TITLE 35: ENVIRONMENTAL PROTECTION
SUBTITLE H: NOISE
CHAPTER II: ENVIRONMENTAL PROTECTION AGENCY

PART 951
MEASUREMENT PROCEDURES FOR THE ENFORCEMENT OF 35 ILL. ADM. CODE 900 & 901

Section

AUTHORITY: Implementing and authorized by Sections 25 and 27 of the Environmental Protection Act (Ill. Rev. Stat., 1981, ch. 111 1/2, pars. 1025 and 1027) and 35 Ill. Adm. Code 900.103.

SOURCE: Adopted at 4 Ill. Reg. 6, p. 179, effective February 1, 1980; codified at 8 Ill. Reg. 18109.

Section 951.100 General

This report, pursuant to 35 Ill. Adm. Code 900.103(a) and (b), (old Rules 103(a) and 103(b), Chapter 8, of the Noise Pollution Control Regulations) establishes: the qualifications necessary for the Illinois Environmental Protection Agency (Agency) personnel to conduct sound pressure level measurements, the definitions necessary to supplement this report, the instrumentation to be used by Agency personnel conducting sound pressure level measurements and the specific sound pressure level measurement techniques to be employed by Agency personnel conducting sound pressure level measurements. Such personnel qualifications, instrumentation and measurement techniques as more specifically set forth herein below, shall apply to Agency personnel in determining whether a noise source is in compliance with 35 Ill. Adm. Code 900 and 901, but do not establish limits on sound.

Section 951.101 Personnel Qualifications

Agency personnel conducting sound measurements shall have been trained and experienced in the current techniques and principles of sound measurement and in the selection and operation of sound measuring instrumentation.

Section 951.102 Instrumentation

a) A sound level meter used alone or used in conjunction with an octave band or one-third octave band filter set shall conform with the following standards or subsequent revisions:

1) American National Standards Institute (ANSI) §1.4 - 1971 Specification for Sound Level Meters, Type 1 Precision Sound Level Meter.

2) American National Standards Institute (ANSI) §1.11 - 1966 Specifications for Octave Band Filter Sets, Class II; One-Half Octave Band Filter Sets, Class III; and One-Third Octave Band Filter Sets, Class III.

3) American National Standards Institute (ANSI) §1.6 - 1967 Preferred Frequencies and Band Numbers for Acoustical Measurements.

4) American National Standards Institute (ANSI) §1.8 - 1969 Preferred Reference Quantities for Acoustical Levels.

b) If a magnetic tape recorder, graphic level recorder or other indicating device is used, the system shall meet the requirements of the Society of Automotive Engineers (SAE) Recommended Practice J184a Qualifying a Sound Data Acquisition System.

c) The laboratory calibration of instrumentation used for acoustic measurement shall be traceable to the National Bureau of Standards, and shall be performed no less than once every 12 months.

d) An anemometer and compass or other suitable devices shall be used to measure wind speed and direction in accordance with the manufacturer's recommended procedures.

e) A thermometer, suitable for measurement of ambient temperature, shall be used in accordance with the manufacturer's recommended procedures.

f) A hygrometer, suitable for the measurement of relative humidity, shall be used in accordance with the manufacturer's recommended procedures.

g) A barometer, suitable for the measurement of barometric pressure, shall be used in accordance with the manufacturer's recommended procedures.

h) For outdoor measurements a suitable windscreen shall be attached to the microphone.

Section 951.103 Definitions

"Angle of incidence": the orientation of the microphone relative to the sound source. See Appendix A.

"Ambient": the all-encompassing sound associated with a given environment without the noise source of interest.

"Discrete tone": a sound wave whose instantaneous sound pressure varies essentially as a simple sinusoidal function of time.

(Agency Note: A discrete tone differs by definition from a prominent discrete tone.)

"Fluctuating sound": a class of nonsteady sound whose sound pressure level varies over a range greater than 6 decibels (dB) with the "slow" meter characteristic, and where the meter indication does not equal the ambient level more than once during the period of observation.

"Impulsive sound": sound characterized by brief excursions of sound pressure (acoustical impulses) above the ambient whose duration is less than one second.

(Agency Note: Examples of impulsive sound sources are a drop forge hammer and explosive blasting.)

"Intermittent sound": a class of nonsteady sound where the meter indicates a sound pressure level equal to the ambient level two or more times during the period of observation. The period of time during which the level of the sound remains at a value different from that of the ambient is of the order of one second or more.

"Noise floor": the electrical noise (in decibels) of the sound measurement system. When the noise floor is determined by placing a calibrator over the microphone of the sound measurement system, the noise floor may include acoustic noise due to leakage around the calibrator.

"Nonsteady sound": a sound whose sound pressure level shifts significantly during the period of observation. Meter variations are greater than $\pm$ 3 dB using the "slow" meter characteristic.

"Period of observation": the time interval during which acoustical data are obtained. The period of observation is determined by the characteristics of the noise being measured and should be at least ten times as long as the response time

of the instrumentation. The greater the variation in indicated sound level, the longer must be the observation time for a given expected precision of the measurement.

"Prominent discrete tone": sound, having a one-third octave band sound pressure level which, when measured in a one-third octave band at the preferred frequencies, exceeds the arithmetic average of the sound pressure levels of the two adjacent one-third octave bands on either side of such one-third octave band by:

5 dB for such one-third octave band with a center frequency from 500 Hertz to 10,000 Hertz, inclusive. Provided: such one-third octave band sound pressure level exceeds the sound pressure level of each adjacent one-third octave band, or;

8 dB for such one-third octave band with a center frequency from 160 Hertz to 400 Hertz, inclusive. Provided: such one-third octave band sound pressure level exceeds the sound pressure level of each adjacent one-third octave band, or;

15 dB for such one-third octave band with a center frequency from 25 Hertz to 125 Hertz, inclusive. Provided: such one-third octave band sound pressure level exceeds the sound pressure level of each adjacent one-third octave band.

"Property-line-noise-source": any equipment or facility, or combination thereof, which operates within any land used as specified by 35 Ill. Adm. Code 901.101 of the Noise Regulations. Such equipment or facility, or combination thereof, must be capable of emitting sound beyond the property line of the land on which operated.

(Agency Note: The property-line-noise-source is the equipment or facility or combination thereof that is emitting the sound to be measured. The surface of the property-line-noise-source is not necessarily on the property line unless they are contiguous.)

"Quasi-steady sound": a train of two or more acoustical impulses.

(Agency Note: Examples of quasi-steady sound are riveting and a pneumatic hammer.)

"Reflective surface": any building, hillside, or similar object (other than the flat ground surface) that reflects sufficient sound to affect the sound pressure level readings obtained from a noise source. Not included as reflective surfaces are small objects such as trees, posts, chain-link fences, fire hydrants, vegetation such as bushes and shrubs, or any similar object.

"Sound level": in decibels, a weighted sound pressure level determined by the use of metering characteristics and frequency weightings specified in ANSI, §1.4-1971 "Specification for Sound Level Meters."

(Agency Note: The sound level may be obtained by the use of a metering characteristic and the weightings A, B, C (or other).)

"Sound pressure level": in decibels, 20 times the logarithm to the base 10 of the ratio of the magnitude of a particular sound pressure to the standard reference pressure. The standard reference pressure is 20 micronewtons per square meter.

"Steady sound": a sound whose sound pressure level remains essentially constant (that is, meter fluctuations are negligibly small) during the period of observation. Meter variations are less than or equal to $\pm$ 3 dB using the "slow" meter characteristic.

Section 951.104 Measurement Techniques for 35 Ill. Adm. Code 900

If sound pressure level measurements are obtained by Agency personnel to determine whether a noise source is in compliance with 35 Ill. Adm. Code 900.102 of the Noise Regulations, the following measurement techniques shall be employed:

a) Instrumentation Set Up

1) Measurement instruments shall be set up in an area where the emitted sound may unreasonably interfere with the enjoyment of life or with any lawful business or activity. Other measurement locations may be used for investigatory purposes such as, but not limited to, the following:

A) Determining the extent of noise pollution caused by the source of sound,

B) Determining the ambient, and

C) Analyzing those acoustical parameters that describe the sound source.

2) Instrumentation set up may include, but is not limited to, any method given in a subsequent Section herein.

b) Data Acquisition and Operation

1) Before taking sound pressure level measurements, measure and record (near the measurement site):

A) Wind speed and direction,

B) Ambient temperature,

C) Relative humidity, and

D) Barometric pressure.

2) Turn the measuring instrument on and allow the instrument to stabilize. Monitor and record the battery condition of the calibrator and all measuring instruments.

3) Turn the calibrator on at its appropriate frequency. Allow the calibrator to stabilize and calibrate the measuring system according to the manufacturer's specifications. After the measuring system has been calibrated, remove the calibrator.

4) Measure the sound pressure level data according to the manufacturer's recommended procedures. Other sound pressure levels may be used for investigatory purposes such as, but not limited to, the following:

A) Determining the extent of noise pollution caused by the source of sound,

B) Determining the ambient, and

C) Analyzing those acoustical parameters that describe the sound source.

5) While measurements are being taken, visual and aural surveillance of extraneous sound sources and varying wind conditions should be made to insure that the conditions of measurement are accurately known. Record any variations in these parameters that may affect data.

6) If necessary to determine the extent of noise pollution caused by the source of sound, determine the ambient at the measurement site by means of measurement or analysis.

7) After recording sound pressure level measurements, attach the calibrator to the microphone. Turn the calibrator on at its appropriate frequency. After allowing the calibrator to stabilize, monitor and record the measuring system response. When the measuring system response varies by more than $\pm$ 0.5 dB from the most recent field calibration, the sound pressure level measurements obtained since such most recent field calibration shall not be used for enforcement purposes.

8) Before removing the calibrator from the microphone, turn the calibrator off. If the ambient has not been determined by means of measurement, determine the noise floor of the measuring system. If the noise floor is within 10 dB of the measured sound pressure level data, such noise floor measurements shall be recorded.

9) At the end of the sound survey, monitor and record the battery condition of the calibrator and all measuring instruments. Near the measurement site, measure and record:

A) Windspeed and direction,

B) Ambient temperature,

C) Relative humidity, and

D) Barometric pressure.

10) If necessary for investigatory purposes, record:

A) The physical and topographical description of the ground surface within the vicinity of the measurement site,

B) Survey site location,

C) A description of the sound source,

D) A diagram of the area,

E) Location of reflective surfaces near the microphone, and

F) The approximate location of the sound source relative to the microphone position.

11) Data acquisition and operation may include, but is not limited to, any method given in a subsequent Section herein.

(Agency Note: 35 Ill. Adm. Code 900.102 prohibits noise that unreasonably interferes with the enjoyment of life or with any lawful business or activity, and 35 Ill. Adm. Code 900.102 is not dependent upon utilization of specific numerical limits expressed in terms of decibels. Thus, applicable law does not necessarily require that sound pressure level measurements be obtained to determine whether a noise source is in compliance with 35 Ill. Adm. Code 900.102. In the event sound pressure level measurements are obtained, such measurements shall be in accordance with this report. However, the contents of this report shall not be interpreted so as to require sound pressure level measurements to determine whether a noise source is in compliance with 35 Ill. Adm. Code 900.102.)

Section 951.105 Measurement Techniques for 35 Ill. Adm. Code 901

a) Site Selection

1) Measurements may be taken at one or more microphone positions within the appropriate receiving land. Measurement instruments shall be set up outdoors within the boundaries of the receiving land for the purpose of determining whether a noise source is in compliance.

2) Measurement instruments shall be set up not less than 25 feet (7.6 meters (m)) from the property-line-noise-source. The 25-foot (7.6 m) set back requirement is from the noise source and not the property line unless the noise source is contiguous to the property line. See Appendix B.

3) Other measurement locations may be used for investigatory purposes such as, but not limit to, the following:

A) Determining the extent of noise pollution caused by the source of sound,

B) Determining the ambient, and

C) Analyzing those acoustical parameters that describe the sound source.

4) For measurements of sound sources with no audible discrete tones, microphones should not be set up less than 25 feet (7.6 m) from any reflective surface which may affect data. If measurements must be taken within 25 feet (7.6 m), the effect, if any, of the reflective surface on the measured data must be determined.

5) For measurements of sound sources with audible discrete tones microphones should not be set up less than 50 feet (15.2 m) from any reflective surface which may affect data. If measurements must be taken within 50 feet (15.2 m), the effect, if any, of the reflective surface on the measured data must be determined.

6) Objects with small dimensions (trees, posts, bushes, etc.) should not be within 5 feet (1.5 m) of the microphone position. If measurements must be taken within 5 feet (1.5 m) of such objects, the effect, if any, on the measured data must be determined.

b) Instrumentation Set Up

After a measurement site has been chosen, a tripod shall be set over the site. The tripod shall be extended to a height between 3 feet 8 inches (1.12 m) and 4 feet 10 inches (1.47 m) above ground. A microphone shall be attached to the appropriate end of a 5-foot (1.5 m) or longer cable and shall be affixed to the top of the tripod. The other end of the cable shall be connected to the measuring instrument. The measuring instrument should be separated from the microphone so as to minimize any influence on the measurements. The cable movement must be minimized during the measurement period.

c) Data Acquisition and Operation

1) Before taking sound pressure level measurements, measure and record (near the measurement site):

A) Wind speed and direction,

B) Ambient temperature,

C) Relative humidity, and

D) Barometric pressure.

2) Turn the measuring instrument on and allow the instrument to stabilize. Monitor and record the battery condition of the calibrator and all measuring instruments.

3) Turn the calibrator on at its appropriate frequency. Allow the calibrator to stabilize and calibrate the measuring system according to the manufacturer's specifications. After the measuring system has been calibrated, remove the calibrator and attach a suitable windscreen to the microphone.

4) Adjust the microphone to the angle of incidence that will yield the flattest frequency response in accordance with the manufacturer's specifications.

5) Measure the sound pressure level data within the limitations of subsection (d) and according to the manufacturer's recommended procedures. Other sound pressure levels may be used for investigatory purposes such as, but not limited to, the following:

A) Determining the extent of noise pollution caused by the source of sound,

B) Determining the ambient, and

C) Analyzing those acoustical parameters that describe the sound source.

(Agency Note: If a conflict should arise, the limitations of subsection (d) supercede the manufacturer's specifications.)

6) While sound measurements are being taken, the operator must be separated from the microphone so as to minimize any influence on the measurements.

7) While measurements are being taken, visual and aural surveillance of extraneous sound sources and varying wind conditions should be made to insure that the conditions of measurement are accurately known. Record any variations in these parameters that may affect data.

8) To minimize wind effects on the microphone, sound measurements shall not be taken when the wind velocity is greater than 12 miles per hour (5.4 m/second) at the microphone position.

9) For the purposes of data correction, determine the ambient sound at the measurement site by means of measurement or analysis.

10) After taking sound pressure level measurements, remove the windscreen and attach the calibrator to the microphone. Turn the calibrator on at its appropriate frequency. After allowing the calibrator to stabilize, monitor and record the measuring system response. When the measuring system response varies by more than $\pm$ 0.5 dB from the most recent field calibration, the sound pressure level measurements obtained since such most recent field calibration shall not be used for enforcement purposes.

11) Before removing the calibrator from the microphone, turn the calibrator off. If the ambient has not been determined by means of measurement, determine the noise floor of the measuring system. If the noise floor is within 10 dB of the measured sound pressure level data, such noise floor measurements shall be recorded.

12) At the end of the sound survey, monitor and record the battery condition of the calibrator and all measuring instruments. Near the measurement site, measure and record:

A) Windspeed and direction,

B) Ambient temperature,

C) Relative humidity, and

D) Barometric pressure.

13) Record the physical and topographical description of the ground surface within the vicinity of the measurement site, survey site location, a description of the sound source, a diagram of the area, the location of reflective surfaces near the microphone, and the approximate location of the noise source relative to the microphone position.

14) Laboratory analyses may be performed on magnetic tape recorded field data. A description of the laboratory instrumentation and procedures shall be recorded. Analyses used in the laboratory shall be correlated to field measurement techniques.

d) Limiting Procedures for Specific Types of Data Acquisition

1) For measurements of non-impulsive sound with audible discrete tones, one-third octave band sound pressure levels shall be obtained in determining whether a noise source is in compliance with 35 Ill. Adm. Code 901.106 of the Noise Regulations.

2) For measurements of non-impulsive sound with no audible discrete tones, octave band sound pressure levels shall be obtained in determining whether a noise source is in compliance with 35 Ill. Adm. Code 901.102 and 901.103 of the Noise Regulations.

3) Steady sound:

A) For measurements of steady sound at one or more octave or one-third octave bands, sound pressure level measurements shall be obtained for such octave or one-third octave bands. The average of the maximum and minimum sound pressure levels shall be obtained for each octave or one-third octave band center frequency during the period of observation (See Appendix C, Figure 1).

B) For measurements of steady sound that varies between two or more levels when observed using the "fast" or "slow" meter characteristic, the average sound pressure level for the steady level of interest shall be obtained (See Appendix C, Figure 2).

C) For steady sound whose duration is five seconds or more the "fast" or "slow" meter characteristic shall be used. For levels that are steady for one to five seconds the "fast" meter characteristic shall be used.

4) Fluctuating Sound:

A) For measurements of fluctuating sound at one or more octave or one-third octave bands where the fluctuations on the indicating meter are between ± 3 dB and ± 5 dB ("slow" meter characteristic), obtain the sound pressure level 3 dB below the maximum level. This corresponds to the root mean square (rms) sound pressure level and shall be obtained for such octave or one-third octave bands (See Appendix C, Figure 3). When successive fluctuations are observed to have different maximum levels, obtain the sound pressure level 3 dB below the mean of the maximum levels for several excursions.

B) For measurements of fluctuating sound at one or more octave or one-third octave bands where the fluctuations on the indicating meter are greater than ± 5 dB, the sound pressure level may deviate from the true rms value by several decibels (See Appendix D, Figure 1). The recorded level shall be obtained by reading the maximum level of the sound level meter 10 or more times during the period of observation. The recorded level shall be obtained from the following equation:

$$L = 10 \log \frac{1}{N} \sum_{i=1}^{N} 10^{L_i/10}$$

where

N = the total number of observations

L_i = the maximum level at each observation

C) For measurements of fluctuating sound that varies between two or more levels when observed using the "slow" meter characteristic, the measurement methods specified in subsection (d)(4)(A) or (D)(4)(B), may be used to obtain sound pressure levels for the fluctuating level of interest (See Appendix D, Figure 2).

5) Intermittent Sound: For measurements of intermittent sound the methods specified in subsections (d)(1), (d)(2), (d)(3) or (d)(4) shall be used during the time the sound exceeds the ambient level (See Appendix D, Figure 3).

6) Impulsive Sound: For measurements of impulsive sound, A-weighting and the "fast" meter characteristic shall be used. The maximum excursion of the indicating meter shall be obtained. Measurements may also be

taken using other weightings and meter characteristics for informational purposes (See Appendix E, Figure 1).

7) Quasi-Steady Sound: For measurement of quasi-steady sound, A-weighting and the "fast" meter characteristic shall be used. The maximum excursion of the indicating meter shall be obtained. Measurements may also be taken using other weightings and meter characteristics for informational purposes (See Appendix E, Figure 2).

e) Correction Factors

If necessary, correction factors rounded to the nearest 1/2 decibel shall be applied to sound pressure level measurements. The correction factors applicable to the measurement system may include, but are not limited to, corrections for windscreen interference and the sound pressure level difference between consecutive field calibrations. Such calibration correction factors shall only be used to make negative corrections (subtraction from the field data). In no case shall such calibration correction factors be added to the measured sound pressure levels so as to raise the sound pressure level field data. The correction factors applicable to the measurement site may include, but are not limited to, corrections for reflective surfaces and ambient sound.