Publication NPC-102

Instrumentation

1. Scope

This Publication sets out minimum specifications for equipment used for the measurement of sound and vibration. For most of the specifications the International Electrotechnical Commission (IEC) recommended standards 123 (First edition 1961), 179 (Second edition 1973) and 179A (First supplement to IEC 179, published 1973) have been adopted. In some cases, these standards are amended or augmented for greater precision.

TABLE 102-1

NPC - 102 Section	Type of Instrument	Application
3	General Purpose Sound Level Meter	Non-Impulsive Sounds
4	Impulse Sound Level Meter	Impulsive Sounds
5	Peak Pressure Level Detector	Peak Pressure Perturbations
6	Type B Integrating Sound Level Meter	Varying Sounds of Low Crest Factor
7	Type A Integrating Sound Level Meter	Varying Sounds of High Crest Factor
8	Vibration Velocity Detector	Peak Vibration Velocity in Solids
9	Acoustic Calibrator	Calibration of Sound Level Meters

2. Technical Definitions

The technical terms used in this Publication are defined in the specifications themselves or in Publication NPC-101 - Technical Definitions.

3. General Purpose Sound Level Meter

(1) Purpose

A General Purpose Sound Level Meter is a sound level meter which is intended to be used for the measurement of non-impulsive sounds, without significant A-weighted acoustic energy above 2000 Hz.

(2) Specifications

A sound level meter which meets the following specifications is a General Purpose Sound Level Meter:

(a the sound level meter, including a microphone equipped with a windscreen shall meet the specifications of IEC 123, except that, in addition to meeting the specifications of subclause 5.2 thereof, the microphone of the sound level meter shall also meet the specifications of subclause 5.2 amended by the substitution therein of an angle of incidence of ±30° instead of ±90° it therein appears, and by the substitution of Table 102-2 hereof instead of Table 1 , as it therein appears;

(b) the sound level meter shall incorporate A-weighting, which is specified in IEC 123 as optional;

(c) the sound level meter shall have a minimum usable range of sensitivity of from 40 dBA to 100 dBA and it shall read to an accuracy of ±l.0 dB over that range;

(d) a windscreen shall be installed on the microphone and shall not affect by more than 1 dB the tolerance prescribed in clauses (a) and (c);

(e) the sound level meter, including a microphone equipped with a windscreen, shall , when operated in the presence of wind, indicate a wind-induced sound level not in excess of the relevant value listed in Table 102-3.

4. Impulse Sound Level Meter

(1) Purpose

An Impulse Sound Level Meter is a sound level meter which is intended to be used for the measurement of any sounds, including sounds for which a General Purpose Sound Level Meter may be used.

(2) Specifications

A sound level meter which meets the following specifications is an Impulse Sound Level Meter:

(a) the sound level meter, including a microphone equipped with a windscreen, shall meet the specifications of a General Purpose Sound Level Meter;

(b) the sound level meter, including a microphone equipped with a windscreen, shall meet the specifications of IEC 179 and IEC 179A, supplement to IEC 179, including the optional characteristics mentioned in subclause 4.5 of IEC 179A;

(c) the sound level meter shall incorporate A-weighting as specified in IEC 179.

5. Peak Pressure Level Detector

(1) Purpose

A Peak Pressure Level Detector is a sound level meter which is intended to be used for the measurement of peak pressure perturbations in air. The value indicated by this device is not an average of the pressure level perturbations.

(2) Specifications

A sound level meter which meets the following specifications is a Peak Pressure Level Detector (the features of this device are incorporated in an Impulse Sound Level Meter as specified in section 4 above):

(a) the microphone of the sound level meter, when equipped with a windscreen, shall perform within a tolerance of ±1 dB throughout the frequency range of from 5 Hz to 31.5 Hz in the circumstances and conditions for use set out in Table 1 of IEC 179;

(b) the sound level meter without the microphone shall be capable of providing linear response as specified in subclause 4.5 of IEC 179, within a tolerance of ±l dB throughout the frequency range of from 5 Hz to 15 kHz;

(c) the sound level meter shall incorporate the optional characteristics specified in subclause 9.5 of IEC 179A;

(d) the sound level meter shall meet the specifications set out in IEC 179 clause 3, subclauses 4.1, 4,2, 4.4, 4.5, 4.7, 4.8, clause 5, subclauses 6.2, 6.3, 6.4, 6.5, 6,8, 6.9, 7.1 through 7.9, 7.11, 8.1, 8.2, 8.3, 8.6 through 8.9, and the appropriate specifications of clause 10.

6. Type B Integrating Sound Level Meter

(1) Purpose

(a) An Integrating Sound Level Meter is a sound level meter which is intended to be used for the measurement of sound over a period of time, such that the equivalent sound level (L_{eq}) of the sound may be obtained.

(b) The Type B Integrating Sound Level Meter is specified with sufficient dynamic range and measurement precision to measure equivalent sound levels of general sounds that exceed limitations set out in this by-law.

(c) Either a Type A or Type B Integrating Sound Level Meter may be used for most such applications, but a Type A Integrating Sound Level Meter must be used when the sound under study is Quasi-Steady Impulsive Sound (see NPC-103 -

Procedures, sections 3 and 4) or when the operational dynamic range greatly exceeds 40 dB.

(2) General Description

The tolerances specified for the microphone, weighting and amplifier of a Type B Integrating Sound Level Meter are the same as those specified for a General Purpose Sound Level Meter in section 3 of this Publication. The computational portions of the instrument must operate within a net accuracy of ±l dB for time periods of 20 minutes to one hour over a dynamic range of at least 40 dB with test signals having a crest factor (as defined in IEC 179A) up to 3. An operator-activated switch is included to inhibit the integration function alone and, if the system includes an elapsed-time clock, to inhibit both the integration and time summation functions.

(3) Specifications

A sound level meter which meets the following specifications is a Type B Integrating Sound Level Meter:

(a) the instrument will generally be a combination of microphone, amplifier, A-weighting network, computation circuit to obtain the integral of the mean square A-weighted pressure, display and a means of inhibiting the integration, but may vary from the above provided that it performs the same functions within the tolerances set out below;

(b) the instrument may include computational circuitry to calculate and display the equivalent sound level directly;

(c) the microphone of the instrument shall meet the specifications of clause 5 of IEC 123, except that, in addition to meeting the specifications of subclause 5.2 thereof, the microphone shall also meet the specifications of subclause 5.2 amended by the substitution therein of an angle of incidence of ±30° instead of ±90° it therein appears, and by the substitution of Table 102-2 hereof instead of Table 1, as it therein appears;

(d) a windscreen shall be installed on the microphone during operation and shall not affect by more than 1 dB the tolerance prescribed in clause (c);

(e) the sound level meter, including a microphone equipped with a windscreen, shall , when operated in the presence of wind, indicate a wind induced sound level not in excess of the relevant value listed in Table 102-3.

(f) the A-weighting network shall meet the specifications of Table II and Figure I of IEC 123;

(g) the amplifier shall meet the specifications of subclauses 7.2, 7.3 and 7.1.1 of IEC 123;

(h) for each sensitivity setting of the instrument the amplifier shall have a power handling capacity at least 10 dB greater than the maximum sound level specified for that sensitivity setting;

(i) if the computation circuit is of the sampling (digital) type, when operating in conjunction with the microphone, windscreen, A-weighting network and amplifier, it shall generate a signal proportional to the mean square A-weighted pressure with a 1 ± 0.25 s exponential averaging time constant;

(j) the computation circuit shall integrate the mean square A-weighted pressure and shall be capable of doing so on each sensitivity setting for a minimum of 6 minutes at the maximum sound level specified for that sensitivity setting;

(k) if the computation circuit is not capable of meeting the specification of clause (j) with the reference therein to "6 minutes" changed to "60 minutes", then the device shall be provided with a means to indicate to the operator when the integration capability has been exceeded;

(l) if the computational circuit is of the sampling (digital) type, sampling shall take place at least twice per second;

(m) the computation circuit shall operate over the usable dynamic range of the instrument with a linearity of ±l dB for any sound with a ratio of peak pressure to root mean square pressure up to 3 (crest factor up to 3) ;

(n) an operator-activated switch shall be provided to inhibit integration or, if the instrument has an internal elapsed time clock, to inhibit both integration and accumulation of time;

(o) the combination of windscreen, microphone, A-weighting network, amplifier and computation circuit shall have a usable dynamic range extending at least from 50 dBA to 90 dBA and the manufacturer shall specify the usable dynamic range;

(p) the instrument may be provided with more than one sensitivity setting and the manufacturer shall specify the minimum and maximum input sound level for each sensitivity setting;

(q) if the maximum sound level specified for any sensitivity setting is less than 100 dBA, the system shall include a means of indicating to the operator that the maximum input sound level for that sensitivity setting has been exceeded and such indication shall be maintained until cancelled by the operator;

(r) the display shall indicate either,

- (i) an output proportional to the integrated mean square A-weighted pressure, or
- (ii) the integrated mean square A-weighted pressure divided by the duration of the period of time for which the equivalent sound level is to be determined, or

(iii) the equivalent sound level for the period of time for which the equivalent sound level is to be determined;

(s) it shall be possible: to read from the display or to calculate from the reading of the display, the equivalent sound level to a resolution of ±l dB over the usable dynamic range of the instrument for integration times from 20 minutes to 60 minutes;

(t) if the indication of the display is as described in subclause (ii) or (iii) of clause (r), the instrument shall include an elapsed-time clock;

(u) the complete instrument shall follow the recommendations and meet the specifications of subclauses 7.4, 7.5, 7.6, 7.7, 7.8 and 7.90 of IEC 123; and

(v) the instrument shall include a means of determining whether the battery of the instrument if any, has sufficient life to permit proper operation for a period of at least one hour.

7. Type A Integrating Sound Level Meter

(1) Purpose

(a) An Integrating Sound Level Meter is a sound level meter which is intended to be used for the measurement of sound over a period of time, such that the equivalent sound level (l_{eq}) of the sound may be obtained.

(b) The Type B Integrating Sound Level Meter is specified with sufficient dynamic range and measurement precision to measure equivalent sound levels of general sounds that exceed limitations set out in this by-law.

(c) Either a Type A or a Type B Integrating Sound Level Meter may be used for most such applications, but a Type A Integrating Sound Level Meter must be used when the sound under study is Quasi-Steady Impulsive Sound (see NPC-103 - Procedures, Sections 3 and 4) or when the operational dynamic range greatly exceeds 40 dB.

(2) General Description

The tolerances specified for the microphone, weighting and amplifier of a Type A Integrating Sound Level Meter are the same as those specified for a General Purpose Sound Level Meter in section 3 of this Publication. The computational portions of the instrument must operate within a net accuracy of ±l dB for time periods of 20 minutes to one hour over a dynamic range of at least 80 dB with test signals having a crest factor (as defined in IEC 179A) up to 5. An operator activated switch is included to inhibit both the integration and time summation functions.

(3) Specifications

A sound level meter which meets the following specifications is a Type A Integrating Sound Level Meter:

(a) the sound level meter shall meet the specifications of a Type B Integrating Sound Level Meter;

(b) the instrument shall be provided with an internal elapsed-time clock;

(c) for each sensitivity setting of the instrument, the amplifier shall have a power handling capacity at least 14 dB greater than the maximum sound level specified for that sensitivity setting;

(d) the computation circuit shall operate over the usable dynamic range of the instrument with a linearity of ±l dB for any sound with a ratio of peak pressure to root mean square pressure up to 5 (Crest Factor up to 5) ; and

(e) the combination of windscreen, microphone, A-weighting network, amplifier and computation circuit shall have a usable dynamic range extending at least from 40 dBA to 120 dBA,

8. Vibration Velocity Detector

(1) Purpose

A Vibration Velocity Detector is a device intended to be used for the measurement of the peak particle velocity of a solid surface.

(2) Specifications

A device which meets the following specifications is a Vibration Velocity Detector:

(a) the device shall include either a transducer which responds to the total vibration vector or three transducers which have their axes of maximum sensitivity mutually orthogonal ±1°;

(b) where three transducers are used to measure three mutually orthogonal components of vibration, the response of any one of the transducers to vibration in the plane normal to its axis of maximum sensitivity shall be less than 10% of its response to the same vibration along its axis of maximum sensitivity;

(c) the output of the device shall be proportional to the velocity of the surface on which the transducer is, or the transducers are, mounted and the output of the device shall be in such form that the device indicates, or can be used to calculate, the peak particle velocity in the frequency range of from 5 Hz to 500 Hz over a range of peak particle velocity of from 0.25 cm/s to 10 cm/s with a tolerance of ±IO% and

(d) it shall be possible to field-calibrate the device with an accuracy of ±5% using either a reference electrical signal in series with the equivalent transducer impedance or a reference vibration source.

9. Acoustic Calibrator

(1) Purpose

An Acoustic Calibrator is an electro-mechanical or mechanical device which produces sound of a known frequency and which, when coupled to a sound level meter, produces a predictable response in the sound level meter if the sound level meter is operating properly at the calibration frequency,

(2) Specifications

A device, capable of producing sound, which meets the following specifications is an Acoustic Calibrator:

(a) the device shall be capable of being physically attached to a sound level meter in such a way that the device and the sound level meter are "acoustically coupled", that is, sound from the device is transmitted through the air by way of a chamber formed by the attachment of the device to the microphone of the sound level meter;

(b) the device shall produce sound of a stated frequency, within a frequency tolerance of ±5%;

(c) the manufacturer of the device shall provide with the device, any data required in order to determine the sound level reading which should be indicated on the sound level meter when calibrated for those microphone and sound level meter types with which the manufacturer recommends the device be used. Where additional accessories must be used to provide this sound level reading, the manufacturer shall state that they must be used;

(d) the maximum tolerance in the sound pressure level generated by the device when coupled to the microphone shall apply over an atmospheric pressure range of 87 kPa to 107 kPa, and shall be ±O.5 dB over the temperature range of from 0°C to 40°C and ±l .0 dB over the temperature range of from -l0°C to 50°C;

(e) if the device is battery powered, means for checking the battery condition shall be included with the device;

(f) the following data shall be provided with the device by the manufacturer,
  (i) the nominal sound pressure level produced,
  (ii) the nominal frequency at which the device operates,
  (iii) the ranges of temperature and atmospheric pressure over which the device is intended to operate, and the applicable overall sound pressure level tolerance for these ranges.

TABLE 102-2

Permissible Tolerances on Microphone Sensitivity Over an Angle of ± 30°

Frequency (Hz)	Permissible Tolerances (dB)	
	A*	B**
31.5 - 500	±1	±1
1000	±1	±1
2000	±2	+1 - 2
4000	±4	+1 - 4
8000	±10	+1 - 10

* COLUMN A: The microphone is mounted on the sound level meter.

** COLUMN B: The microphone is physically separated from the sound level meter but electrically connected thereto.

TABLE 102-3

Maximum Wind Induced Sound Level Indication Using A-weighting and Slow Response (where available)

Wind Speed	dBA
15 km/h	41
20 km/h	48
25 km/h	53