Noise – Measurement of Workplace Noise Fact Sheets



WHY MEASURE NOISE IN THE WORKPLACE?

Measuring noise levels and workers' noise exposures is the most important part of a workplace hearing conservation and noise control program. It helps identify work locations where there are noise problems, employees who may be exposed to noise levels that can cause hearing loss, and where additional noise measurements need to be made. This information also helps determine appropriate noise control measures that need to be put in place.

How is workplace noise measured?

For occupational hygiene purposes, the sound pressure level is measured to determine noise exposures. Various instruments and techniques may be used. The choice depends on the workplace noise and the information needed. However, the first step is to determine if there is a noise problem in the workplace.

This document briefly outlines the steps involved in the noise measurement. For details, you should consult the current version of the Canadian Standard CSA Z107.56-13 (R2018) or the standard that applies in your jurisdiction.

How do you identify noise problems in the workplace?

The first step is to determine whether or not noise is a potential problem in your workplace. A walk-through survey is recommended. The indicators of potentially hazardous noise level include:

- Noise is louder than busy city traffic.
- People have to raise their voice to talk to someone at one metre (3 feet) away.
- At the end of work shift people have to increase the volume of their radio or TV to a level too loud for others.
- After working for a few years at that workplace, employees find it difficult to communicate in a crowd or party situation where there are other sounds or many voices.
- People hear a ringing or humming noise when they leave work.

Noise measurement data from studies in similar situations are very helpful in assessing the potential noise problem.

What things do you consider when planning noise measurement?

Before taking field measurements, it is important to determine the type of information required. The person making the measurement must understand:

- The purpose of measurement: compliance with noise regulations, hearing loss prevention, noise control, community annoyance etc.
- The sources of noise, and times when the sources are operating.
- The temporal pattern of noise – continuous, variable, intermittent, impulse.
- Locations of exposed persons.
- Conditions during both a typical and atypical shift (noise sources, activities, shift length, etc.)

The initial measurements are noise surveys to determine if:

- Noise problem exists.
- Further measurements are needed.

The second step is to determine personal noise exposure levels; that is, the amount of noise to which individual employees are exposed. If the workplace noise remains steady, workers are stationary throughout the shift, and measurements are representative of a typical day, the noise survey data can be used to determine if there is a potential exposure to harmful noise levels and if additional measurements are required. However, noise dosimetry (such as personal noise exposure measurements) is necessary if the workplace noise levels vary throughout the day or if the workers are fairly mobile.

What types of instruments are used for measuring noise?

The most common instruments used for measuring noise are the sound level meter (SLM), the integrating sound level meter (ISLM), and the noise dosimeter. It is important that you understand the calibration, operation and reading the instrument you use. The user’s manual provided by the instrument manufacturer provides most of this information. Table 1 provides some instrument selection guidelines.

Table 1
Guidelines for Instrument Selection

Type of Measurement	Appropriate Instruments (in order of preference)	Result	Comments

Personal noise exposure	**1) Dosimeter**	**Dose or equivalent sound level**	**Most accurate for personal noise exposures, and is worn by the worker.**
	2) ISLM*	**Equivalent sound level**	**If the worker is mobile, it may be difficult to determine a personal exposure, unless work can be easily divided into defined activities.**
	3) SLM**	**dBA**	**If noise levels vary considerably, it is difficult to determine average exposure. Only useful when work can be easily divided into defined activities and noise levels are relatively stable all the time.**
Noise levels generated by a particular source	**1) SLM**	**dBA**	**Measurement should be taken 1 to 3 metres from source (not directly at the source).**
	2) ISLM	**Equivalent sound level dBA**	**Particularly useful if noise is highly variable; it can measure equivalent sound level over a short period of time (1 minute).**
Noise survey	**1) SLM**	**dBA**	**To produce noise map of an area; take measurements on a grid pattern.**
	2) ISLM	**Equivalent sound level dBA**	**For highly variable noise.**
Impulse noise	**1) Impulse SLM**	**Peak pressure dBA**	**To measure the peak of each impulse.**

*** ISLM stands for Integrating Sound Level Meter**
**** SLM stands for Sound Level Meter**

What is a sound level meter (SLM)?

The SLM consists of a microphone, electronic circuits and a readout display. The microphone detects the small air pressure variations associated with sound and changes them into electrical signals. These signals are then processed by the electronic circuitry of the instrument. The readout displays the sound level in decibels. The SLM takes the sound pressure level at one instant in a particular location.

To take measurements, the SLM is held at arm's length at the ear height for those exposed to the noise. With most SLMs it does not matter exactly how the microphone is pointed at the noise source. The instrument's instruction manual explains how to hold the microphone. The SLM must be calibrated before and after each use. The manual also gives the calibration procedure.

With most SLMs, the readings can be taken on either SLOW or FAST response. The response rate is the time period over which the instrument averages the sound level before displaying it on the readout. Workplace noise level measurements should be taken on SLOW response.

A Type 2 SLM is sufficiently accurate for industrial field evaluations. The more accurate and much more expensive Type 1 SLMs are primarily used in engineering, laboratory and research work. Any SLM that is less accurate than a Type 2 should not be used for workplace noise measurement.

An A-weighting filter is generally built into all SLMs and can be switched ON or OFF. Some Type 2 SLMs provide measurements only in dBA, meaning that the A-weighting filter is ON permanently.

A standard SLM takes only instantaneous noise measurements. This is sufficient in workplaces with continuous noise levels. But in workplaces with impulse, intermittent or variable noise levels, the SLM makes it difficult to determine a person's average exposure to noise over a work shift. One solution in such workplaces is a noise dosimeter.

What is an integrating sound level meter (ISLM)?

The integrating sound level meter (ISLM) is similar to the dosimeter. It determines equivalent sound levels over a measurement period. The major difference is that an ISLM does not provide personal exposures because it is hand-held like the SLM, and not worn.

The ISLM determines equivalent sound levels at a particular location. It yields a single reading of a given noise, even if the actual sound level of the noise changes continually. It uses a pre-programmed exchange rate, with a time constant that is equivalent to the SLOW setting on the SLM.

What is a noise dosimeter?

A noise dosimeter is a small, light device that is worn by the worker with the microphone positioned above the outside edge of the wearer's shoulder, close to their ear. The dosimeter stores the noise level information and carries out an averaging

process. It is useful in industry where noise usually varies in duration and intensity, and where the person change's locations.

A noise dosimeter requires the following settings:

a. **Criterion Level:** exposure limit for 8 hours per day five days per week. Criterion level is 85 dBA for many jurisdictions, 90 dBA for Quebec and 87 dBA for Canadian federal jurisdictions.
b. **Exchange rate:** 3 dB or 5 dB as specified in the noise regulation.
c. **Threshold:** noise level limit below which the dosimeter does not accumulate noise dose data.

Wearing the dosimeter over a complete work shift gives the average noise exposure or noise dose for that person. This is usually expressed as a noise exposure level, Lex,T. This is a logarithm which takes into account the exposure and the actual time worked. In the past, it was often expressed as a percentage of the maximum permitted exposure. If a person has received a noise dose of 100% over a work shift, this means that the average noise exposure is at the maximum permitted. For example, with a criterion level of 90 dBA and an exchange rate of 3 dBA, an eight-hour exposure to 90 dBA gives a 100% dose. A four-hour exposure to 93 dBA is also a 100% dose, whereas an eight-hour exposure to 93 dBA is a noise dose of 200%.

Usually the manufacturer electronically adjusts dosimeters to the criterion level and exchange rate in use. You may have to adjust them to suit the exposure guidelines/standards in force in your jurisdiction.

Dosimeters also give an equivalent sound or noise level. This is the average exposure level for noise over the time dosimeter was on. It has the same total sound energy as the actual, variable sound levels to which a person is exposed over the same time period. Scientific evidence suggests that hearing loss is affected by the total noise energy exposure. If a person is exposed over an eight-hour work shift to varying noise levels, it is possible to calculate an equivalent sound level which would equal the same total sound energy exposure. This would have the same effect on the person's hearing as the variable exposure actually received (Figure 1).

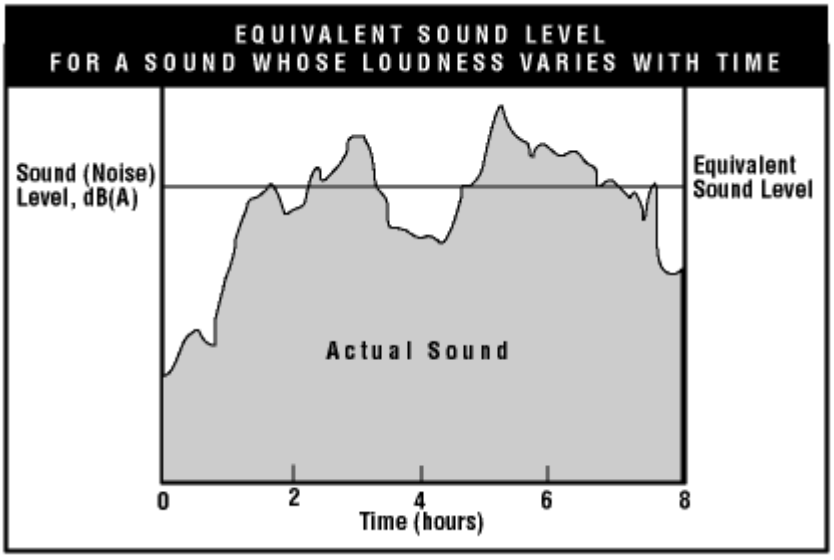


Figure 1

In Figure 1, the shaded area under the line that shows how the sound level changes over time (the "curve") represents the total sound exposure over eight hours.

When do you use a windshield?

When air blows by the microphone, the noise reading is altered. To avoid the effect of wind, one uses a windshield or windscreen to cover the microphone in areas with considerable air movement. Wind shields or screens are available from manufacturers of sound level meters.

What techniques are used for measuring noise?

Before taking any field measurements, it is important to determine the type of information required. Do the workplace noise levels vary throughout the day? Are the workers fairly mobile? Do workers operate different equipment?

In a bottle washing and filling facility in Ontario, for example, the noise levels vary over the work shift. Instantaneous noise measurements, taken with an SLM (Type 2, SLOW RESPONSE, A-filter), at one person's work station, ranged from 63 dBA to 114 dBA over the day, although levels most commonly ranged from 90 to 96 dBA and 104 to 107 dBA. This information strongly suggested that there was a potential for excessive noise exposure.

The worker was asked to wear a noise dosimeter over a full eight-hour work shift. At the end of the shift, the noise dosimeter indicated a 270% dose. This was a substantial exposure. In addition, the dosimeter provided an equivalent noise level of 97 dBA. In other words, a constant eight-hour exposure to a steady, continuous noise of 97 dBA would have resulted in the same exposure.

An ISLM could also have been used in this example, particularly if the worker spent most of the work shift in a defined location, or the first half of the shift in one area and the remainder in another area. The ISLM could have provided equivalent sound level measurements and a fairly accurate exposure assessment.

How is impulse/impact noise measured?

Measurements of impulse or impact noise depend on the guidelines and standards in force. Before you measure impact or impulse noise, you must ensure that the equipment has the capacity to measure this kind of noise. Normally measurements of either peak noise levels together with the actual number of peaks, or percentage dose or equivalent sound levels are required. Where there is little background noise, as for example on an outdoor rifle range, the measuring of peak pressures may be most appropriate.

In industrial settings, there is usually considerable background noise in addition to the impulse noise. In such cases, provided that a 3 dB(A) exchange rate is used, dosimeters or ISLMs which are sufficiently sensitive to respond well to peaks may be more appropriate. One can account for all of the noise, continuous and impulse, in the one measurement.

What is a frequency analysis?

Frequency analysis is measuring noise level at each frequency or pitch. Frequency analysis is not required when the purpose of noise measurement is to assess compliance with regulatory exposure limits or to assess risk of hearing loss. For such purposes the A-weighted noise level in dBA, percent noise dose or time-weighted average (TWA) equivalent sound level is sufficient. The frequency analysis is usually needed only for the selection of appropriate engineering control methods.

Sometimes it is necessary to determine the actual frequency distribution of the noise. A detailed frequency analysis is called narrow band analysis. In this method the entire audible frequency range is divided into frequency windows of fixed width of a few hertz and noise level is measured in dB units at each of these frequency

windows. Narrow band analysis is normally not needed for workplace noise. Such analysis is used for engineering measurements. For workplace noise we need octave band analysis.

Octave bands are identified by their centre frequency. The band width increases as the centre frequency increases. The audible sound frequency range (approximately 20 to 20,000 Hz) has been divided into 11 octave bands for this purpose. An octave band filter set can be attached to an SLM to measure the sound level in each octave band.

When and how do you make corrections for background noise?

Sometimes it is necessary to determine whether or not the background noise is influencing the total noise level measured when the noise source is “on”. In such cases, two readings of noise level are taken – one with the noise source “on” and the other with the noise source “off”. The following table can be used to determine noise level due to the noise source. For example if the total noise level is 97 dB and the background noise is 90 dB, the noise due to source is 96 dB (97-1). If the difference is more than 10 dB, no correction is needed.

Table 2
Background Noise Level Correction

TOTAL NOISE LEVEL(dB) minus BACKGROUND NOISE LEVEL (dB) dB	VALUE TO SUBTRACT FROM TOTAL NOISE LEVEL TO GET NOISE DUE TO THE SOURCE
8 – 10	0.5
6 – 8	1
4.5 – 6	1.5
4 – 4.5	2
3.5	2.5
3	3

What is a noise survey?

A noise survey takes noise measurements throughout an entire plant or section to identify noisy areas. Noise surveys provide very useful information which enables us to identify:

- Areas where employees are likely to be exposed to harmful levels of noise and personal dosimetry may be needed.

- Machines and equipment which generate harmful levels of noise.
- Employees who might be exposed to unacceptable noise levels.
- Noise control options to reduce noise exposure.
- Variability in noise levels during different operating conditions
- Impact on noise level from modifications or changes in operations

Noise survey is conducted in areas where noise exposure is likely to be hazardous. Noise level refers to the level of sound. A noise survey involves measuring noise level at selected locations throughout an entire plant or sections to identify noisy areas. This is usually done with a sound level meter (SLM). A reasonably accurate sketch showing the locations of workers and noisy machines is drawn. Noise level measurements are taken at a suitable number of positions around the area and are marked on the sketch. The more measurements taken, the more accurate the survey is. A noise map can be produced by drawing lines on the sketch between points of equal sound level. Noise survey maps, like that in Figure 2, provide very useful information by clearly identifying areas where there are noise hazards.

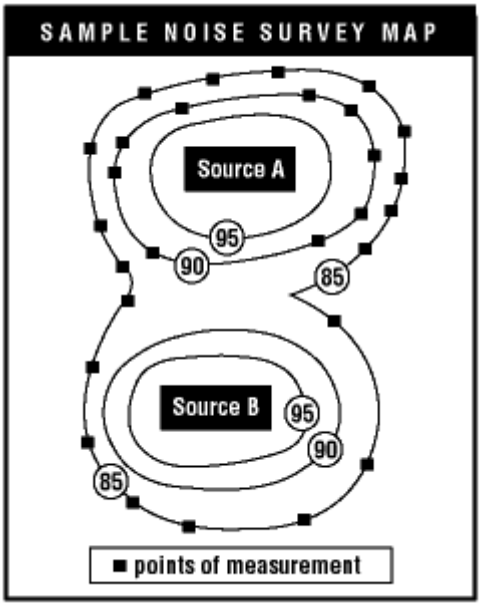


Figure 2

The SLM must be calibrated before and after each use. The manual gives the calibration procedure. To take measurements, the SLM is held at arm’s length at the ear height for those exposed to the noise.

When the purpose of noise measurement is to assess the risk of hearing loss, the microphone position should be as close as possible to the location of the ears of the employee for whose benefit the noise exposure data are being taken. Shielding by presence of employee and other objects between the noise source and microphone should be avoided. The employee need not be present during the measurement. For a stationary employee, the microphone should be positioned above the shoulder or as near as feasible. The microphone should be located within 0.5 metre of the employee’s shoulder. If the employee works in a standing position, the microphone should be positioned preferably 1.5 metres above the floor. If the employee works in a sitting position, the microphone should be positioned at 1.1 metres above the floor.

A standard SLM takes only instantaneous noise measurements. This is sufficient in workplaces with continuous noise levels. But in workplaces with impulse, intermittent or variable noise levels, the SLM makes it difficult to determine a person’s average exposure to noise over a work shift. One solution in such workplaces is a noise dosimeter.

When and how do you measure employee noise exposures using a noise dosimeter?

The need for measuring the employees' noise exposure arises when noise survey indicates the possibility that the employees may be exposed to noise exceeding the noise exposure limits set by noise regulations or the limits set by the company. Personal noise exposure of employees is measured using a noise dosimeter.

The dosimeter is worn by the employee during the entire or part of the shift. The employee does not need to be followed by the person responsible for taking the noise measurements during the entire measurement period. However, the worker should keep a log detailing tasks performed, areas visited, and any other important information that can help with understanding results, especially if noise levels are high. Any unwitnessed peaks in noise levels (if a logging dosimeter is used) should also be investigated. The reliability of the noise data will depend on the employee's cooperation in the proper use of the dosimeter. The following are some helpful tips to ensure employee's cooperation in noise dosimetry.

- Inform the employees about the purpose of measurement.
- Explain the importance of the accuracy of noise data in assessing the need for noise control.
- Emphasize the importance of wearing it all the time during the measurement period.
- Explain the consequences of tampering with the microphone – shouting in it, using it to knock on doors, etc
- Reassure the employee that the device records sound levels only, not actual words or conversations..

Usually, the manufacturer electronically adjusts dosimeters to the criterion level and exchange rate in use. You may have to adjust them to suit the exposure guidelines/standards in force in your jurisdiction. The manufacturer's instructions for proper use must be followed. The dosimeter is to be calibrated before and after each measurement. If, after the measurement, calibration is off by more than 0.5 dB, resampling may be needed as the results may not be accurate.

The start and stop times of the dosimeters must be noted. It is also important to talk with the worker and supervisor to ensure conditions during the day of sampling are typical of a normal shift. If conditions are not typical, this variation should be noted and resampling may be required.

How can we measure equivalent noise level using an Integrating Sound Level Meter (ISLM)?

The integrating sound level meter (ISLM) can be used to measure equivalent noise level averaged over the measurement period which could be several minutes, a few hours or an entire work shift. In this respect it is similar to a dosimeter used as area monitor. An ISLM does not provide personal exposure level because it is not worn on person. It gives equivalent sound levels at a particular location. The ISLM uses a pre-programmed exchange rate, with a time constant that is equivalent to the SLOW setting on the SLM.

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