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100 Barr Harbor Dr., West Conshohocken, PA 19428

Standard Guide for Measurement of Outdoor A-Weighted Sound Levels[1]

This standard is issued under the fixed designation E 1014; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε[1] NOTE—Keywords were added editorially in November 1995.

1. Scope

1.1 This guide covers the measurement of A-weighted sound levels outdoors at specified locations or along particular site boundaries, using a general purpose sound-level meter.

1.2 Three distinct types of measurement surveys are described:

1.2.1 Survey around a site boundary,

1.2.2 Survey at a specified location,

1.2.3 Survey to find the maximum sound level at a specified distance from a source.

1.3 Since outdoor sound levels almost always vary with time over a wide range, the data obtained using this guide may be presented in the form of a histogram of sound levels. The data obtained using this guide enables calculations of average or statistical sound levels for comparison with appropriate criteria.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 634 Terminology Relating to Environmental Acoustics[2]

2.2 *ANSI Standard:*

S1.4 Specification for Sound Level Meters[3]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this guide, see Terminology C 634.[4]

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *barrier*—any obstacle that blocks the line-of-sight between a source and a receiver or a measurement location.

3.2.2 *impulse noise*—a brief, intrusive sound, such as that associated with a tire blowout, operation of a power press, the discharge of a firearm, or a shout.

3.2.3 *measurement set*—the set of data obtained at a measurement location during a specific time period. For the types of measurements covered by this guide, evaluation of a site may require several measurement sets. The time period is flexible but should not extend beyond the time when the conditions influencing noise, or atmospheric conditions affecting noise propagation, are reasonably uniform. As an example, a significant change in traffic density or start-up of a machine indicate the beginning or end of a measurement set.

4. Significance and Use

4.1 There are numerous situations for which outdoor sound level data are required. These include, but are not limited to, the following:

4.1.1 Documentation of sound levels before the introduction of a new sound source (for example, assessment of the impact due to a proposed use).

4.1.2 Comparison of sound levels with and without a specific source (for example, assessment of the impact of an existing source).

4.1.3 Comparison of sound levels with criteria or regulatory limits (for example, indication of exceedence of criteria or non-compliance with laws).

4.2 This guide provides a means for selecting measurement locations, operating a sound level meter, documenting the conditions under which the measurements were performed, and recording the results.

4.3 This guide provides the user with information to (*1*) make and document the sound level measurements necessary to quantify relatively steady or slowly varying outdoor sound levels over a specific time period and at specific places and (*2*) make and document the physical observations necessary to qualify the measurements.

4.4 The user is cautioned that there are many nonacoustical factors that can strongly influence the measurement of outdoor sound levels and that this guide is not intended to supplant the experience and judgment of experts in the field of acoustics. The guide is not applicable when more sophisticated measurement methods or equipment are specified. This guide, depending as it does on simplified manual data acquisition, is necessarily more appropriate for the simpler types of environmental noise situations. As the number of sources and the range

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[2] *Annual Book of ASTM Standards*, Vol. 04.06.

[3] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

[4] Terminology C 634 – 81a was used in the development of this guide.

of sound levels increase, the more likely experienced specialists with sophisticated instruments are needed.

4.5 This guide can be used by individuals, regulatory agencies, or others as a measurement method to collect acoustical data for many common situations. The data are obtained in the form of a histogram, a graph, or a table indicating the number of occurrences of each sound level observed during the measurement. Criteria for evaluating or analyzing the data obtained are beyond the scope of this guide.

4.6 Note that this guide is only a measurement procedure and, as such, does not address the methods of comparison of the acquired data with the specific criteria. No procedures are provided for estimating or separating the influences of two or more simultaneously measured sounds. This guide can be useful in establishing compliance when the measured data are below a specified limit.

4.7 Paragraph 8.2.1 outlines a procedure that can be used for a survey of the site boundary; paragraph 8.2.2 for a survey of specified monitoring points; and paragraph 8.2.3 for determining the location and magnitude of maximum sound level.

5. Apparatus

5.1 *Acoustical Measurements*:

5.1.1 *Sound Level Meter* (required), Type 2, as defined by ANSI S1.4–1971 preferably with an a-c output port to permit the use of headphones.

5.1.2 *Microphone Windscreen* (required), recommended by the sound level meter manufacturer.

5.1.3 *Acoustical Calibrator* (required), with adaptors necessary to fit the microphone.

5.1.4 *Set of Headphones* (desirable), compatible with and electrically connected to the a-c output of the sound level meter. Monitoring the output of the sound level meter with headphones may enable the operator to detect equipment malfunctions or anomalies in the data caused by wind, humidity, and electrical interference.

5.1.5 *Tripod* (desirable), to ensure a steady and repeatable microphone position.

5.2 *Physical Measurements*:

5.2.1 To assure an accuracy of 1 dB in values derived from these measurements, the accuracy of distance measurements must be within 5 %. Any instrument that provides this degree of accuracy is satisfactory.

5.2.2 *Pocket Compass* (desirable), used for site layout work and for determination of wind direction.

5.2.3 *Site Map* (optional).

5.3 *Meteorological Measurements*—Any of the many available general-accuracy meteorological instruments may be used in order to enable the measurement of:

5.3.1 Wind speed (5-km/h or 2.5-mph increments),

5.3.2 Wind direction (in octants),

5.3.3 Relative humidity (in 10 % increments),

5.3.4 Dry bulb temperature (in 2°C or 5°F increments).

6. Calibration

6.1 The calibration of the sound level meter shall be checked using an acoustical calibrator immediately before and after each measurement set, in a manner prescribed by the manufacturer. Adjustments, if required, shall be made at this time. Calibration shall also be verified if the sound level meter is abused (dropped, etc.). If the change in the calibration reading, as shown on the sound level meter, is 1 dB or greater, the data gathered since the preceding calibration are considered invalid and should be discarded.

6.2 The sound level meter and the acoustical calibrator shall have been thoroughly calibrated with equipment traceable to the National Institute of Standards and Technology within 1 year before the survey. Included in this calibration shall be checks of frequency response, amplifier sensitivity, internal noise, and verification of correct operation of meter circuits and microphone.

7. Interference

7.1 Wind may influence sound level measurements, even with a windscreen in place, particularly at wind speeds above 20 km/h (12 mph). Manufacturers' instructions shall be followed with respect to meter limitations under windy conditions. When wind speeds approach or exceed 20 km/h, headphones shall be used to monitor the sound level meter output or the sound level meter indicator shall be carefully observed to determine if fluctuations correspond to wind speed or actual sound sources. Data obtained during intervals when wind is influencing the measurements shall not be used. No measurements shall be made when steady wind speeds exceed 20 km/h.

7.2 Measurable precipitation almost always influences outdoor sound levels. For example, tires rolling on a paved surface result in higher sound levels when the pavement is wet. Also, fallen snow may affect the propagation of sound so that sound levels may be different with and without fallen snow. For these reasons, making measurements during precipitation or when pavement is wet or snow covered is discouraged. If it is necessary to obtain data when ground surfaces are wet or snow covered, the conditions shall be carefully described in the report. High humidity can influence certain microphones; manufacturers' instructions should be closely followed under these conditions.

7.3 This guide is not intended to evaluate impulse noise because Type 2 sound level meters operating in "fast" or "slow" modes do not accurately or precisely measure impulse noise. If occasional impulses occur during the survey, estimation of their magnitude may be attempted using the fastest available meter response, either "fast," "peak," or "impulse." The maximum meter reading, the meter response setting, and the repetition rate within the measurement set shall be reported. Whenever most of the sound level meter readings in any measurement set are influenced by impulse noise, this guide shall not be used.

7.4 Occasionally it is necessary to measure sources of pure tone noise perceived as a "buzz," "hum," or "whistle." Since both the operator's body and reflections can significantly influence the sound level meter indication when tones are present, the report must include observations of tonal noise when present.

7.5 Electromagnetic radiation from high voltage transmission lines, or strong television or radio signals may affect the sound level meter indication. The operator should use caution when these are nearby. Such electrical interference problems, when they occur, might result in wild and unexpected swings

of the sound level meter indicator or upward indications even when the instrument is turned off. These effects may be audible through monitoring headphones. This is the most effective way to detect these conditions and other anomalies.

7.6 Temperature inversions and other meteorological conditions may strongly influence the propagation of sound over long distances. Therefore, when sound from sources at horizontal distances of about 500 m (1600 ft) or more need to be measured, an acoustical specialist should be consulted.

7.7 During certain times of the year, naturally occurring sounds such as from birds or insects (crickets, locusts) may dominate A-weighted sound levels particularly during evening and nighttime periods. Such noises should be noted in the report. Where possible, an effort may be made to document their influence by making measurements at different times or different locations to document conditions with and without such naturally occurring sounds.

8. Procedure

8.1 *Preparation of Equipment*—Prepare the sound level meter for use as follows:

8.1.1 Check the battery condition indicator (recheck every 15 to 30 min during the measurement set).

8.1.2 Verify calibration of the sound level meter in accordance with the manufacturer's instructions.

8.1.3 Place the windscreen over the microphone.

8.1.4 Set the weighting to "A."

8.1.5 Set the response to "slow" or as required in 7.3 (unless otherwise specified).

8.1.6 Select a range so that the sound level meter reading is on scale.

8.1.7 Support the instrument and orient the microphone in accordance with the manufacturer's instructions. In the absence of a specified height, position the microphone between 1.2 m (4 ft) and 1.5 m (5 ft) above the ground.

8.2 *Selecting Measurement Locations and Times*:

8.2.1 *Survey Around a Site Boundary*—Follow procedures in 8.2.1.1-8.2.1.5 when it is necessary to measure A-weighted sound levels at the boundary of a site.

8.2.1.1 Select the time periods of the survey. In general, the time of day that each measurement set is obtained should be such that the sound levels are representative of a specific condition. The period of operation of a time-varying or time-restricted source may also dictate the time to measure. In the absence of specified time periods the following shall apply: (*1*) day (7 am through 7 pm), (*2*) evening (7 pm through 10 pm), and (*3*) night (10 pm through 7 am).

(1) Unless otherwise specified, at least one measurement set within each time period should be taken. For example, if the source is predominantly traffic noise, it may be useful to subdivide the daytime period into "rush" hours (that is, from 7 to 9 am and from 4 to 6 pm) and "non-rush" hours for purposes of comparing noise levels with and without peak traffic flow.

(2) Both a weekday (Monday to Friday) and a weekend day (Saturday or Sunday) should be monitored if a difference in sound levels is expected unless otherwise specified. Whenever a particular noise source tends to dominate the measured sound level only intermittently, the survey shall include periods with and without the source present, as two different measurement sets.

8.2.1.2 The sound level meter may be used in selecting the locations on the basis of sound level. For each time period, walk the site boundary, measure and note the trend of sound levels. Select a minimum of two locations to meet one or more of the following:

(1) Local maximum, the location where the highest A-weighted sound level is observed.

(2) Local minimum, the location where the lowest A-weighted sound level is observed.

8.2.1.3 Alternatively, locations may be selected for other reasons:

(1) Sensitive Locations, considering sound sources and receivers either inside or outside the site, including upper floors of nearby structures.

(2) Locations Nearest to a Community, considering sound sources within the site.

(3) Intermediate Locations, locations selected so that the indicated sound level at adjacent locations might not differ by more than 5 dB.

(4) Other Locations: (*1*) so that locations are separated by no more than one-half the site perimeter; (*2*) so that such conditions as variable terrain, acoustical barriers adjacent to site activities, and presence of adjoining structures are considered.

NOTE 1—The location of the microphone, relative to barriers and large reflecting surfaces influences the indicated sound level. It is extremely important to record the location of the microphone relative to other objects.

(*5*) Measurement locations should be chosen so that they are at least 1.5 m (5 ft) apart.

8.2.1.4 Measure the sound levels at each location in accordance with 8.3.1.

8.2.1.5 Measure the meteorological conditions in accordance with 8.3.2.

8.2.2 *Survey at a Specified Location*—Follow procedures in 8.2.2.1-8.2.2.3 for those surveys where a particular sound source is being evaluated. These steps can be used to determine compliance with a criterion given in terms of A-weighted sound level at a specified location relative to the source. When a local ordinance or other requirement states the exact location of the microphone (that is, "4 ft from the center of the building facade and 4 ft off the ground"), these steps are applicable.

8.2.2.1 Select the time period(s) for the survey in accordance with 8.2.2.1. Note the period and the day of week the survey is conducted. An additional measurement set is recommended during the same time period with the source not operating. When a specific noise source is being evaluated, specify its mode of operation clearly for each measurement. For example, if the equipment cycles on and off, the sound levels and duration should be reported for each cycle.

8.2.2.2 Measure the sound levels at each location with and without the source operating in accordance with paragraph 8.3.1.

8.2.2.3 Measure the meteorological conditions in accordance with 8.3.2.

8.2.3 *Survey to Find the Maximum Sound Level at a*

Specified Distance from a Source—Follow procedures in 8.2.3.1-8.2.3.3 when a particular noise source is being evaluated and the applicable criterion specifies the maximum sound level at a given distance from the source. When an ordinance or regulation states that the microphone must be located at a fixed distance from the source (that is "10 ft from the cooling tower in any direction, etc."), this measurement procedure should be used.

8.2.3.1 Select the time period of the survey from those given in accordance with 8.2.1.1. Note the period and the day of week the survey is conducted and the operating mode of the source, including" off."

8.2.3.2 Walk slowly and quietly along points at the specified distance from the source while measuring the sound level. Obtain a measurement set in accordance with 8.3.1 at the position where the A-weighted sound level from the test source appears highest. Repeat the measurements for each principal operating mode of the source.

8.2.3.3 Measure the meteorological conditions in accordance with 8.3.2.

8.3 *Measuring and Recording the Data*:

8.3.1 Obtain a measurement set using the sound level meter by reading the indication to the nearest decibel at approximately equal time intervals of from 5 to 20 s. The operator should avoid visually averaging the movement of the sound level meter indicator. The reading should be obtained by glancing at the indicator and noting the sound level at that instant. Continue recording at the same interval until the number of observations is at least ten times the range of the readings in decibels. The range is the difference between the maximum and minimum sound levels (that is, 90 dB − 80 dB = 10 dB, 10 dB × 10 = 100 observations required). A minimum of ten readings must be obtained.

8.3.2 Measure the wind speed, wind direction, relative humidity, and dry bulb temperature, and note the general sky condition. This information shall be obtained for each day of the survey and is recommended for each measurement set or on an hourly basis, whichever is less.

NOTE 2—In place of direct measurement, data from National Oceanographic and Atmospheric Administration (NOAA) Weather is acceptable for all weather data except wind velocity values.

8.3.3 Record data as follows on suitable data sheets. See Fig. 1 for a sample data sheet.

8.3.3.1 Record the measurement locations on a map, plan, or chart, and, when not obvious, indicate the reason for each selection, together with a brief description of the area, including ground cover.

8.3.3.2 Note the characteristics of the dominant noise sources and expected changes. Note any acoustical events such as intermittent operation of machinery, aircraft, sound made by animals, and impulse noise events including estimated rate of occurrence.

8.3.3.3 Record the sound levels measured in accordance with 8.3.1 in either tabular or graphical form.

8.3.3.4 Record the ambient temperature, relative humidity, barometric pressure, wind speed, wind direction, and sky condition measured in accordance with 8.3.2. If NOAA weather radio is used, record the station location, the call letters, and the station frequency, or the source from which the data were taken.

8.3.3.5 Record the start time, stop time, and date of the measurements and the serial number, type, and manufacturer of the sound level meter, microphone, and calibrator.

8.3.3.6 Using the acoustical calibrator, record the sound level meter indication before and after the measurement set.

9. Report

9.1 The report shall include the following:

9.1.1 A tabulation of sound levels for each measurement set with identification of the location and time the data were obtained.

9.1.2 Information on the weighting network and meter response setting ("fast" or "slow," etc.) used for the measurements.

9.1.3 Calibration data including time of calibrations. If applicable, battery checks should also be noted.

9.1.4 Meteorological data including notations of wet pavement or fallen snow.

9.1.5 A schematic map of the area showing:

9.1.5.1 Measurement locations,

9.1.5.2 Nearby sensitive noise receivers,

9.1.5.3 Location of potential future noise receivers within the area,

9.1.5.4 Identifiable noise sources,

9.1.5.5 Explanatory legend relating measurement locations and observation periods, if necessary,

9.1.5.6 Relevant topography and foliage,

9.1.5.7 Barrier locations including their height and other dimensions.

9.1.6 Instrument data, including manufacturer, model, and serial number, and dates of the last factory (or laboratory) calibration of the sound level meter and acoustical calibrator.

9.1.7 Times, dates, and durations of measurements, and the names and telephone numbers of persons making the measurements.

9.1.8 A description of the measured sounds (steady, tonal, impulse), the identified or suspected sound sources, and the rate of repetition of any impulsive components.

9.1.9 A statement, to the extent true, that this guide was followed. Any exceptions should be noted.

9.2 It is recommended that all raw data sheets, whether or not they are included in the report, be permanently retained.

10. Precision and Bias

10.1 *Precision*—The precision of this guide is estimated to be ±2 dB for the arithmetic mean sound level of a given measurement set. This precision is estimated from the prescribed ratio of ten to one (10:1) of the number of observations to the range of observed sound levels. It is expected to hold true for most typical outdoor environmental data.

10.2 *Bias*—Bias is limited to the accuracy of the acoustical instruments (see ANSI S1.4–1971).

11. Keywords

11.1 A-weighted sound levels; community noise; outdoor noise; noise sampling

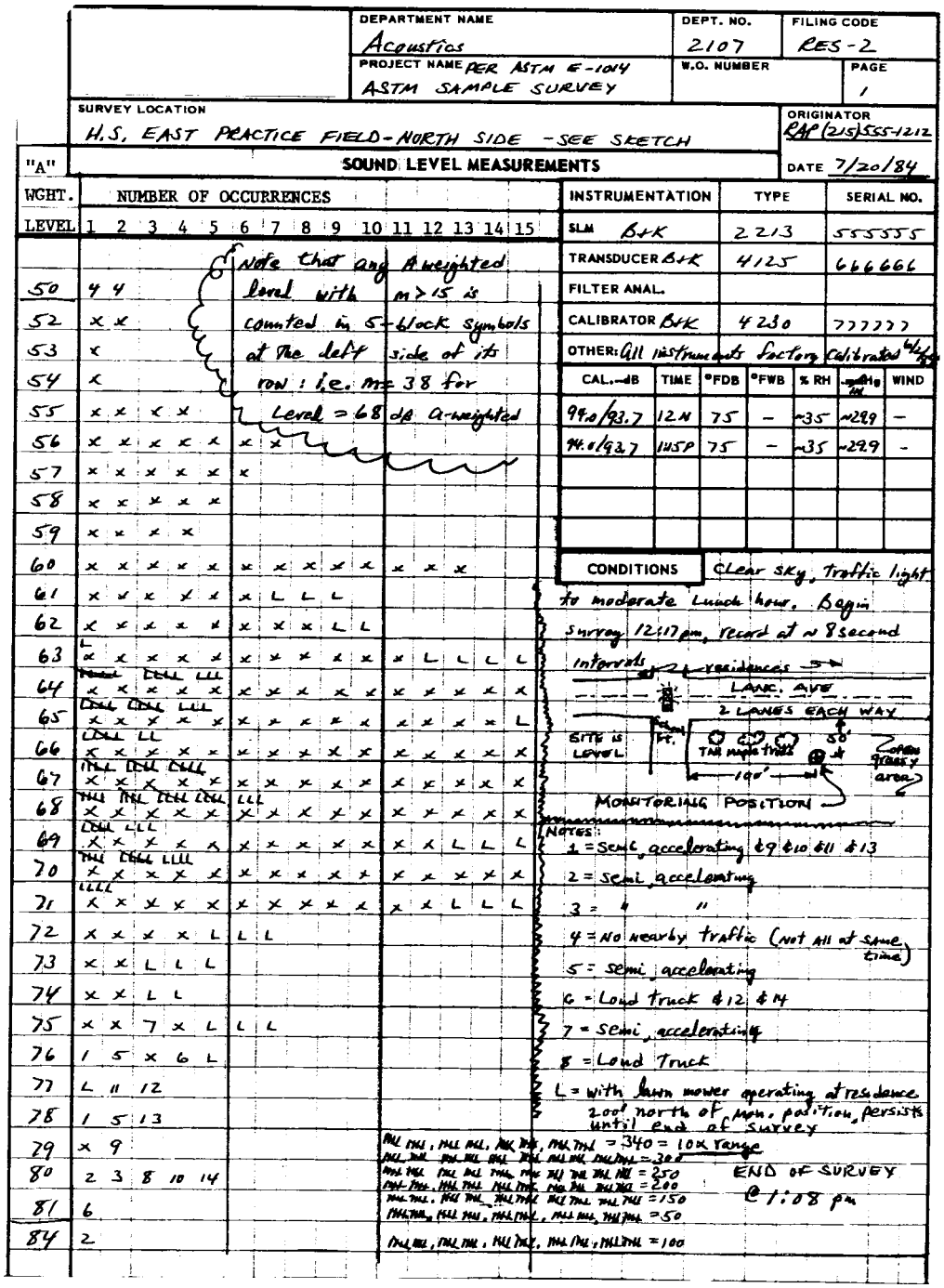

FIG. 1 Sample Data Sheet

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