sound pressure levels by land use categories and octave band sound pressure level or for standard A- and C-frequency weightings [a]

Nominal mid-band frequency (Hz)	Land use category					
	1	2	3	4	5	6
31.5	75	70	64	59	54	49
63	75	70	64	59	54	49
125	72	67	61	56	51	46
250	68	63	57	52	47	42
500	64	59	53	48	43	38
1000	59	54	48	43	38	33
2000	55	50	44	39	34	29
4000	52	47	41	36	31	26
8000	48	43	37	32	27	22
A	66	61	55	50	45	40
C	78	73	67	62	57	52
NOTE [a] Land use categories are described in this annex, above.						

Table C.4 — Nighttime equivalent-continuous background sound pressure levels by land use categories and octave band sound pressure level or for standard A- and C-frequency weightings [a]

Nominal mid-band frequency (Hz)	Land use category					
	1	2	3	4	5	6
31.5	67	63	58	53	48	43
63	67	63	58	53	48	43
125	64	60	55	50	45	40
250	60	56	51	46	41	36
500	56	52	47	42	37	32
1000	51	47	42	37	32	27
2000	47	43	38	33	28	23
4000	44	40	35	30	25	20
8000	40	36	31	26	21	16
A	58	54	49	44	39	34
C	70	66	61	56	51	46
NOTE [a] Land use categories are described in this annex, above.						

Table C.5 — Daytime equivalent-continuous background sound pressure levels by land use categories and one-third octave band sound pressure levels [a]

Nominal mid-band frequency (Hz)	Land use category					
	1	2	3	4	5	6
25	70	65	59	54	49	44
31.5	70	65	59	54	49	44
40	70	65	59	54	49	44
50	70	65	59	54	49	44
63	70	65	59	54	49	44
80	69	64	58	53	48	43
100	68	63	57	52	47	42
125	67	62	56	51	46	41
160	66	61	55	50	45	40
200	65	60	54	49	44	39
250	63	58	52	47	42	35
315	61	56	50	45	40	33
400	60	55	49	44	39	32
500	59	54	48	43	38	31
630	58	53	47	42	37	30
800	56	51	45	40	35	28
1000	54	49	43	38	33	26
1250	52	47	41	36	31	24
1600	51	46	40	35	30	23
2000	50	45	39	34	29	22
2500	49	44	38	33	28	21
3150	48	43	37	32	27	20
4000	47	42	36	31	26	19
5000	46	41	35	30	25	18
6300	45	40	34	29	24	17
8000	43	38	32	27	22	15
10,000	42	37	31	26	21	14
12,500	41	36	30	25	20	13

NOTE [a] Land use categories are described in this annex, above.

Table C.6 — Nighttime equivalent-continuous background one-third-octave-band sound pressure levels by land use categories

Nominal mid-band frequency (Hz)	Land use category					
	1	**2**	**3**	**4**	**5**	**6**
25	62	58	53	48	43	38
31.5	62	58	53	48	43	38
40	62	58	53	48	43	38
50	62	58	53	48	43	38
63	62	58	53	48	43	38
80	61	57	52	47	42	37
100	60	56	51	46	41	36
125	59	55	50	45	40	35
160	58	54	49	44	39	34
200	57	53	48	43	38	33
250	55	51	46	41	36	31
315	53	49	44	39	34	29
400	52	48	43	38	33	28
500	51	47	42	37	32	27
630	50	46	41	36	31	26
800	48	44	39	34	29	24
1000	46	42	37	32	27	22
1250	44	40	35	30	25	20
1600	43	39	34	29	24	19
2000	42	38	33	28	23	18
2500	41	37	32	27	22	17
3150	40	36	31	26	21	16
4000	39	35	30	25	20	15
5000	38	34	29	24	19	14
6300	37	33	28	23	18	13
8000	35	31	26	21	16	11
10,000	30	30	25	20	15	10
12,500	33	29	24	19	14	9

NOTE [a] Land use categories are described in this annex, above.

Bibliography

[1] G. L. Bonvallet, “Levels and Spectra of Traffic, Industrial, and Residential Area Noise,” *J. Acoust. Soc. Am.* **23**(4), 435–439 (1951).

[2] D. E. Bishop and P. D. Schomer, in *Handbook of Acoustical Measurements and Noise Control, Chapter 50, Community Noise Measurements,* edited by C. M. Harris (McGraw-Hill, New York, 1991), 3rd ed.

[3] EPA, “Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety,” U.S. Environmental Protection Agency, 550/9-74 (March 1974).

[4] K. M. Eldred, “Community Noise,” U.S. Environmental Protection Agency, NTID 300.3 (December 1971).

[5] W. J. Galloway, K. M. Eldred, and M. A. Simpson, “Population Distribution of the United States as a Function of Outdoor Noise Level,” U.S. Environmental Protection Agency, 550/9-74-009 (June 1974).

[6] P. D. Schomer, Clement Dossin, Jack Freytag, Cheng Luo, Annie Machesky, Nishant Nookala, and Arnav Pamdighantam, “A Re-analysis of Day-night Sound Level (DNL) as a Function of Population in the United States,” US Department of Transportation, Office of the Secretary, Contractor Report, Contract No. DTOS59-09-P-00129 (February 2010).

[7] L. C. Sutherland, “Indoor Noise Environments Due to Outdoor Noise Sources,” *Noise Cont. Eng. J.* **11**, 124–137 (1978).

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