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Publication NPC-103

Procedures

1. Scope

This Publication comprises the various measurement procedures to be used in connection with other Publications which provide limits or standards for sound or vibration. Several of the procedures adopted are those of nationally or internationally recognized agencies. Table 103-1 lists the measurement procedures which are included in this Publication.

TABLE 103-1

NPC - 103 Section	Type of Measurement	Procedure
3	Steady or Impulsive Sound	Ministry
4	Varying Sound	Ministry
5	Sound and Vibration from Blasting	Ministry
6	Powered Mobile Construction Equipment	SAE J88a
7	Pneumatic Equipment	MEMAC
8	Small Engines	SAE J1046
9	Trucks with Governed Diesel Engines	CSA 107.22-M

2. Technical Definitions

The technical terms used in a procedure shall have the meaning given either in that procedure or in Publication NPC-101 - Technical Definitions.

3. Procedure for Measurement of Steady or Impulsive Sound

(1) (a) **Classification**

For the purposes of this procedure sounds can conveniently be placed in four mutually exclusive categories as follows:

- (i) impulsive sounds, other than Quasi-Steady Impulsive Sounds, such as, but not limited to, the sound from gunshots, certain explosive pest control devices and certain industrial metal working operations (e.g. forging, hammering, punching, stamping, cutting, forming and moulding);
- (ii) Quasi-Steady Impulsive Sounds, such as, but not limited to, the sound from pavement breakers, rivetting guns, ineffectively muffled internal combustion engines or ineffectively muffled air compressors;
- (iii) buzzing sounds, such as, but not limited to, the sounds from positive displacement blowers, chain saws, small combustion engines and concrete finishers;
- (iv) all other sounds.

(b) **Application**

This procedure applies to measurements at a point of reception of:

- (i) sound of a type mentioned in category (i) or (ii) of clause (a); and
- (ii) sound of a type mentioned in categories (iii) or (iv) of clause (a), which is always higher than the permissible level or which, when the sound is present, does not vary in level over a range of more than 6 dB during the period of observation.

(2) **Instrumentation**

(a) **Sound Level Meter**

- (i) An Impulse Sound Level Meter shall be used for the measurement of sound in category (i), (ii) or (iii) of clause 3(1) (a).
- (ii) A General Purpose Sound Level Meter shall be used for the measurement of sound in category (iv) of clause 3(1) (a).

NOTE: An Integrating Sound Level Meter may be used for the measurement of sound in category (iv) of clause 3(1)(a), but the procedure set out in section 4 - Procedure for Measurement of Varying Sound must be used.

(b) **Calibrator**

An Acoustic Calibrator shall be used.

(c) **Windscreen**

A windscreen shall be used in all outdoor measurements.

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(3) **Measurement Location**

For sound transmitted solely through air, the measurement location shall be one or more of the following points of reception:

- (a) a location out-of-doors where a person may be exposed to the sound; or
- (b) the plane of an exterior door or window of a room in which a person may be exposed to the sound, where the door or window is open.

(4) **Use of Instrumentation**

(a) **Battery Check**

If the sound level meter is battery powered the condition of the battery shall be checked after the meter has been allowed to warm up and stabilize. The battery condition shall be rechecked at least once per hour during a series of measurements and at the conclusion of such measurements.

The meter shall not be used unless the battery condition is confirmed to be within the range recommended by the manufacturer for proper operation.

(b) **Calibration**

The sound level meter shall be calibrated after the meter has been allowed to warm up and stabilized at least once per hour during a series of measurements and at the conclusion of such measurements.

(c) **Sound Level Meter Settings**

Measurements shall be taken using the following response settings:

(i) **Impulse Response (dBA I)**

The impulse response and A-weighting shall be used for impulsive sound in category (i) of clause 3 (1)(a). An "impulse hold" facility may be used if available on the meter.

(ii) **Slow Response (dBA)**

The slow response and A-weighting shall be used for sound in categories (ii), (iii) or (iv) of clause 3 (1)(a).

(d) **Instrument Configuration**

(i) **Reflective Surfaces**

The microphone shall be located not less than 1 m above the ground, not less than 1 m from any sound reflective surface except for the purposes of clause 3(3)(b) and not less than arm's length from the body of the person operating the meter. Not more than one person, other than the operator of the meter, shall be within 7 m of the microphone and that person shall be behind the operator of the meter.

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For the case of clause 3(3)(b) the microphone shall be in the middle of the aperture located not less than 15 cm from the window frame or door frame.

(ii) **Microphone Orientation**

The microphone shall be oriented such that the sound to be measured is incident at an angle recommended by the microphone manufacturer for flattest frequency response in a free field.

(e) **Measurement - Slow Response**

(i) **Readings Taken**

For sound in categories (ii), (iii) or (iv) of clause 3 (1)(a), a minimum of three observations with a minimum observation time of 15 s each shall be made. The observed average reading for each of the observations shall be noted as well as the minimum and the maximum of the range of sound levels during each observation period. If the difference between any two observed average readings is greater than 3 dB, a minimum of six observations shall be made. For the purpose of adjustments for intermittency the duration of the sound in any one hour shall be noted.

(ii) **Readings Reported**

The arithmetic mean of the observed average readings shall be reported, rounded to the nearest decibel. Adjustments for intermittence and quality of sound shall be made in accordance with Publication NPC-104 - Sound Level Adjustments, and the result shall be reported. The result is the one hour equivalent sound level (L_{eq}) of the sound under study for any one hour period during which the readings were taken pursuant to subclause (i).

(iii) **Wide Variation of Sound Levels**

If, in making observations pursuant to subclause (i), there is a difference of more than 6 dB between the lowest and highest values of the observed ranges of sound levels, this procedure shall not be used unless the lower limit of each such range is above the maximum permissible level. Instead, the procedure set out in Section 4 - Procedure for Measurement of Varying Sound at a point of reception, shall be used.

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- (f) **Measurement - Impulse Response - Frequent Impulses**
- (i) **Readings Taken**
For sound in category (i) of clause 3 (1) (a) not less than 20 impulses shall be measured within a continuous period of 20 minutes and each measurement taken shall be reported.
 - (ii) **Extension of Time**
Where a minimum of 20 impulses cannot be measured within a continuous period of 20 minutes pursuant to subclause (i) the time period may be extended to 2 hours if an impulse occurred in each of the four consecutive periods of five minutes each during the initial 20 minute measurement period.
 - (iii) **Level Reported**
The Logarithmic Mean Impulse Sound Level (LLM) of the 20 or more measurements shall be calculated and reported to the nearest decibel. This Logarithmic Mean Impulse Sound Level is a valid and effective sound level for any one hour period during which readings were taken pursuant to subclauses (i) and (ii).
- (g) **Measurement - Impulse Response - Single Event**
Readings Taken and Reported for impulsive sounds in category (i) of clause 3(1)(a), that occur as single, seemingly independent events not normally measurable using the procedure set out in clause (f) for frequent impulses, each impulse shall be independently measured and each impulse sound level reported to the nearest decibel.
- (h) **Variation in Calibration**
Measurements shall not be reported if the sound level meter calibration has changed more than 0.5 dB from the previous calibration.
- (i) **Weather Conditions**
- (i) **Wind**
Measurements shall not be taken unless the wind-induced sound level is more than 10 dB below the measured levels. Reference should be made to Publication NPC-102 - Instrumentation, particularly Table 102-3.
 - (ii) **Humidity**
Measurements shall not be taken if the relative humidity is above the maximum for which the meter specification is guaranteed by the manufacturer (normally 90%) .
 - (iii) **Precipitation**
Measurements shall not be taken during precipitation.
 - (iv) **Temperature**
Measurements shall not be taken when the air temperature is outside the range for which the specification of the instrument is guaranteed by the manufacturer. (Normally, only the lower temperature limit is significant.)

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(5) **Documentation**

The following represents the minimum information which shall be contained in a report of an investigation where the above procedure was used. (Adapted from CSA Z107.2-1973 Methods for the Measurement of Sound Pressure Levels.)

(a) **Acoustic Environment**

- (i) Location and description of sound sources.
- (ii) Dimensioned sketch including photographs, if possible, of the location of the sound source and the point of reception, showing all buildings, trees, structures and any other sound reflective surfaces.
- (iii) Physical and topographical description of the ground surface.
- (iv) Meteorological conditions prevailing at the time of the investigation including approximate local wind speed in km/h, wind direction, air temperature in °C, approximate relative humidity and extent of cloud cover.

(b) **Instrumentation**

All the equipment used for making sound level measurements shall be listed, including:

- (i) type, model and serial number of sound level meter;
- (ii) type, model and serial number of microphone;
- (iii) type, model and serial number of Acoustic Calibrator;
- (iv) extension cables and additional amplifier, if used.

(c) **Acoustical Data**

The measurement details shall be described, including:

- (i) the location of the microphone, using a sketch if necessary;
- (ii) measurements or readings obtained, preferably listed in tabular form, referencing location on a sketch or map, time periods involved, and relevant data required for making calculations;
- (iii) adjustments made for quality of sound or intermittence;
- (iv) details of any calculations;
- (v) comparison with applicable sound level limits, standards or guidelines.

4. Procedure for Measurement of Varying Sound

(1) (a) **Classification**

For the purposes of this procedure sounds can conveniently be placed in four mutually exclusive categories as follows:

- (i) impulsive sounds, other than Quasi-Steady Impulsive Sounds, such as, but not limited to, the sound from gunshots, certain explosive pest control devices and certain industrial metal working operations (e.g. forging, hammering, punching, stamping, cutting, forming and moulding);
- (ii) Quasi-Steady Impulsive Sounds, such as, but not limited to, the sound from pavement breakers, rivetting guns, ineffectively muffled internal combustion engines or ineffectively muffled air compressors;
- (iii) buzzing sounds, such as, but not limited to the sound from positive displacement blowers, chain saws, small combustion engines and concrete finishers;
- (iv) all other sounds.

(b) **Application**

This procedure applies to measurements at a point of reception of continuous or intermittent sound mentioned in category (ii), (iii) or (iv) of clause (a).

(2) **Instrumentation**

(a) **Integrating Sound Level Meter**

An Integrating Sound Level Meter shall be used which is appropriate for the sound to be measured:

- (i) Either a Type A or Type B Integrating Sound Level Meter may be used for the measurement of sound in category (iv) of clause 4(1)(a);
- (ii) A Type A Integrating Sound Level Meter shall be used for the measurement of sound in categories (ii) or (iii) of clause 4(1)(a).

(b) **Calibrator**

An Acoustic Calibrator shall be used.

(c) **Windscreen**

A windscreen shall be used in all outdoor measurements.

(3) **Measurement Location**

(a) **Air-Borne Sound**

For sound transmitted solely through air, the measurement location shall be one or more of the following points of reception:

- (i) a location out-of-doors where a person may be exposed to the sound; or
- (ii) the plane of an exterior door or window of a room in which a person may be exposed to the sound, where the door or window is open.

(4) **Use of Instrumentation**

(a) **Battery Check**

If the Integrating Sound Level Meter uses a battery, the condition of the battery shall be checked before each measurement, and measurement shall not commence unless the battery has sufficient life remaining to permit proper operation for a period of at least one hour.

(b) **Calibration**

The Integrating Sound Level Meter shall be calibrated before and after each measurement period.

(c) **Instrument Configuration**

(i) **Reflective Surfaces**

The microphone shall be located not less than 1 m above the ground, not less than 1 m from any sound reflective surface except for the purposes of subclause 4(3)(a)(ii) and not less than arm's length from the body of the person operating the meter. Not more than one person, other than the operator of the meter, shall be within 7 m of the microphone and that person shall be behind the operator of the meter. For the case of subclause 4(3)(a)(ii) the microphone shall be in the middle of the aperture located not less than 15 cm from the window frame or door frame.

(ii) **Microphone Orientation**

The microphone shall be oriented such that the sound to be measured is incident at an angle recommended by the microphone manufacturer for flattest frequency response in a free field.

(d) **Extraneous Sources**

When measuring the sound from a source, integration shall from time to time be inhibited by the operator immediately when the received sound is dominated by sound from a source other than the source under study and it shall remain inhibited while such a condition persists and for at least 10 seconds thereafter. While integration is inhibited the elapsed time used to calculate the equivalent sound level shall not be allowed to accumulate.

(e) **Timing**

If the Integrating Sound Level Meter is not provided with an internal elapsed-time clock, the operator shall accumulate the elapsed time during the measurement period by means of a stop-watch or other time measuring device.

(f) **Readings**

(i) **Stationary Source**

When measuring the sound from a stationary source, measurements to be used in calculating results shall be taken during a continuous period not in excess of one hour and, for purposes of calculation and reporting of results, the accumulated elapsed time of measurement as obtained in accordance with clause (d) is deemed to be one hour if the accumulated time is 20 minutes or more. Measurements containing information from an accumulated time period of less than 20 minutes are insufficient for purposes of calculating the equivalent sound level (L_{eq}) of a stationary source.

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- (ii) **Road Traffic Noise Sources**

When measuring the sound from road traffic the accumulated elapsed time obtained in accordance with clause (d) shall not be less than twenty minutes and the actual accumulated elapsed time of measurement shall be used for purposes of calculation.
- (g) **Adjustments**

Adjustments for quality of sound shall be made in accordance with Publication NPC-104 - Sound Level Adjustments and the result reported. No adjustment shall be made for intermittence.
- (h) **Variation in Calibration**

A measurement shall not be reported if the Integrating Sound Level Meter calibration after the measurement period is more than 0.5 dB different from that before the measurement commenced.
- (i) **Weather Conditions**
 - (i) **Wind**

Measurements shall not be made unless the wind-induced sound level is more than 10 dB below the measured levels. Reference should be made to Publication NPC-102-Instrumentation and particularly Table 102-3.
 - (ii) **Humidity**

Measurements shall not be taken if the relative humidity is above the maximum for which the meter specification is guaranteed by the manufacturer (normally 90%).
 - (iii) **Precipitation**

Measurements shall not be taken during precipitation.
 - (iv) **Temperature**

Measurements shall not be taken when the air temperature is outside the range for which the specification of the instrument is guaranteed by the manufacturer. (Normally, only the lower temperature limit is significant.)
- (j) **Readings Reported**
 - (i) For sound from a stationary source, the value to be reported based on Measurements made during the accumulated elapsed time of 20 minutes or more and the time period for calculation which is one hour is, after adjustment in accordance with clause (g), the one hour equivalent sound level (L_{eq}) of the sound under study for any one hour period during which measurements were taken pursuant to subclause 4(4)(f)(i).

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- (ii) For sound from road traffic, the value to be reported based on measurements made during the accumulated elapsed time of 20 minutes or more and the time period for calculation which is the actual accumulated elapsed time, is the one hour equivalent sound level (L_{eq}) of the sound under study for any one hour period during which measurements were taken pursuant to subclause 4(4)(f)(ii).
- (iii) The one hour equivalent sound level (L_{eq}) shall be reported to the nearest decibel.

(5) **Documentation**

The following represents the minimum information which shall be contained in a report of an investigation where the above procedure was used. (Adapted from CSA Z107.2-1973 Methods for the Measurement of Sound Pressure Levels.)

(a) **Acoustic Environment**

- (i) Location and description of sound sources.
- (ii) A list of the types of extraneous noise sources which caused integration to be inhibited during measurement.
- (iii) Dimensioned sketch including photographs, if possible, of the location of the sound source and the point of reception, showing all buildings, trees, structures and any other sound reflective surfaces.
- (iv) Physical and topographical description of the ground surface.
- (v) Meteorological conditions prevailing at the time of the investigation including approximate local wind speed in km/h, wind direction, air temperature in °C, approximate relative humidity and extent of cloud cover.

(b) **Instrumentation**

All the equipment used for making sound level measurements shall be listed, including:

- (i) type, model and serial number of Integrating Sound Level Meter;
- (ii) type, model and serial number of microphone;
- (iii) type, model and serial number of Acoustic Calibrator;
- (iv) extension cables and additional amplifier, if used.

(c) **Acoustical Data**

The measurement details shall be described, including:

- (i) the location of the microphone, using a sketch if necessary;
- (ii) the continuous time period of observation;
- (iii) the accumulated elapsed time of measurement following the procedure of clauses 4(q)(d) and (e);

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- (iv) the Integrating Sound Level Meter reading or output and any other relevant data required for calculations;
- (v) adjustments made for quality of sound;
- (vi) details of all calculations;
- (vii) the equivalent sound levels obtained, preferably listed in tabular form, referencing location on a sketch or map;
- (viii) comparison with applicable sound level limits, standards or guidelines.

5. **Procedure for Measurement of Sound and Vibration Due to Blasting Operations**

(1) **Application**

This procedure applies to the measurement of sound (concussion) and vibration due to blasting operations.

(2) **Sound**

(a) **Instrumentation**

(i) **Measuring Device**

A Peak Pressure Level Detector shall be used.

(ii) **Calibrator**

An Acoustic Calibrator shall be used .

(iii) **Windscreen**

A windscreen shall be used in all outdoor measurements.

(b) **Measurement Location**

The measurement location shall be at a point of reception out-of-doors within 7 m of a building.

(c) **Use of Instrumentation**

(i) **Battery Check**

If the measuring device is battery powered, the condition of the battery shall be checked after the device has been allowed to warm up and stabilize and after each measurement has been made. The device shall not be used unless the battery condition is confirmed to be within the range recommended by the manufacturer for proper operation.

(ii) **Calibration**

The measuring device shall be calibrated after it has been allowed to warm up and stabilize and after each measurement has been made.

(iii) **Meter Setting**

The measuring device shall be set to read the peak pressure level using linear response and a "hold" facility, if available.

(d) **Instrument Configuration**

(i) **Reflective Surfaces**

The microphone shall be located not less than 1 m above the ground, not less than 1 m from any sound reflective surface and not less than arm's length from the body of the person operating the device. Not more than one person, other than the operator of the meter, shall be within 7 m of the microphone and that person shall be behind the operator of the meter.

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- (ii) **Microphone Orientation**

The microphone shall be oriented such that the concussion wave to be measured is incident at an angle recommended by the microphone manufacturer for flattest frequency response in a free field.
- (e) **Readings**
 - (i) **Peak Pressure Level**

The value of peak pressure level reported shall be given to the nearest decibel.
 - (ii) **Variation in Calibration**

A measurement shall not be reported if the meter calibration after the measurement is more than 0.5 dB different from that before the measurement.
 - (iii) **Battery Deterioration**

A measurement shall not be reported if the battery condition after the measurement is not within the range recommended by the manufacturer for proper operation.
- (f) **Weather Conditions**
 - (i) **Wind**

Measurements shall not be reported unless the wind-induced sound pressure level is more than 10 dB below the measured peak pressure level. Reference should be made to Publication NPC-102 - Instrumentation.
 - (ii) **Humidity**

Measurements shall not be taken if the relative humidity is above the maximum for which the meter specification is guaranteed by the manufacturer (normally 90%).
 - (iii) **Precipitation**

Measurements shall not be taken during precipitation.
 - (iv) **Temperature**

Measurements shall not be taken when the air temperature is outside the range for which the meter specification is guaranteed by the manufacturer. (Normally only the lower temperature limit is significant.)
- (3) **Vibration**
 - (a) **Instrumentation**
 - (i) **Measuring Device**

A Vibration Velocity Detector shall be used.
 - (ii) **Calibrator**

An electrical reference signal of known voltage and frequency shall be used in the field for calibration of the Vibration Velocity Detector excluding the transducer. A reference vibration source shall be used for laboratory calibration of the complete Vibration Velocity Detector.

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- (b) **Measurement Location**

Vibration measurements shall be made at a point of reception inside a building below grade or less than 1 m above grade, preferably on a basement floor close to an outside corner.
- (c) **Use of Instrumentation**
 - (i) **Battery Check**

If the measuring device is battery powered, the condition of the battery shall be checked after the device has been allowed to warm up and stabilize and after each measurement has been made. The device shall not be used unless the battery condition is confirmed to be within the range recommended by the manufacturer for proper operation,
 - (ii) **Calibration**

Field calibration shall be carried out before and after each measurement. Laboratory calibration of the complete Vibration Velocity Detector as used in the field, including the transducer, shall be carried out not less than once per calendar year and the results certified.
- (d) **Instrument Configuration**
 - (i) **Mounting**

The transducer shall be affixed to a part of the structure so as to prevent movement of the transducer relative to the structure. The preferred structural element is the basement floor as indicated in clause (b),
 - (ii) **Transducer Orientation**

If three vector components of vibration velocity are recorded individually, it is preferable to orient the transducers such that the three axes of measurement are (a) vertical, (b) radial (along a horizontal line joining the location of the blast to the location of measurement) and, (c) transverse (along a horizontal line at right angles to the line joining the location of the blast to the location of measurement).
- (e) **Readings**
 - (i) **Peak Particle Velocity**

The peak particle velocity in cm/s shall be reported.
 - (ii) **Variation in Calibration**

A measurement shall not be reported if calibration after the measurement is more than 5% different from that before the measurement.

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(iii) **Battery Deterioration**

A measurement shall not be reported if the battery condition after the measurement is not within the range recommended by the manufacturer for proper operation.

(4) **Documentation**

The following represents the minimum information which shall be contained in a report of an investigation where the above procedure was used.

(a) **Description of Area**

- (i) Location and description of the blasting operation.
- (ii) Dimensioned sketch including photographs, if possible, of the location of the blasting operation, the nearest premises and the measurement location.
- (iii) Description of the measurement location.
- (iv) Physical and topographical description of the ground surface.
- (v) Meteorological conditions at the time of the investigation, including approximate wind speed in km/h, wind direction, air temperature in degrees Celsius, approximate relative humidity, degree of cloud cover and whether or not a condition of thermal inversion prevailed.

(b) **Instrumentation**

All the equipment used for making sound and vibration measurements shall be listed, including:

- (i) type, model and serial number of Peak Pressure Level Detector;
- (ii) type, model and serial number of microphone;
- (iii) type, model and serial number of Acoustic Calibrator;
- (iv) windscreen;
- (v) extension cables and additional amplifiers, if used;
- (vi) type, model and serial number of Vibration Velocity Detector;
- (vii) type, model and serial number of transducers.
- (viii) type, model and serial number of vibration calibrator.

(c) **Sound and Vibration Data**

The measurement details shall be described, including:

- (i) the location where measurements were taken, the time period involved and the orientation of instrumentation using a sketch, if necessary;
- (ii) details of all calculations;
- (iii) the peak pressure level in dB and/or peak particle velocity in cm/s
- (iv) comparison with applicable peak pressure limits and/or peak particle velocity limits.

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6. **Exterior Sound Level Measurement Procedure For Powered Mobile Construction Equipment - SAE J88a**

SAE J88a Recommended Practice is adopted by the Ministry with the following change:

Where ANSI Type 1 sound level meter specification is referred to, reference shall be made instead to Publication IEC-179 (1973) for Precision sound level meters. (General Purpose Sound Level Meter)

7. **MEMAC Test Code For the Measurement of Sound From Pneumatic Equipment**

The MEMAC Test Code For The Measurement Of Sound From Pneumatic Equipment is adopted by the Ministry with the following additional requirement:

For measurement of percussive machines the sound level meter used shall meet the specifications of IEC Publications 179 and 179A (1973). (Impulse Sound Level Meter)

8. **Exterior Sound Level Measurement Procedure For Small Engine Powered Equipment - SAE J 1046**

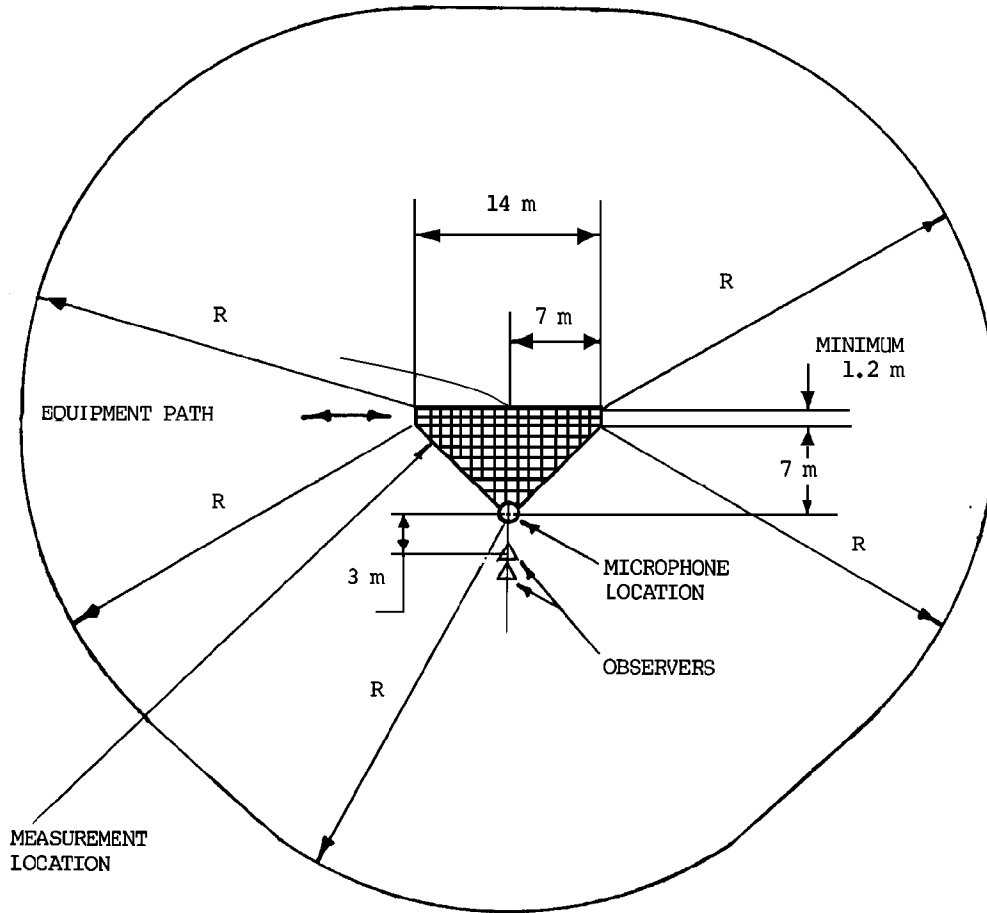
SAE J 1046 - Recommended Practice, is adopted by the Ministry with the following changes:

- (1) Where ANSI Type 1 sound level meter specification is referred to, reference shall be made instead to IEC Publications 179 and 179A (1973). (Impulse Sound Level Meter)
- (2) Replace clause 3.1.1 with the following:
The minimum dimensions of the measurement zone are defined as a path of travel 1.2 m wide by 14 m long plus an adjacent area having the base along the edge of the path of travel and the apex 7 m from the midpoint of the base.
- (3) Replace Fig. 1 with Fig. 103-1, hereof.
- (4) In section 3.3 Measurements, all references to 25 ft. shall be changed to 7 m.

9. **Procedure for Measurement of the Maximum Exterior Sound Level of Stationary Trucks with Governed Diesel Engines-CSA Z107.22-M1977**

- (1) CSA Z107.22-M1977 standard is adopted by the Ministry with the following change:

A General Purpose Sound Level Meter shall be used.



REF. US EPA 550/9-74-011

R = 30 m MINIMUM RADIUS

FIGURE 103 - 1 : TEST SITE CONFIGURATION FOR EXTERIOR SOUND LEVEL MEASUREMENT PROCEDURE FOR SMALL ENGINE POWERED EQUIPMENT - SAE J 1046