

# Workplace Safety and Health Guidelines

Hearing Conservation Programme



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# 1. Introduction

Noise is generated during processes, operations and work activities. It is one of the most common occupational health hazards. Prolonged exposure to excessive noise can cause noise-induced hearing loss, or commonly known as noise-induced deafness (NID). NID refers to a permanent loss in hearing sensitivity which leads to communication difficulties, impairment of personal relationships, social isolation and degradation in the quality of life.

Other detrimental effects of excessive noise exposure include:

- Tinnitus (a distressing condition characterised by ringing in the ear which can lead to disturbed sleep);
- Acoustic trauma (temporary or permanent hearing loss due to sudden exposure to very loud noise);
- Interference with speech communication and perception of warning signs;
- Disruption of job performance;
- Annoyance; and
- Extra-auditory effects.

To protect exposed employees from the adverse effects of noise, every workplace with a noise hazard should implement a comprehensive Hearing Conservation Programme (HCP), as part of the company's workplace safety and health (WSH) programme.

The *Guidelines on Hearing Conservation Programme* serves to assist employers, plant engineers, noise monitoring and noise control personnel, safety and health officers, and other stakeholders in the implementation of the HCP.

## 1.1 Objective of Hearing Conservation Programme

The objective of the HCP is to minimise the risk associated with workplace noise exposure and to prevent NID.

## 1.2 Elements of Hearing Conservation Programme

The basic elements of a HCP are:

- Identifying the noise hazard and evaluating the risk involved;
- Implementing noise control measures, such as engineering controls to minimise the risk;
- Providing suitable hearing protectors and ensuring the proper use of the hearing protectors by persons exposed to excessive noise;
- Training and educating persons involved in the HCP to raise their awareness of noise hazard and prevention of NID;

- Conducting annual audiometric examinations to monitor the effectiveness of the HCP in preventing NID, and detecting early hearing impairment;
- Keeping records of the measures taken to protect employees from noise hazard; and
- Evaluating the HCP to determine its effectiveness and identifying areas for improvements.

An effective HCP can eliminate or minimise noise hazard and prevent NID. Strong commitment by the management and active involvement by the employees are critical for the success of the HCP. Therefore, management should take the appropriate steps to encourage employees' participation in the development and implementation of the HCP.

A flowchart which provides an overview of the HCP is shown in Annex A.

**A HCP is required when:**

any person in the workplace is exposed to excessive noise, which is defined as an equivalent sound pressure level of 85 dB(A) or more over an eight-hour workday.

## 2. Planning for Hearing Conservation Programme

### 2.1 Development of a Hearing Conservation Programme Policy

A HCP policy should demonstrate the commitment of the management towards the programme. The policy should be based on effective practices rather than minimum compliance with the legislation. More importantly, the policy and strategies should be endorsed by the top management, and should, as much as possible, address the following:

- Promoting a positive safe and healthy culture at the workplace where employees are empowered and motivated to protect their health and that of their fellow co-workers;
- Adopting a prescribed schedule for monitoring noise exposure levels and other risks, including ensuring that the equipment and personnel training are appropriate for the task;
- Setting targets for minimising daily peak noise exposure levels in the workplace and developing strategies to achieve them;
- Requiring consistent and proper wearing of hearing protectors in designated areas;
- Ensuring the correct use of hearing protectors through onsite inspection;
- Educating, training and motivating employees to support the HCP; assessing employee attitude and knowledge gained from periodic training;
- Purchasing appropriate hearing protectors, noise measuring equipment and quieter machinery;
- Requiring employees who are exposed to excessive noise to undergo pre-placement and periodic audiometric examinations;
- Counselling affected employees after each audiometric examination;
- Reviewing audiometric data to verify the effectiveness of the HCP; and
- Establishing a proper procedure for selecting vendors and contractors for services which cannot be undertaken by in-house staff such as noise monitoring and audiometric examinations.

Companies that issue a clearly defined HCP policy, and follow or apply the policy will be able to implement it more effectively. With a well-defined policy, employees are informed of their functional roles and duties.

With the formation of a HCP team, the appointment of a HCP administrator and establishment of the HCP policy, the team can proceed to implement the HCP. The following sections contain the details of each HCP element.

## 2.2 Establish a Hearing Conservation Programme Team

Where it has been identified that a HCP is required in a workplace, the employer should set up a team to implement the HCP, in consultation with the employees. The composition and size of the HCP team should be proportionate to the size of the company and the number of employees exposed to excessive noise.

The HCP team may comprise the following:

- Safety and health personnel;
- Noise monitoring officer;
- Noise control officer;
- Occupational hygiene officer;
- Industrial hygienist;
- Industrial nurse;
- Employees' representative; and
- Designated Workplace Doctor (DWD).

## 2.3 Identify the Roles and Responsibilities

### 2.3.1 Management Responsibilities

- The management should ensure that noise control measures are in place such that no employees are exposed to excessive noise.
- Where 50 or more persons employed are exposed or likely to be exposed to excessive noise, a competent person (Noise Control Officer) should be appointed to advise the management on the proper noise control measures.
- The management should ensure that the individuals who are advising on noise control are suitably qualified, whether in-house personnel or service providers.
- The management should allocate appropriate resources and as far as it is reasonably practicable, implement the noise control plan put up by the competent person.
- The management should ensure that the noise control plan is reviewed at least once every three years or until such time when the noise is reduced to an acceptable level and the noise hazard is eliminated.
- The management should take into consideration the noise emission levels during the selection and procurement of new machines. Instead of introducing noise control measures after installation, selecting quieter machines at the initial stage can help to save costs.
- The management should ensure that all noise control systems or devices are well-maintained, for e.g., a machine enclosure should be kept closed, its seals are in good condition, and isolators should be replaced when they have worn out.

### 2.3.2 Appointment and Roles of a HCP Administrator

Management needs to designate a programme administrator to take charge of the HCP. The programme administrator has the authority to make decisions, correct deficiencies and enforce necessary actions.



The HCP administrator should be an individual who has an interest in the company's HCP. He/she should possess good communication skills and be able to interact with the employees at the production floor to discuss the noise problems and preventive measures or solutions.

The HCP administrator should coordinate all aspects of the programme and possess knowledge on:

- Individual elements of HCP;
- Relevant provisions of the WSH Act, WSH (Noise) Regulations, WSH (Medical Examinations) Regulations, WSH (Risk Management) Regulations, and WSH (Incident Reporting) Regulations;
- Effects of noise on hearing;
- Purpose and selection of hearing protectors; and
- Purpose of audiometric examinations.

The role of the HCP administrator involves:

- Coordinating the HCP;
- Monitoring its progress;
- Assessing its performance;
- Evaluating its effectiveness;
- Reviewing the HCP at regular intervals;
- Ensuring that the set objectives are met;
- Arranging meetings or discussions to promote collaboration of efforts between management and team members; and
- Fostering exchange of information between management and team members on the progress of the programme.

Once the team members understand how they can contribute to the success of the programme, they would be motivated to cooperate in preventing hearing loss.

### **2.3.3 Competent Person for Noise Monitoring**

A competent person for noise monitoring is an individual who is trained to conduct proper noise monitoring. The person should work with the HCP administrator to ensure that noise monitoring is conducted properly. The tasks of a noise monitoring officer are listed in Annex B.

#### **Useful references:**

- WSH (Noise) Regulations
- SS 549 : 2009 Code of Practice for selection, use, care and maintenance of Hearing Protectors

### **2.3.4 Competent Person for Noise Control**

A competent person for noise control is an individual who is adequately trained and is knowledgeable on the details of noise control. He/she must be able to provide the management with good advice on the proper noise control measures. He/she should also work with the HCP administrator and employees to ensure that the proposed noise control measures are implemented. The tasks of a noise control officer include the following:

- Identifying all possible noise sources;
- Evaluating specific machinery or noise source for noise control, and determining the most practical and effective methods of reducing the noise to meet the desired criteria;
- Involving the machine operators or production personnel on the selection of noise control measures which may interfere with their work; communicate with them on the proper use, and of the noise control devices to ensure that the controls are kept in good condition;
- Developing a comprehensive noise control plan with recommendations on engineering noise controls where practicable. A sample template of the noise control plan is in Annex D;
- Working closely with the management when putting in place the noise control plan, especially in recommending priorities and setting targets for noise control;
- Assisting the management in implementing the noise control plan and evaluating the effectiveness of noise control measures; and
- Reviewing and revising the noise control plan at least once every three years or whenever there is a significant change in the work processes, machinery or occurrence of NID.

# 3. Identification of Noise Hazard and Evaluation of Noise Risk

Under the WSH (Risk Management) Regulations, a risk assessment must be conducted and documented for all work activities, including noisy works, operations and processes. The first step of risk assessment involves hazard identification which can be qualitative or quantitative in nature.

Qualitative hazard identification can be performed using a checklist or through site inspection. If the outcome of the site inspection suggests that noise problems exist in the workplace, the hazard should be quantified and evaluated through noise assessments.

Risk assessments should be reviewed and revised at least once every three years; or upon occurrence of NID or significant change in work practices or procedures.

## 3.1 Identification of Noise Hazard

Identification of noise hazard in a workplace enables employers to identify employees who may be exposed to excessive noise so that their exposures can be assessed. Hazard identification should involve participation of the affected employees and those who understand the works, operations or processes and have knowledge of the work situation.

### Qualitative approach

A sample noise hazard identification checklist is provided in Annex C for a quick assessment to identify if noise hazard is present at the workplace. In addition, a site inspection should be carried out to identify noisy work activities, the type of noise generated (for e.g., steady, fluctuating or impulse/impact noise), the persons exposed to the noise and their work or exposure pattern.

When it has been identified that a noise hazard exists in the workplace, noise monitoring should be conducted.

### Quantitative approach : Noise monitoring

Noise exposure levels should be assessed in a manner that would accurately identify employees exposed to or likely to be exposed to noise levels at or above the permissible exposure limits specified in the Schedule of the WSH (Noise) Regulations. Measurements should be made whenever any modifications are made to the machinery or processes that may increase the noise levels to which employees are exposed.

Under the WSH (Noise) Regulations, where 10 or more persons are exposed to excessive noise, a competent person must be appointed to conduct noise monitoring once every three years, or earlier when changes in conditions occur which may cause any employee in the workplace to be exposed to excessive noise. Management can engage an acoustical consultant or appoint a qualified person in-house to conduct noise monitoring.

The noise monitoring results should be compared with the previous report so that any significant changes can be identified and investigated. It is important that monitoring is performed after implementation of noise control measures to evaluate the residual risk.

## **3.2 Objectives of Noise Monitoring**

All workplaces where employees may be exposed to excessive noise should perform noise monitoring to achieve these objectives:

- Quantify the noise hazard;
- Identify employees affected by the noise hazard for inclusion in the HCP;
- Classify employees' noise exposures for prioritising noise control efforts and establishing hearing protection practices;
- Evaluate specific noise sources for noise control purposes;
- Evaluate the effectiveness of the measures taken to minimise noise exposure; and
- Delineate hearing protection areas.

## **3.3 Methods of Noise Monitoring**

Please refer to Annex B for more information on noise monitoring.

# 4. Noise Control Measures

After the noise hazard has been identified and evaluated, the next step of risk assessment involves the reduction of the noise risk to an acceptable level through the application of reasonably practicable controls. The risk assessment should address priorities for action, the person responsible for implementing the controls and the assessment of residual risk after the noise controls are in place to ensure that they are effective.

## 4.1 Principles of Control

Control or reduction of noise can be carried out:

- At the source;
- Along the path; and
- At the receiver.

The best approach to control noise is to eliminate or reduce the hazard at its source. If the noise cannot be controlled at its source, attempts should be made to control it along the path which it travels. As a last resort, the noise control problem may be approached at the receivers or exposed persons.

### 4.1.1 Noise Control at the Source

Noise control at the source is an engineering remedy. Vibration control or isolation, damping or lagging of vibrating surfaces, proper balancing and maintenance of machinery can reduce noise. Mufflers or silencers can control noise generated by turbulent fluid flow.

### 4.1.2 Noise Control along the Path

The control of noise along the path of transmission involves the modification of the paths by which noise travels through the air to the employees. It can be achieved by complete or partial enclosure of the source by placing an acoustical shield or barrier wall between the source and the receiver, or by increasing the distance between them. Sometimes, the installation of acoustical absorbing materials on ceilings or walls may result in significant reduction of noise.

### 4.1.3 Noise Control at the Receiver

Noise control at the receiver can be achieved by the use of hearing protectors, by use of personal enclosure or application of administrative controls such as job rotation.

## 4.2 Hierarchy of Control

The control of noise hazard can be accomplished through the WSH Hierarchy of Control. See Figure 1.

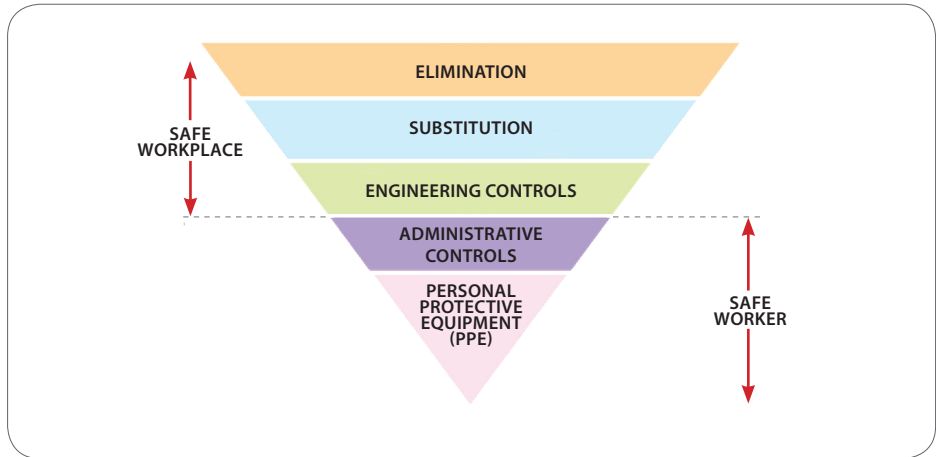


Figure 1: WSH Hierarchy of Control.

### 4.2.1 Substitution and Engineering Controls

Under the WSH (Risk Management) Regulations, reasonably practicable steps should be taken to eliminate any foreseeable safety and health risk at the workplace, including excessive noise from equipment and machinery. Where it is not reasonably practicable to eliminate the risk, the option of replacing noisy machines with quieter ones should be considered.

Intrinsically quieter machinery is often more efficient, easier to maintain and less costly than machinery retrofitted with treatments. Engineering noise control is another measure which can be taken to minimise the risk. It involves the application of physical means to reduce the noise level at the source, along the path or in the hearing zone of the employees.

#### Qualitative approach

Substitution involves replacing the hazard by one that presents a lower risk. For example, substituting noisy machinery or equipment with ones designed for operation at lower noise levels.

See Table 1 for examples of substitutes and Figure 2 which shows an example of substitution.

Examples of Noisy Equipment/Processes	Examples of Substitutes
<b>Noisy equipment/machinery:</b>	
<ul style="list-style-type: none"> <li>• Pneumatic ejector</li> <li>• Mechanical press</li> <li>• Square shear</li> <li>• Gear drive</li> <li>• Single operation die</li> <li>• Power press</li> </ul>	<ul style="list-style-type: none"> <li>• Mechanical ejector</li> <li>• Hydraulic press</li> <li>• Rotating shear</li> <li>• Belt drive</li> <li>• Step die</li> <li>• Laser cutting</li> </ul>
<b>Noisy processes:</b>	
<ul style="list-style-type: none"> <li>• Rolling or forging</li> <li>• Riveting</li> <li>• Chipping</li> </ul>	<ul style="list-style-type: none"> <li>• Pressing</li> <li>• Welding</li> <li>• Arc or flame gouging</li> </ul>

Table 1: **Examples of substitution.**



Figure 2: **Substitution of jack hammer (left) with automated machine (right) to break concrete reduced the noise level from 90 dB(A) to 83 dB(A).**

### Engineering controls

Engineering controls are physical means that limit the hazard. These include structural changes to the work environment or work processes. Table 2 shows examples of engineering controls.

Types of Engineering Controls	Examples
<b>Control noise from sources with vibrating surfaces</b>	
Reduce the driving force of vibrating surfaces.	<ul style="list-style-type: none"> <li>• Reduce the speed</li> <li>• Maintain dynamic balance</li> <li>• Provide vibration isolation</li> </ul>
Reduce the response of vibrating surfaces.	<ul style="list-style-type: none"> <li>• Increase damping</li> <li>• Provide additional support</li> <li>• Increase stiffness of material</li> <li>• Increase mass of vibrating members</li> <li>• Modify size to change resonance frequency</li> </ul>
Reduce the sound radiation from vibrating surfaces.	<ul style="list-style-type: none"> <li>• Reduce area of vibrating surface</li> <li>• Reduce overall size</li> <li>• Use perforated panels instead of solid ones</li> </ul>
Modify material handling processes to ensure that impact and shock during handling and transport are minimised.	<ul style="list-style-type: none"> <li>• Minimise height of fall onto hard surface</li> <li>• Provide wear resistant rubber or plastic coatings to absorb shocks</li> </ul>
Reduce noise produced by fluid flow (refer to Figure 3).	<ul style="list-style-type: none"> <li>• Install intake and exhaust mufflers or silencers</li> <li>• Reduce velocity of fluid flow</li> <li>• Increase cross section of streams</li> <li>• Reduce pressure</li> <li>• Reduce air turbulence</li> </ul>
<b>Noise control along the transmission path</b>	
Reducing noise transmitted through the air (refer to Figure 4).	<ul style="list-style-type: none"> <li>• Complete enclosure of noise sources</li> <li>• Confine high-noise machines to insulated room and acoustically treat the area</li> <li>• Use sound absorbing material on walls and ceilings in working areas to reduce sound level due to reverberation</li> <li>• Erect acoustic barrier between the noise source and the employees</li> </ul>
Reduce noise transmitted through solid structures.	<ul style="list-style-type: none"> <li>• Use flexible mountings</li> <li>• Use flexible section in pipe runs</li> <li>• Use flexible shaft couplings</li> <li>• Use fabric sections in ducts</li> <li>• Lay resilient flooring</li> </ul>
<b>Noise control at the receiver</b>	
Enclose employees to minimise the noise transmitted to them	<ul style="list-style-type: none"> <li>• Enclosure of noisy machines</li> </ul>

**Table 2: Examples of engineering controls.**



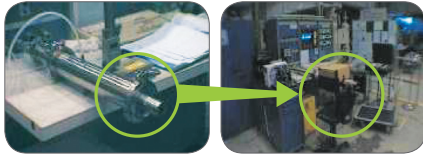


Figure 3: Installation of expansion chamber.

Expansion chamber (right) was installed at the outlet of the calibration nozzle (left) to reduce the noise generated by the high pressure air jet at the nozzle. The noise level was reduced from 112 dB(A) to 80 dB(A).



Figure 4: Enclosure of noise generating chamber blast pot.

The noise generating chamber blast pot (left) was completely enclosed (right). The noise level was reduced from 85 dB(A) to 78 dB(A).

Some of the noise control measures described in Tables 1 and 2 can be implemented by plant personnel, while other measures may require detailed noise analysis and specialised technical knowledge to obtain the desired results.

In both cases, employees, particularly those who are directly involved in the work, should be encouraged to participate in the development of the control measures to ensure that the controls are practical and will not interfere with the employees' tasks. Employees should be involved in decisions that help improve working conditions and make them more receptive to new control measures implemented.

The noise control officer can advise on the feasibility of the measures developed.

In addition, other health hazards such as ergonomics and lighting, associated with the engineering controls should be taken into consideration during the design of the controls.

#### 4.2.2 Administrative Controls

Administrative controls are any arrangements or procedures that limit the daily noise exposure of employees by control of the work or production schedule. Examples of administrative methods include:

- Shortening the length of time an employee is exposed to excessive noise by job rotation; and
- Scheduling machine operating times to reduce the number of employees exposed to noise.

Job rotation will reduce the noise exposure of some employees while increasing others, so proper care and judgement is needed. For example, employees will need to be rotated away from noisy jobs for a significant proportion of time to make an appreciable difference to their daily exposure.

Administrative methods do not reduce the noise level and therefore, should not be used as a primary means of preventing hearing loss. However, administrative controls can be considered when engineering methods are not practicable.

### 4.2.3 Personal Protection

Appropriate, proper fitting individual hearing protectors should be considered as an interim solution to reduce the sound exposure of the employees before engineering and administrative noise controls can be administered or when the controls are not yet feasible. It can be used to provide added protection in addition to engineering and administrative controls.

Refer to Section 5 for more information on hearing protectors.

## 4.3 Noise Control Plan

Once it has been ascertained through the risk evaluation process that the risk posed by excessive noise present at the workplace is unacceptable, noise control measures should be proposed as part of the risk assessment process to address the noise hazard identified. The proposed control measures, the implementer and target date of completion should be documented in the risk assessment form. From the risk assessment, an action plan for noise control, or noise control plan, can be developed in which priorities for action are established based on the level of risk.

The following should be taken into consideration when developing the noise control action plan:

- Noise control measures for new and existing processes, machinery and equipment should be considered;
- In the case of new processes, machinery and equipment, the noise control officer should, where possible, advise the management to specify low noise output of the processes, machinery and equipment as a condition of purchase alongside production-related specifications;
- Arrange the workplace layout to minimise noise exposure to the employees;
- In the case of existing processes, machinery and equipment, the noise control officer should advise the management to consider alternative ways of production without generating excessive noise;
- If elimination of the noisy process or machine is not practicable, the noise control officer should advise the management to consider replacing the noisy parts with quieter alternatives;
- If elimination and substitution are not practicable, the use of engineering and administrative controls should be considered; and
- Hearing protectors must be provided to all persons exposed to noise hazard during the interim period of noise control implementation and in the absence of feasible engineering and administrative controls. The noise control officer should advise the management to provide hearing protection devices and ensure correct usage by the affected employees.

After the noise control action plan has been developed, the top management should endorse it to ensure commitment in the implementation of the controls. There should be regular monitoring of the noise control projects to ensure timely completion. After the noise control measures have been implemented, their effectiveness should be evaluated through assessing the residual risk.

# 5. Provision of Hearing Protectors

The purpose of hearing protection is to ensure that the exposed employees are adequately protected from excessive noise. Employees who are exposed to excessive noise should be provided with suitable hearing protectors. The hearing protectors serve to protect the employees against excessive noise during the interim period before the noise is successfully reduced through engineering control measures, or when engineering or administrative measures are not feasible. Before hearing protectors are issued to the affected employees, the need for their use and limitations should be fully explained.

## 5.1 Types of Hearing Protectors

The commonly used hearing protectors are ear muffs and earplugs. See Tables 3A and 3B for the advantages and disadvantages of both types of protectors. Please refer to the Singapore Standard *SS 549 : 2009 Code of practice for selection, use, care and maintenance of hearing protectors for details on special types of hearing protectors.*

Types of Hearing Protectors	Advantages	Disadvantages
a. Ear Muffs (refer to Figure 5).	<ul style="list-style-type: none"><li>• A single size can fit most employees</li><li>• Easily worn and taken off</li><li>• Generally provide better protection compared to earplugs</li><li>• More durable</li><li>• Easily seen at a distance to assist in the monitoring of their use</li><li>• Not easily misplaced or lost</li></ul>	<ul style="list-style-type: none"><li>• More expensive</li><li>• Uncomfortable to wear, especially in hot environment</li><li>• Difficult to use in tight spaces</li><li>• More inconvenient when used with other personal protective equipment</li><li>• May interfere with the wearing of safety or prescription glasses: wearing glasses results in breaking the seal between the ear muff and the skin, reducing hearing protection</li></ul>

Table 3A: Advantages and disadvantages of ear muffs.

Types of Hearing Protectors	Advantages	Disadvantages
b. Earplugs (refer to Figures 6 & 7).	<ul style="list-style-type: none"> <li>• Small</li> <li>• Cheap</li> <li>• Convenient to use with other personal protective equipment</li> <li>• More comfortable in hot, humid work areas</li> <li>• Convenient for use in confined work areas</li> </ul>	<ul style="list-style-type: none"> <li>• Requires more time to fit</li> <li>• More difficult to insert and remove</li> <li>• Require good hygiene practices</li> <li>• May irritate the ear canal</li> <li>• Easily misplaced</li> <li>• More difficult to see and monitor usage</li> </ul>

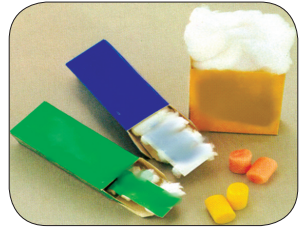
Table 3B: Advantages and disadvantages of earplugs.



**Figure 5: Ear Muffs**  
Ear muffs consist of a pair of cushioned cups that form a seal around the ears. The muffs are designed to cover the entire ear, preventing the entry of noise.



**Figure 6: Earplugs**  
Non-disposable or reusable earplugs are made of silicone, rubber or plastic, and they come in various shapes and sizes as the size of the ear canal varies from person to person.



**Figure 7: Disposable earplugs**  
Disposable earplugs are made of polyurethane foam or glass wool and they are thrown away after a few uses.

## 5.2 Selection of Hearing Protectors

The following are factors to consider when selecting hearing protectors.

### 5.2.1 Noise Exposure Level of the Employees

Selection of hearing protectors should be based on their ability to reduce noise at the ear below the permissible exposure limit (PEL) in specific exposure situations, hence the noise exposure that employees are exposed to in an equivalent 8-hour period should be known. The measurement of noise levels should be carried out by a competent noise monitoring officer. Reference should be made to the WSH (Noise) Regulations and/or guides available on the MOM website.

Where employees are exposed to noise levels at or above 100 dB(A), earplugs or ear muffs alone do not provide sufficient protection. In such cases, employees are required to wear both earplugs and ear muffs.

### 5.2.2 Degree of Attenuation Required

Three methods of estimating the effective noise level at the ear when hearing protectors are worn are given in *SS 549 : 2009* and the reader is advised to refer to it for guidance. Hearing protection is considered adequate when hearing protection is able to reduce the noise level at the ear between 5 and 10 dB(A) below the PEL for noise.

When selecting hearing protectors, one must know the noise exposure level and the noise reduction rating (NRR) of the hearing protectors, which is the expected level of noise reduction in the ears when they are properly worn. The higher the NRR, the higher is the attenuation for a specific ideal situation. The NRR is provided by the manufacturers and it differs from one model to another. However as the effectiveness of hearing protection in the “real world” may differ from the NRR that is derived from laboratory studies, refer to *SS 549 : 2009* for more information on adjustment (“derating”) of NRR of the hearing protectors.

The following are reproduced from *SS 549 : 2009*.

- Ear muffs: subtract 25% from the labelled NRR
- Foam earplugs and custom moulded earplugs: subtract 50% from the labelled NRR
- All other earplugs, including semi-inserts: subtract 70% from the labelled NRR

#### **Useful reference:**

*SS 549 : 2009* Code of practice for selection, use, care and maintenance of hearing protectors

### 5.2.3 Comfort and Fit to the User

Individual fitting of the hearing protectors is necessary to ensure optimum performance. Adequate protection can be achieved if the hearing protectors are individually fitted to each employee and therefore, achieve an acoustic seal with acceptable comfort.

### 5.2.4 Suitability for Use

The types of hearing protectors selected should be suitable for the working environment and the type of job involved. For example, ear muffs will be a preferred choice over earplugs in unclean working conditions, where there is a risk of infection to the user. Earplugs are recommended in work areas with high temperature and humidity.

### 5.2.5 Need for Hearing Warning Signals and Speech Intelligibility

The selected hearing protectors should be able to reduce the noise level to below the PEL of 85 dB(A) at the ear. However, employees should not be issued hearing protectors with unnecessarily high attenuation as it may bring about communication difficulties and cause isolation. Such problems caused by over protection can result in employees’ refusal to wear the hearing protectors. A suitable hearing protector should reduce the noise level to between 5 and 10 dB(A) below the PEL.

## 5.2.6 Medical conditions

Before hearing protectors are issued to the employees, they should be examined to determine if they are suffering from any medical conditions related to the ears such as irritation of the ear canal. In such cases, they should avoid wearing earplugs.

Individuals react differently to the use of hearing protectors. Therefore, a successful HCP should consider and respond to the needs of each employee. Employees should be provided with a range of hearing protectors to enable them to choose the appropriate ones which fit them comfortably. Such employees' involvement in the selection of their hearing protectors will increase their acceptance and therefore, encourage the wearing of hearing protectors.

Management can also promote wearing hearing protectors at the workplace by requesting all personnel including the managers, supervisors and visitors to wear protectors at all times when they are in the hearing protection areas. Such a practice will demonstrate the management's commitment to hearing protection and encourage the employees to use their hearing protectors even while they are involved in noisy activities after working hours.

## 5.3 Proper Wearing of Hearing Protectors

Improper wearing of hearing protectors can lead to diminished hearing protection. Thus, employees should be adequately trained in the correct method of wearing hearing protectors to ensure that they receive the maximum protection. In addition, employees should be encouraged to periodically check their hearing protectors during the work day if they need to be adjusted to maintain a reliable fit.

Prior to using hearing protectors, employees should perform a visual check to ensure that there is no deformity or damage.

### Techniques for wearing earplugs

- a. Disposable foam earplugs:
  - i. Roll and squeeze the earplug.
  - ii. Pull the upper part of the ear (pinna) up, out and back.
  - iii. Insert the foam earplug.
  - iv. Keep the plug in place using a finger for five to ten seconds while it expands as this will prevent it from being dislodged.
- b. Reusable earplugs:
  - i. Pull the upper part of the ear (pinna) up, out and back.
  - ii. Insert the disposable earplug till it fits snugly.

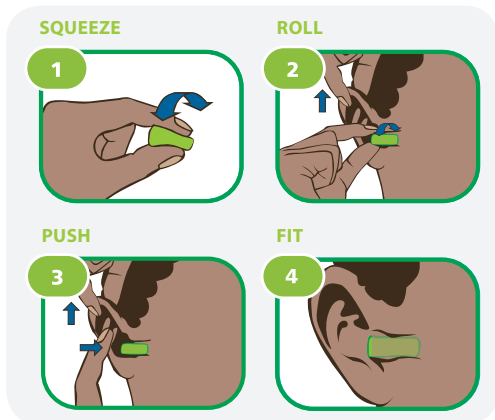


Figure 8: Correct way of wearing disposable foam earplugs.

When wearing ear muffs, the ear cup of the ear muffs should cover the ear lobes completely.



Figure 9: Correct way of wearing ear muffs.

## 5.4 Maintenance of Hearing Protectors

Employees should be trained on the proper use and care of their hearing protectors to maintain the effectiveness of the hearing protectors. For personal hygiene, reusable earplugs must be washed frequently in warm, soapy water and left to dry before keeping. Ear muffs may be cleaned with disposable alcohol wipes. See Figures 10 and 11.



Figure 10: Cleaning of earplugs.



Figure 11: Cleaning of ear muffs.

Wear and tear, and hardening of the earplugs or ear muff cushions will cause them to crack and lose their shape resulting in an improper fit. Hearing protectors should be checked regularly and replaced when necessary. They should also be kept in a clean place when not in use.

A system should be set up to check the state of the hearing protectors regularly and employees must repair and replace them whenever necessary. This will ensure that the hearing protectors are in good condition at all times.



Figure 12: Dirty earplugs.



Figure 13: Deformed ear muffs.

## 5.5 Consistent Use of Hearing Protectors

Areas where employees are likely to be exposed to excessive noise should be identified and clearly defined. Warning signs should be posted at all entrances to the “Hearing Protector Areas” to indicate the use of hearing protectors. See Figure 14.

Regular inspections should be conducted to ensure that employees are wearing hearing protectors correctly at all times in these designated areas. Employees who do not wear hearing protectors should be counselled to help them understand that they are responsible for conserving their own hearing.



Figure 14: Hearing protector sign.

### Important

Employees should be informed that the removal of hearing protectors for even a short period of time can significantly reduce their effectiveness and result in inadequate protection. If hearing protectors are worn for only 50% of the time, a protection of only about 3 dB(A) reduction is obtained. Employees should only take off their hearing protectors when they are away from the loud noise.

For example, a person is exposed to an equivalent continuous noise level (Leq) of 105 dB(A). In order to reduce the Leq to 85 dB(A) which is the PEL, hearing protectors have to be worn for as much as 99% of the total exposure time. In practice, however, hearing protectors do not provide infinite attenuation as some sound energy reaches the ear while they are worn.

As it is uncomfortable to wear hearing protectors for long periods of time in certain environments, the management should provide quiet rest areas where employees can take a break without wearing the hearing protectors.



# 6. Training and Education

## 6.1 Importance of Training and Education

Training and education are necessary for employees to understand the importance of protecting their hearing. They will then be more motivated to actively participate in the programme. Besides noise-exposed employees, supervisors and managers who are responsible for the noisy areas, and persons involved in the HCP should be included in the training. The training should increase employees' awareness of the noise hazard and approaches they can adopt to take care of their hearing.



Figure 15: Employee receiving training on the proper wearing of hearing protectors.

## 6.2 Content of Training

The HCP training should be carried out annually for employees exposed to excessive noise and within three months of job commencement for new employees. The training programme should include:

- Relevant provisions of the WSH Act, WSH (Risk Management) Regulations, WSH (Noise) Regulations and WSH (Medical Examinations) Regulations;
- Adverse effects of noise on hearing;
- Purpose and benefits of the HCP;
- HCP policies;
- Purpose of hearing protectors;
- Advantages, disadvantages and attenuation of the various hearing protectors;
- Instructions on the proper selection, fitting, use, care and maintenance of hearing protectors;
- Importance of the consistent wearing of hearing protectors;
- Purpose and procedures of audiometric testing, including pre-test instructions; and
- Explanation of the audiometric results and preventive measures.

During the training sessions, employees should be encouraged to provide suggestions and comments on:

- Suitability of available hearing protectors in relation to their job;
- Possible ways to further reduce the noise levels; and
- Ways to motivate the wearing of hearing protectors.

Employees should be informed of the progress of the HCP implementation. In this way, they will appreciate the level of management's commitment to the programme. In addition to the training sessions, discussions on hearing health topics can be included in the general safety meetings scheduled regularly.

All training should be conducted in languages understood by all employees who are exposed to excessive noise. The training content should be reviewed periodically to ensure that it remains effective in meeting the objectives. The effectiveness of the training can be determined through compliance with proper and consistent use of hearing protectors, understanding the noise hazard, and its control and prevention.

# 7. Audiometric Examinations

Audiometric examinations are an important part of the HCP as employees with mild hearing loss can be identified. The symptoms of NID do not manifest till a significant threshold shift has occurred. Such early detection of hearing loss will provide the opportunity for immediate measures to be taken to prevent further deterioration. The results of the audiometric examinations can also be used to check if hearing protectors have been worn by the exposed subjects.

## 7.1 WSH (Medical Examinations) Regulations

The WSH (Medical Examinations) Regulations requires all persons exposed to excessive noise to undergo pre-placement and periodic medical examinations. These examinations include an audiometric examination.

Some of the regulations relevant to the HCP are as follows:

- Pre-placement check-up for employees exposed to excessive noise: Employees exposed to excessive noise must be medically examined by a DWD and certified fit for work in the occupation before or within three months of commencement of work.
- Periodic medical check-up for employees exposed to excessive noise: Annual audiometric examinations must be conducted for all persons exposed to excessive noise.
- The audiometric examination has to be conducted by a person who has undergone a training course acceptable to the Commissioner for WSH.
- All examinations shall be arranged by the employer at his expense:
  - i. The employer is to grant paid leave of absence to that person required to undergo such medical examinations;
  - ii. The employer is to keep the report of every medical examination of each person exposed to excessive noise for a period of at least five years from the date of the medical examination; and
  - iii. The results of the examinations are to be summarised in the “Summary Report of Examinations” and submitted to the Commissioner for WSH annually.
- The employer has to keep a record of persons who are or have been exposed to excessive noise in the last five years.
- The occupier of the factory shall permit the DWD to inspect the premises of the workplace and any process or work that the person being examined by the DWD is to be employed in.

### **7.1.1 Audiometric Examinations Records and Forms**

Records of audiometric examinations must be kept for at least five years from the date of examination. A Summary Report of the Examinations, together with the abnormal audiometric examination results should be submitted annually to the Occupational Safety and Health Division, Ministry of Manpower. The following are designed for use in meeting the statutory requirements:

#### **i. Audiometric Examinations**

- This documents each employee's hearing status at the time of examination.
- It allows the doctor or employer to observe progression of the hearing status.
- The DWD could include certification of fitness or unfitness together with the results of the audiometric examinations.
- The employer should file results of the audiometric examinations for each worker chronologically.
- Copies of abnormal results are to be included with the Summary Report of Examinations.

#### **ii. Certificate of Fitness**

- Certification by the DWD that the employee is fit or unfit for noise exposure at pre-employment testing or upon re-exposure after being transferred out.

#### **iii. Certificate of Suspension**

- Certification by the DWD that the employee should not work in the noisy environment for a particular period of time.

#### **iv. Register of persons exposed to excessive noise**

- Know who are at risk of developing NID and should undergo regular medical examinations.
- The register should be kept up-to-date at all times.
- The DWD would summarise the findings of a round of medical examinations in a Summary Report of Examinations for exposure to excessive noise. The Occupational Safety and Health Division requires a copy of the Summary Report of Examinations to be submitted annually to the Division together with the results of the abnormal audiograms.

### **7.1.2 Notification Procedure**

Under the WSH (Incident Reporting) Regulations, persons suspected to be suffering from NID have to be notified to the Commissioner for WSH. The employer of that employee shall submit a report to the Commissioner, no later than 10 days after receipt of the written diagnosis prepared by the registered medical practitioner diagnosing the NID. Similarly, any registered medical practitioner who diagnoses any employee with NID shall, no later than 10 days after the diagnosis, submit a report to the Commissioner. Any notification or reporting shall be made in such form and manner as set out on the website [www.mom.gov.sg/iReport](http://www.mom.gov.sg/iReport)

## 7.2 Audiometric Examinations

Accurate audiometric results help to ensure correct interpretation of findings and correct diagnosis. The results also help reduce employees and employer's anxiety from false outcome and time wastage from repeat tests.



Figure 16: Giving pre-test instructions.



Figure 17: Conducting the audiometric examination.

### 7.2.1 Achieving an Accurate Test Result

#### Pre-test instruction to employees

Employees should not be exposed to noise for at least 16 hours before the test. Employees who are suffering from a cold, chest infection, sore throat or ear ache should seek medical advice prior to the test. This is to ensure that the test results reflect the employee's actual hearing levels.

#### Acoustic environment

The background noise level can interfere and affect the accuracy of the test results. Therefore, testing should be conducted in a proper booth where the background noise level does not exceed the levels given below. The DWD should check that the audiometric testing facilities meet the standard.

#### Maximum Allowable Octave-band Sound Pressure Levels for Audiometric Test Booths

The background noise levels in audiometric booths should be within the following values.

Octave-band Centre Frequency (Hz)	Sound Pressure Level (dB)
250	40
500	40
1000	40
2000	47
4000	57
6000	62
8000	67

## **Audiometer**

DWDs should ensure that their audiometers are calibrated regularly.

## **Testing procedure**

Testing should include air conduction testing and/or bone conduction testing. If the air conduction test results are abnormal (i.e., more than 30 dB(A)), bone conduction testing is required.

## **Role of audiometric technician**

The tester is responsible for an accurate test result and is required under the WSH (Medical Examinations) Regulations to undergo formal training in industrial audiometry.



Figure 18: An audiometer.

## **7.2.2 Role of Designated Workplace Doctor**

The DWD has to ensure that the audiometric testing facilities meet the conditions stated in Section 5.2.1 and employees are given proper pre-test instructions.

The DWD has to examine all newly discovered abnormal cases as an abnormal audiometric result may be the result of causes other than occupational noise. Cases previously diagnosed as NID may need to be reviewed if there is deterioration in the hearing status. To help the doctor reach a diagnosis, all serial audiograms (past audiograms) should be made available to him.

The DWD may not conduct the actual audiometric test but has to ensure that the employee is informed of the results of the test. The DWD has to advise the employee on measures to prevent further hearing loss. The employee should also be taught the correct technique of wearing hearing protectors and the possibility of being transferred to a non-noisy place if significant deterioration in hearing is found during the next medical examination.

If an employee needs to be transferred, the DWD will issue a Certificate of Suspension to the employee, his employer and the Commissioner for WSH.

In addition, the DWD should assist the employer in evaluating the test results and identifying employees at risk of hearing loss. With this information, management can plan preventive measures and prioritise their actions. Any follow up action arising from such evaluation should be implemented and documented by the company.

# 8. Record Keeping

The objective of record keeping is to document HCP activities. As NID occurs gradually upon exposure to excessive noise, complete documentation can also aid in retaining information needed for the evaluation on the effectiveness of the preventive and control measures.

## 8.1 Types of Records

The records should include all items listed below for each element of the programme:

- HCP policy statement;
- Records of noise monitoring made available for at least 10 years from the date of monitoring;
- Records of risk assessment kept available for at least three years;
- Noise Control Plan kept available for at least three years;
- Documentation of noise control solutions;
- Documentation to show the issue, fitting and training of hearing protectors;
- Documentation of employee's training;
- Records of audiometric calibration data (for audiometric technician);
- Records of audiometric examinations kept for at least five years from the date of examination;
- Records of follow up actions in response to employees' hearing threshold shifts; and
- Records of programme evaluation.

The records should include the names of the personnel who performed the HCP tasks, date of the records and results.

## 8.2 Management's Responsibilities in Record Keeping

Management should ensure that adequate resources are provided for efficient record processing, review and storage. In addition, management should ensure that confidentiality of personal data is maintained and the records are available to WSH inspectors and authorised personnel such as occupational physicians, DWDs and nurses. Employees should also be allowed access to his/her records.

# 9. Programme Evaluation

Evaluation of a HCP is required to determine the effectiveness of the programme in preventing NID and to identify any gaps with specific elements for immediate corrective actions to be taken. The evaluation should be performed on a periodic basis to ensure continual improvements and involves a team effort.

## 9.1 Approaches to Programme Evaluation

Three approaches can be used to evaluate the effectiveness of the HCP:

**i. Assess the completeness and quality of the programme elements**

The evaluation can be performed through the use of a checklist as shown in Annex D.

**ii. Analysis of employees' audiometric test records**

Audiometric test records provide the data that can be used to determine whether the programme is effective in preventing NID. Current audiometric examination results of the exposed employee can be compared to his/her previous audiograms to identify hearing loss progression.

Results of individual employee can also be compared to the results of other employees with similar noise exposure. If all the employees with similar noise exposure exhibit increased hearing loss, it suggests that the existing noise control measures are not effective. Nevertheless, if significant threshold shift occurs only for one employee, it suggests that the employee may not be wearing the required hearing protectors properly and consistently or is likely to be exposed to excessive noise from off-the-job activities. In such cases, the employee will have to be counselled and the training content and methodology will have to be reviewed.

**iii. Gather feedback from the employees**

As employees are one of the key participants in the HCP, they should be encouraged to provide feedback on the merits or shortcomings of the programme and offer suggestions that can improve the HCP. To maintain active participation from the employees, management and the HCP team should be receptive to the feedback and respond actively in making modifications to address the deficiencies when necessary.

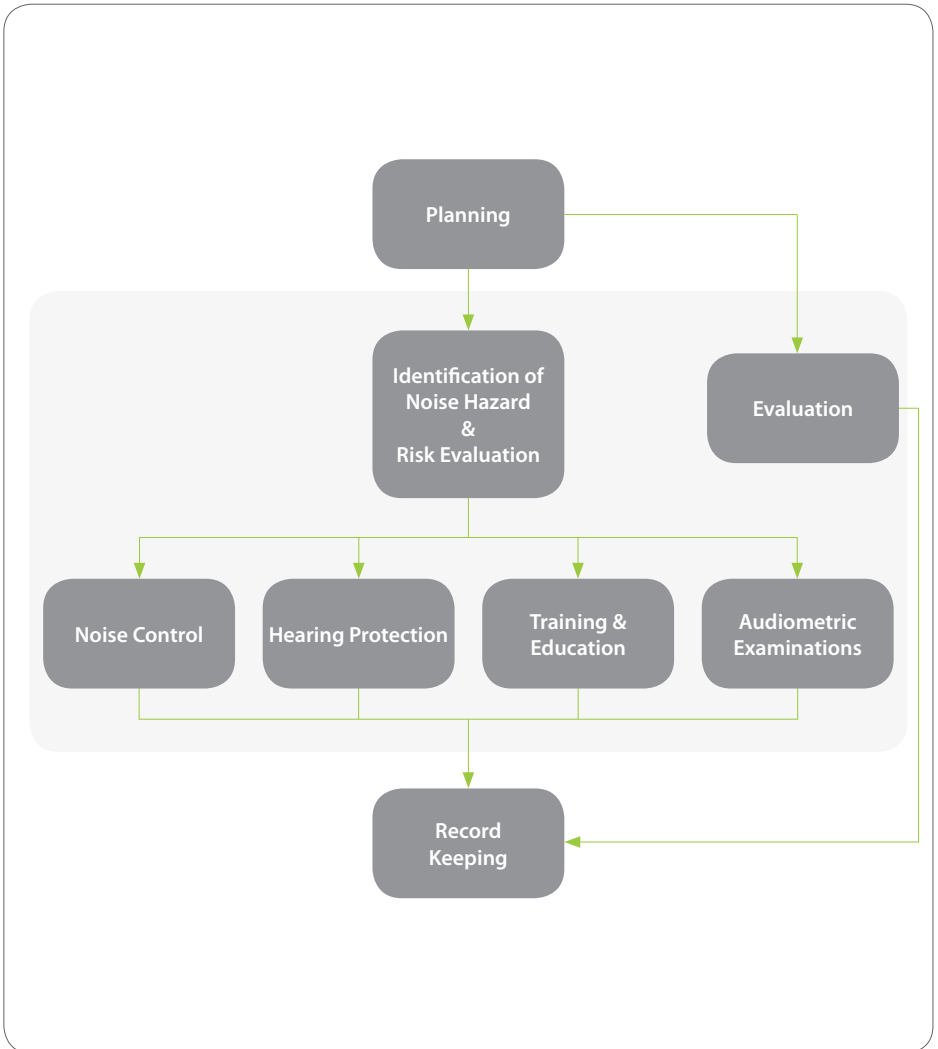
The management needs to be committed to act on the outcome of the programme evaluation. They should promptly acknowledge and correct any deficiencies identified.



# 10. Annexes

## Annex A:

### Hearing Conservation Programme for Managing Noise Risk



## Annex B:

### Guidelines on Noise Monitoring and Submission of Reports

#### Introduction

Noise monitoring is a quantitative assessment of persons exposed to noise. It helps to identify persons at risk from excessive noise. It is one of the key elements in the Hearing Conservation Programme (see Appendix 1 of Annex B) which aims to conserve the hearing of persons exposed to excessive noise.

Under the WSH (Noise) Regulations (hereby referred to as Noise Regulations), the occupier of a workplace shall appoint a competent person to conduct regular noise monitoring if there are 10 or more persons exposed to, or are likely to be exposed to excessive noise at the workplace. The competent person must correctly interpret the results of noise monitoring, prepare a noise monitoring report and submit the report to the occupier. The occupier will keep the report as records and submit a copy to the Commissioner for WSH.

These guidelines provide guidance in carrying out noise monitoring and in preparation for submission of Noise Monitoring Reports in accordance with the Noise Regulations.

#### Legal Requirements

Under the Noise Regulations, it is mandatory for all workplaces to conduct noise monitoring at least once every three years if there are 10 or more persons exposed, or likely to be exposed to excessive noise. In the Noise Regulations<sup>1</sup>, a person is deemed to be exposed to excessive noise if the noise that he will be exposed to when not wearing any hearing protectors exceeds:

- PEL for noise specified in the Schedule of the Noise Regulations;
- An equivalent sound pressure level of 85 dB(A) over an 8-hour work day, in any case where the noise is at a fluctuating sound pressure level; or
- Peak sound pressure level exceeding 140 dB(C).

Noise monitoring shall be conducted by a competent person who has attended and passed an approved training course such as the Noise Monitoring Officer course conducted by Accredited Training Providers (ATPs). The competent person shall carry out noise monitoring using:

- Recognised methods;
- Accepted standard procedures; and
- Suitable equipment which is properly calibrated to ensure accuracy.

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<sup>1</sup> For the WSH (Noise) Regulations, visit <http://www.mom.gov.sg/legislation/occupational-safety-health/Pages/default.aspx>

The competent person must properly interpret the results of the monitoring, prepare a report of the results of the monitoring and submit it to the occupier of the workplace, no later than 14 days after the monitoring.

Upon receiving the report, the occupier must communicate the contents of the report to all relevant persons within 14 days and submit a copy to the Commissioner for WSH no later than 30 days. The method for submission can be found on Page 39. The records of noise monitoring should be kept by the occupier for at least 10 years.

## Instrumentation

Competent persons conducting noise monitoring should ensure that the equipment used during monitoring should minimally meet the following standards:

- **Sound level meters**, including the microphone and associated cables must meet the requirements for *IEC 61672-1:2002 Electroacoustics - Sound level meter - Part 1 Specifications*, Class 1 or Class 2. Class 1 instrumentation is preferred and should be used when measuring noise dominated by high frequencies.
- **Dosimeters**, including the microphone and associated cables must meet the requirements specified in *IEC 61252 Electroacoustic. Specifications for personal sound exposure meters*. Dosimeters fulfilling the requirements of IEC 61672-1:2002, Class 1, are recommended and should be used when measuring noise dominated by high frequencies.
- **Calibrators** shall meet the requirements specified in *IEC 60942:2003 Electroacoustics - Sound calibrators*, Class 1.

In addition, the calibration of the instruments should be verified at intervals in a laboratory making calibrations traceable to appropriate standards. It is recommended that the instruments should be verified at intervals not exceeding 12 months. The date of the last verification and name of the laboratory that verified it should be recorded in the monitoring report.

## Method for Assessing Noise Exposure

### Defining Similar Exposure Groups

Every worker who is exposed to or is likely to be exposed to excessive noise must be included in the Noise Monitoring exercise. However, some workplaces employ a large number of workers who are exposed to excessive noise. A better alternative of utilising resources for noise monitoring is statistical monitoring that collects sufficient noise exposure data to make informed decisions. This can be achieved by grouping workers who have similar noise exposure (e.g., perform the same tasks, have similar job functions, or work in the same area), into similar exposure groups (SEGs).

A well defined SEG helps to minimise the variability of exposure monitoring data. Regardless of how the groups are defined, it is important that they must be verified in consultation with the workers and supervisor. The maximum number of workers per SEG is 50, as specified in Table 4.

**N.B.** Competent persons must justify the reasons for classifying each SEG and include the justifications as part of the Noise Monitoring Report.

## Determining Daily Noise Exposure Levels

After the SEG is defined, workers from the SEG are randomly selected to be assessed for their daily noise exposure levels. The number of subjects per SEG is provided in Table 4. It is important for the competent person to maintain randomness in the approach to select workers for assessing noise exposure. For example, it is not appropriate to exclude workers on days when their exposure are likely to be “less than normal” due to a scheduled training class, personnel meeting, or other activities carried out in a quiet setting.

A personal monitoring, sometimes known as dosimetry, gives a more accurate representation of the worker’s exposure to noise during his entire work shift. The dosimeter which is used for personal monitoring stores the noise level measured during the monitoring and averages the data that it collects concurrently. At the end of the monitoring, a Sound Pressure Level versus Time plot (hereby referred to as the Sound Level Profile) can be retrieved from the accompanying computer software.

For practical reasons, it may not be possible to measure the noise levels over the entire working day. In these cases, measurements should as far as possible, be taken during the major part of the day (~80% of the work shift) and at least cover all significant periods of noise exposure.

At the end of the personal monitoring, the validity of the measurement should be examined by the worker and a competent person so as to identify the different tasks and events logged by the dosimeter.

Monitoring should be assessed carefully to ensure estimation with reasonable confidence. To identify the top 20% noise exposed persons within a 95% confidence level, refer to Table 4<sup>2</sup> to determine the number of dosimetry samples required.

**N.B.** Competent persons conducting the dosimetry must include the following items in the Noise Monitoring Report:

- Criterion Level;
- Exchange Rate;
- Threshold; and
- Name and identification number (NRIC/FIN) of worker monitored.

<b>Total Number in Job (N)</b>	7-8	9-11	12-14	15-18	19-26	27-43	44-50
<b>Required Number of Samples (n)</b>	6	7	8	9	10	11	12

**Table 4: Sample Size for Top 20% and Confidence 0.95.**

Note: Use n=N if N≤6

2 Leidel, N.A., Busch, K.A., and Lynch, J.R. (1977). “Occupational Exposure Sampling Strategy Manual,” NIOSH Publication No. 77-173, U.S. Department of Health, Education, and Welfare, Cincinnati, OH.

### **Determining Noise Levels Emitted by Machines**

Machine noise levels must be monitored and recorded, including unwanted sounds emitted by machines, especially those in the manufacturing sectors. Monitoring machine noise levels also ensures that the noisiest machine receives the top priority for allocation of budget for noise controls. Majority of the noisy machines generate noise similar to the patterns listed in Table 5. Competent persons should record the noise levels in accordance with the recommended sampling method for each noise pattern as closely as possible.

For each machine, at least three measurements should be taken and the average result is recorded. It is recommended that noise levels be measured at different times during the task or at different areas having the same machine type or model to ensure that the variation in noise levels is captured.

**N.B.** If it is not possible to follow the recommended sampling method, the competent person should verify his method and justification should be included as part of the Noise Monitoring Report.

### **Calibrating the Dosimeter or Sound Level Meter Before and After Monitoring (Field Calibration)**

Field calibration includes an acoustic calibration check of the dosimeter or sound level meter and should be performed with a sound calibrator at a quiet location. At the start of each dosimetry, a field calibration with appropriate adjustments should be performed. At the end of the dosimetry, a field calibration without adjustment should be performed. If the reading at any frequency at the end of a dosimetry differs from the reading of that frequency at the beginning by more than 0.5 dB<sup>3</sup>, the results should be discarded.

**N.B.** Competent persons should include documentary proof of field calibration (dosimetry or machine noise measurements).

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3 BS EN ISO 9612:2009 Acoustics. Determination of occupational noise exposure. Engineering method.

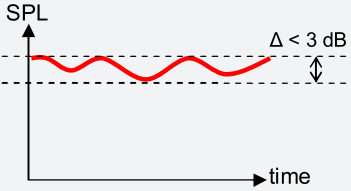
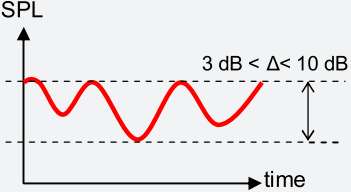
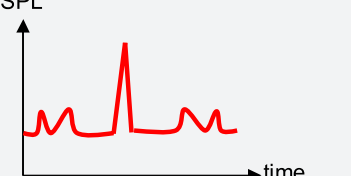
Machine Noise Patterns	Sampling Method
<p><b>Steady Noise</b></p>  <p>The graph shows Sound Pressure Level (SPL) on the vertical axis and time on the horizontal axis. A red line fluctuates slightly around a central horizontal dashed line. A vertical double-headed arrow to the right of the line indicates the fluctuation range, labeled as <math>\Delta &lt; 3 \text{ dB}</math>.</p>	<p><b>Description:</b> Noise levels are fairly steady and meter reading on slow response does not fluctuate more than 3 dB.</p> <p><b>Method:</b> A spot measurement, as close to the operator's hearing zone as possible.</p> <p><b>Duration:</b> At least 5 minutes. If task duration is less than 5 minutes, measurement duration shall be equal to the duration of the task.</p>
<p><b>Fluctuating Noise</b></p>  <p>The graph shows SPL on the vertical axis and time on the horizontal axis. A red line fluctuates more significantly than in the steady noise graph. A vertical double-headed arrow to the right indicates the range, labeled as <math>3 \text{ dB} &lt; \Delta &lt; 10 \text{ dB}</math>.</p>	<p><b>Description:</b> Noise levels are not steady and meter reading on slow response varies over a 3 to 10 dB range.</p> <p><b>Method:</b> A spot measurement, as close to the operator's hearing zone as possible.</p> <p><b>Duration:</b> Sufficient to include the maximum and minimum readings and at least 5 minutes (for average results). If task duration is less than 5 minutes, measurement duration shall be at least equal to 3 times the duration of the task.</p>
<p><b>Impulse/Impact Noise</b></p>  <p>The graph shows SPL on the vertical axis and time on the horizontal axis. A red line shows a sharp, high-amplitude peak (impulse) followed by smaller, lower-amplitude fluctuations.</p>	<p><b>Description:</b> A sudden loud noise that differs greatly from the normal noise levels experienced in the workplace.</p> <p><b>Method:</b> A spot measurement, as close to the operator's hearing zone as possible.</p> <p><b>Duration:</b> Sufficient to capture the peak sound level on the 'A' weightage and the 'C' weightage scales.</p>

Table 5: Noise Patterns and Recommended Sampling Method.

## Presentation of Results

### Noise Maps and Machine Noise

Noise mapping is an important aid to visualise the work locations and noise exposure levels on a general layout plan of the workplace. Depending on the layout of the workplace, a noise map can be prepared by demarcating the workplace in the form of:

- Grid;
- Radial;
- Contour; or
- Other patterns.

The competent person can apply one or a combination of the above methods to ensure the noise mapping is done accurately and objectively to indicate the noise levels at the workplace.

In the noise maps, areas with excessive noise (i.e., any machine or area, after averaging at least three spot measurements, those with measurements more than 85 dB(A)) must be clearly indicated in the periphery of the machine or area depending on the segregation method deployed. A sign indicating the need for hearing protection should also be posted.

Noise mapping is covered in greater detail in the training of the competent persons and therefore, will not be covered in this set of guidelines.

On the noise maps, the competent person should measure the average sound pressure level by spot measurements of each machine and include the measurements in the final report. Depending on the workplace monitored, the noise from the machine to be measured can vary extensively and the competent person should try to include all machines at the workplace for noise measurement.

### **Results Table**

The results of each dosimetry obtained shall be summarised and tabulated in accordance with the Results Table (see Appendix 2).

The Results Table should minimally address the following:

- Identification of jobs, work, operations or processes that expose workers to excessive noise. The descriptors are either  $L_{Aeq,8\text{ hr}}$  in dB(A) or peak noise level in dB(C);
- Noise results rounded up to a whole number. For example, if a dosimetry measures 96.7 dB(A), the result should be rounded up to 97 dB(A); and
- A statement stating work conditions (or otherwise) at the point the noise measurements were taken and description of the work activities carried out.

### **Recommendation to Implement a Hearing Conservation Programme**

In a workplace where workers are exposed to excessive noise, the competent person who compiles the Noise Monitoring Report, must include a Recommendation section (see Appendix 4) that addresses the workplace's shortfalls after implementing a HCP.

The recommendations shall include, but are not limited to the following:

- Identify the noisy processes, operations or work, equipment and machines;
- Conduct a risk assessment, or revise the existing risk assessment and include noise as a potential hazard at workplace. Evaluate its risk and identify control measures to be implemented to control and reduce the noise levels at the workplace;
- Identify person(s) who require hearing protection devices (HPDs) and:
  - Recommend suitable type of HPDs according to Singapore Standard *SS 549: 2009 Code of practice for selection, use, care and maintenance of hearing protectors*; and
  - Recommend training topics or materials for responsible persons to train workers exposed to excessive noise annually, on topics such as the correct method of putting on the HPD and the frequency to replace the protectors provided to ensure their effectiveness.

- Post appropriate signs, warning of the noise hazard reminding workers to put on HPDs. Warning signs should be posted at all entrances to and at the periphery of all areas of the workplace in which noise is excessive;
- Identify areas with excessive noise levels and ensure that all workers in these areas have gone through periodic audiometric examinations. Audiometric examinations shall be carried out by person who has undergone a course of training in audiometric screening acceptable to the Commissioner for WSH; and
- Identify areas with excessive noise levels and ensure that any new worker in the area is certified fit for work by a DWD, no later than three months after the date he commences work.

## **Noise Monitoring Report**

After conducting the noise monitoring, the competent person must prepare a Noise Monitoring Report (see page 40 for sample) and submit it to the occupier for risk assessment of noise hazard.

The occupier must retain a copy of the Noise Monitoring Report for at least 10 years. The same report must be submitted to the Commissioner for WSH, Ministry of Manpower.

There are two ways to submit Noise Monitoring Reports to the Commissioner for WSH:

### **Method 1 – Soft Copy (Recommended Method)**

Submit online. More information on e-submission can be found on:

<http://www.mom.gov.sg/workplace-safety-health/worker-workplace-surveillance/workplace-health-surveillance/Pages/NoiseMonitoringReportSubmission.aspx>

**N.B.** A scanned copy of the Report must be uploaded during the e-submission. All relevant documents must also be uploaded during the e-submission to prevent delays in approving the reports. Maximum file size is 3 MB per file. Multiple uploads are acceptable.

If you experience technical difficulties in submitting your report electronically, you may contact us at [mom\\_oshd@mom.gov.sg](mailto:mom_oshd@mom.gov.sg) or refer to our website at [www.mom.gov.sg](http://www.mom.gov.sg) for more details.



# Noise Monitoring Report (Sample)

## Workplace Safety and Health (Noise) Regulations Regulation 7(1) Noise Monitoring Report

### Part A. Details of Competent Person

Name: \_\_\_\_\_ NRIC No.: \_\_\_\_\_

### Part B. Details of Workplace Monitored

Name of Workplace: \_\_\_\_\_

Workplace Number: \_\_\_\_\_

Address: \_\_\_\_\_

Tel No.: \_\_\_\_\_ Fax No.: \_\_\_\_\_

Date and Time of Monitoring: \_\_\_\_\_

### Part C. Workplace Representative(s)

Name: \_\_\_\_\_ Designation: \_\_\_\_\_ Tel No.: \_\_\_\_\_

Name: \_\_\_\_\_ Designation: \_\_\_\_\_ Tel No.: \_\_\_\_\_

Name: \_\_\_\_\_ Designation: \_\_\_\_\_ Tel No.: \_\_\_\_\_

### Part D. Details of Instrumentation

Instrument	Brand	Model	Serial No.	Type	Date of Last Calibration

Calibrator Used (Brand/Model/Serial No.) \_\_\_\_\_

### **Part E. Certification**

Attached to this report is a copy of the following certificates and documents:

- Certificate of the competent person (after completing the relevant training courses);
- Certificate of primary calibration (as per manufacturer's recommendations); and
- Printouts of field calibration (before and after monitoring).

### **Part F. Noise Map & Machine Noise Levels**

Attached to this report is a copy of the following:

- Layout plan clearly highlighting areas or machines with sound pressure levels above 85 dB(A); and
- A separate table collating the noise levels emitted by individual machine at the workplace and an indication of the number of hours the machine operates on a normal working day.

### **Part G. Results Table for Personal Monitoring**

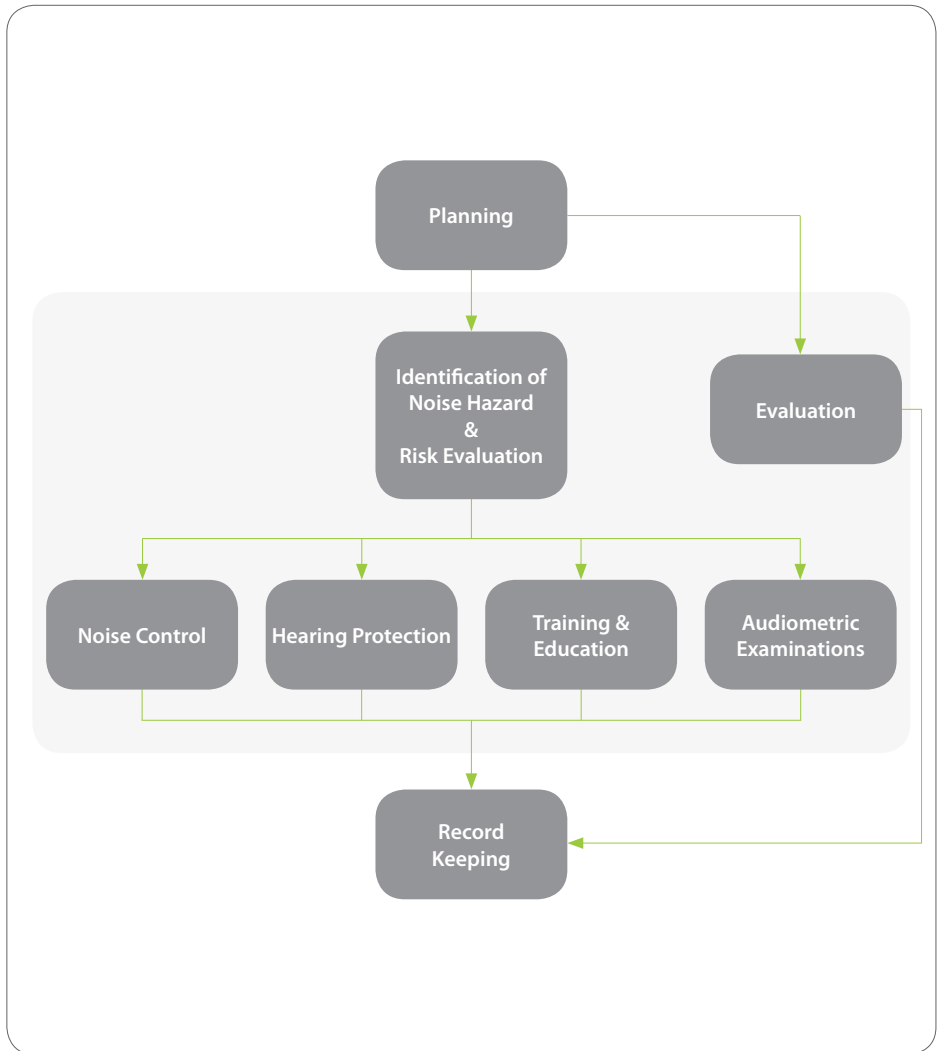
A Results Table for the dosimetry conducted for workers from different SEGs is attached, and workers who are exposed to excessive noise are clearly highlighted and identified.

### **Part H. Recommendations for Implementation of Hearing Conservation Programme**

The monitored workplace is assessed for the implementation of a HCP and the findings are included in this report. Any shortfalls in the implementation are highlighted and the occupier is briefed on how to implement the various elements.

**N.B.: All parts, i.e., Part A to H, must be completed and submitted in the Noise Monitoring Report, unless otherwise specified. Any submitted report that is missing any part(s) may render the report incomplete and be considered as not submitted.**

## Appendix 1 - Hearing Conservation Programme



## Appendix 2 - Results Table (Personal Monitoring)

Part G (rev.1). Results Table (Personal Monitoring)

S/N	Process /Activity	Name of Person Monitored	NRIC/FIN of Person Monitored	SEG No.	No. of persons in the SEG	$L_{Aeq,T}$ dB(A)	Running Time of Dosimeter (minutes)	Duration of Exposure Per Day (minutes)	$L_{Aeq,8hr}$ dB(A)	% Dose	Remarks

Part G (rev.1). Results Table (Machine Noise Levels)

S/N	Machine /Equipment	Process /Activity	No of person(s) likely to be exposed	$L_{Aeq,T}$ dB(A)	Measurement Time (Minutes)	Remarks

### N.B:

- Each dosimetry should occupy one row of the Results Table. Please specify all activities under Job Description column.
- If any worker is exposed to excessive noise, his results should be clearly highlighted to stand out from those that are not.
- $L_{Aeq,T}$  is the equivalent sound pressure level measured over a period of time T.  $L_{Aeq,8h}$  is the equivalent sound pressure level measured over an 8-hour work shift. Duration of exposure per day is the time the person is exposed to noise at the corresponding level during a normal work shift.

SEG = Similar Exposure Group

### Appendix 3 - Recommendations for Implementation of HCP for Noisy Workplaces (An Example)

S/N	Element of HCP	Implemented <sup>4</sup> (Y/N)	Remarks
1	<b>Identification of Noise Hazard</b> Risk assessment identifies noise as a hazard and controls are put in place to manage exposure.	Yes	Supporting documents
	Noise monitoring successfully identifies work stations or tasks exposing workers to excessive noise.	Yes	Supporting documents
2	<b>Noise Control Plans</b> If there are more than 50 workers exposed to excessive noise, the legal requirement for a Noise Control Officer is made known to the occupier/responsible person(s).	Yes	Included in Noise Monitoring Report
	If the company has more than 50 workers exposed to excessive noise, a long term and short term plan are put in place to manage excessive noise at the workplace.	No	<b>Short Term:</b> Provide hearing protectors to exposed workers. <b>Long Term:</b> Company to appoint a Noise Control Officer to advise on all noise control solutions. <b>N.B.</b> All reasonably practicable noise controls must be explored. The provision of hearing protectors is a short term measure while long term controls are being implemented.

<sup>4</sup> Implementation at the point of compiling the Noise Monitoring Report.

S/N	Element of HCP	Implemented <sup>4</sup> (Y/N)	Remarks
3	<b>Audiometric Examinations</b> If any worker is exposed to excessive noise, he is included in the list of workers to be examined for hearing loss (including audiometric examinations) annually.	Yes	Supporting documents
	Any new worker expected to be working in the identified noisy areas must have a pre-placement audiometric examination conducted no later than three months of commencing work in the workplace.	Yes	Supporting documents
	Audiometric examinations are carried out by trained persons i.e., industrial audiometric technicians.	Yes	Supporting documents
4	<b>Training and Education</b> If any worker is exposed to excessive noise, he is included in the list of workers to be trained annually. Any new workers who are expected to be working in the identified noisy areas must be trained within three months of commencing work in the workplace. The training topics should include the following: <ul style="list-style-type: none"> <li>- Relevant provisions of the WSH Act and Noise Regulations;</li> <li>- Effects of noise on hearing;</li> <li>- Purpose of hearing protectors;</li> <li>- Advantages, disadvantages and attenuation of various types of hearing protectors;</li> <li>- Selection, use, care and maintenance of hearing protectors;</li> <li>- Purpose of hearing tests and appropriate procedures and requirements of such tests; and</li> <li>- Any other relevant topics.</li> </ul>	Yes	Supporting documents
	Hazard identification of noisy areas/machines/processes including posting of warning signs displaying the typical noise levels and the requirement of wearing hearing protectors when working or entering the area. Warning signs should be posted at all entrances or at periphery of all areas of the workplace identified to be noisy.	No	<ul style="list-style-type: none"> <li>• Supporting documents</li> <li>• Evidence to support claims that warning signs are being posted in noisy areas.</li> </ul>

S/N	Element of HCP	Implemented* (Y/N)	Remarks
5	<p><b>Provision of Personal Protective Equipment</b></p> <p>Workers working in the identified noisy areas must be provided with hearing protectors while long term controls are being put in place. There should be an issue and maintenance record.</p>	Yes	Supporting documents
	<p>Workers are instructed on the proper use, care, maintenance and change of the hearing protectors.</p>	Yes	Supporting documents

# Annex C

## Sample Noise Hazard Identification Checklist

Department : \_\_\_\_\_

Processes Involved : \_\_\_\_\_

Conducted By : \_\_\_\_\_

Employee Representative : \_\_\_\_\_

Date : \_\_\_\_\_

Checking “Yes” to any of the following items indicates a need for a detailed noise assessment.

Items to be checked	Yes	No	Remarks
1. Is it difficult for the employees to carry out normal conversation without raising their voices at the current noise level?			
2. Is there any feedback from the employees regarding the difficulty of hearing warning shouts or alarms?			
3. Do any of the employees involved in the work process experience a reduction in hearing over the course of their work? (The reduction in hearing can also occur after work.)			
4. Do any of the employees experience any of the following conditions: <ul style="list-style-type: none"> <li>- Ringing or buzzing in the ears;</li> <li>- Unequal hearing in one ear compared to the other ear; or</li> <li>- Muffled hearing?</li> </ul>			
5. Has the company made compensation claims to any employees for NID?			
6. Does any machine or equipment in the work area contain manufacturer's noise label that indicates that noise levels generated by the machine or equipment can exceed 85 dB(A)?			
7. Do the records of the audiometric examinations show that any past or present employees have suffered NID?			
8. Does your workplace belong to a noisy industry, for example, construction, woodworking, metal working, canning, bottling, ship building or repairing?			
9. Are there any noisy processes, for example, hammering, punching, pressing, stamping, grinding, cutting, or usage of pneumatic tools being carried out at the work area?			





## Annex E

### Sample Hearing Conservation Programme Evaluation Checklist

**Date of Evaluation:**

Name of Evaluators	Designation	Signatures

Checking "No" to any of the following items indicates a need for corrective actions to be taken to address the deficiencies.

1. Planning for Hearing Conservation Programme	Yes	No	Remarks
<ul style="list-style-type: none"> <li>Is a programme administrator appointed for the Hearing Conservation Programme (HCP)?</li> </ul>			
<ul style="list-style-type: none"> <li>Does the programme administrator have the relevant knowledge to coordinate all aspects of the programme? (Relevant knowledge includes: Understanding of the individual elements of the HCP, relevant provisions of the legislation, effects of noise on hearing and the purpose of hearing protectors and audiometric examinations.)</li> </ul>			

#### Elements of Hearing Conservation Programme

2. Identification of Noise Hazard	Yes	No	Remarks
<ul style="list-style-type: none"> <li>Has risk assessment been conducted and documented for all noisy processes?</li> </ul>			
<ul style="list-style-type: none"> <li>Is the risk assessment reviewed and revised at least once every three years; and upon occurrence of any bodily injury or significant change in work practices or procedures?</li> </ul>			
<ul style="list-style-type: none"> <li>Is the noise monitoring performed once every three years or when there are changes in the conditions which are likely to cause any persons in the workplace to be exposed to excessive noise (more than 85 dB(A) over eight hours)? (For workplaces with 10 or more persons exposed to excessive noise.)</li> </ul>			
<ul style="list-style-type: none"> <li>Is the noise monitoring conducted by a competent person?</li> </ul>			
<ul style="list-style-type: none"> <li>Is the noise measuring equipment used for noise monitoring calibrated before use?</li> </ul>			

<ul style="list-style-type: none"> <li>Is a copy of the noise monitoring report submitted to the Ministry of Manpower, and kept available for at least 10 years?</li> </ul>			
<ul style="list-style-type: none"> <li>Are the contents of the report communicated to all persons exposed to excessive noise not later than 14 days after preparation of the report?</li> </ul>			
<ul style="list-style-type: none"> <li>Is the latest noise monitoring result compared with the previous report to determine if there is any significant change in noise levels?</li> </ul>			
<ul style="list-style-type: none"> <li>Have appropriate steps been taken to include or exclude workers in the HCP whose exposures have changed significantly?</li> </ul>			
<b>3. Noise Control</b>	<b>Yes</b>	<b>No</b>	<b>Remarks</b>
<ul style="list-style-type: none"> <li>Are all practicable measures taken to reduce or control noise from any machinery, equipment or processes such that no employees are exposed to excessive noise?</li> </ul>			
<ul style="list-style-type: none"> <li>Is a competent person appointed to advise the management on proper noise control measures? (For workplaces with 50 or more persons exposed to excessive noise.)</li> </ul>			
<ul style="list-style-type: none"> <li>Are employees encouraged to participate in the development of noise control measures?</li> </ul>			
<ul style="list-style-type: none"> <li>Are noise emission levels considered during the selection and procurement of new machines?</li> </ul>			
<ul style="list-style-type: none"> <li>Is a noise control plan to reduce the excessive noise through engineering controls established?</li> </ul>			
<ul style="list-style-type: none"> <li>Is the noise control plan implemented?</li> </ul>			
<ul style="list-style-type: none"> <li>Is the noise control plan reviewed at least once every three years after noise monitoring is conducted?</li> </ul>			
<ul style="list-style-type: none"> <li>Are the noise control projects monitored to ensure timely completion?</li> </ul>			
<ul style="list-style-type: none"> <li>When the implementation of engineering controls is not reasonably practical, are the administrative controls implemented to reduce employees' exposure to excessive noise?</li> </ul>			
<ul style="list-style-type: none"> <li>Is noise monitoring performed after noise control to evaluate the residual risk?</li> </ul>			
<ul style="list-style-type: none"> <li>Is a maintenance programme established to ensure that all noise control systems or devices remain effective and do not deteriorate over time?</li> </ul>			

4. Hearing Protectors	Yes	No	Remarks
<ul style="list-style-type: none"> <li>• Are suitable hearing protectors provided to all persons exposed to excessive noise?</li> </ul>			
<ul style="list-style-type: none"> <li>• Are procedures established and implemented to ensure that:               <ul style="list-style-type: none"> <li>- Hearing protectors are properly issued and maintained;</li> </ul> </li> </ul>			
<ul style="list-style-type: none"> <li>- Persons exposed to excessive noise use hearing protectors; and</li> </ul>			
<ul style="list-style-type: none"> <li>- Such persons are instructed on the proper use of hearing protectors?</li> </ul>			
<ul style="list-style-type: none"> <li>• Are employees provided with a range of appropriate hearing protectors to allow them to choose the ones which fit them comfortably?</li> </ul>			
<ul style="list-style-type: none"> <li>• Are the hearing protectors checked regularly for wear and defects and replaced immediately when necessary?</li> </ul>			
<ul style="list-style-type: none"> <li>• Are replacements for hearing protectors readily available to employees who are using the disposable hearing protectors?</li> </ul>			
<ul style="list-style-type: none"> <li>• Are warning signs indicating the use of hearing protectors placed at all entrances to areas where persons are or are likely to be exposed to excessive noise?</li> </ul>			
<ul style="list-style-type: none"> <li>• Are regular inspections conducted to ensure that employees wear hearing protectors correctly and consistently in designated areas?</li> </ul>			
<ul style="list-style-type: none"> <li>• Is there an incentive or disincentive scheme in place to encourage employees to put on hearing protection?</li> </ul>			
5. Training and Education	Yes	No	Remarks
<ul style="list-style-type: none"> <li>• Is a training programme implemented and conducted every year for all persons exposed to excessive noise?</li> </ul>			
<ul style="list-style-type: none"> <li>• Is training provided to all new employees within three months of commencing work?</li> </ul>			

<ul style="list-style-type: none"> <li>Does the training programme include instructions in:               <ul style="list-style-type: none"> <li>Relevant provisions of the WSH Act, WSH (Risk Management) Regulation, WSH (Noise) Regulations and WSH (Medical Examinations) Regulations;</li> <li>Effects of noise on hearing;</li> <li>Purpose of hearing protectors and its proper use and maintenance; and</li> <li>Purpose and procedure of audiometric examinations?</li> </ul> </li> </ul>			
<ul style="list-style-type: none"> <li>Is the training content reviewed periodically?</li> </ul>			
<ul style="list-style-type: none"> <li>Does the management demonstrate commitment to HCP by personal example, such as wearing hearing protectors in designated areas and participating in the training programme?</li> </ul>			
<b>6. Audiometric Examinations</b>	<b>Yes</b>	<b>No</b>	<b>Remarks</b>
<ul style="list-style-type: none"> <li>Are all employees who are exposed to excessive noise medically examined by a designated workplace doctor and certified fit to work in the occupation before commencement of work?</li> </ul>			
<ul style="list-style-type: none"> <li>Are yearly audiometric examinations conducted for all persons exposed to excessive noise?</li> </ul>			
<ul style="list-style-type: none"> <li>Are the audiometric examinations performed by competent persons who are properly trained?</li> </ul>			
<ul style="list-style-type: none"> <li>Are records of audiometric examinations kept for at least five years from the date of examination?</li> </ul>			
<ul style="list-style-type: none"> <li>Are the audiometric examination results evaluated to determine information such as identification of high risk group, etc?</li> </ul>			
<ul style="list-style-type: none"> <li>Are the results of the audiometric examinations communicated to the employees?</li> </ul>			
<ul style="list-style-type: none"> <li>Is counselling provided to employees who show significant threshold shifts and are they informed of the preventive measures they can take to avoid further hearing loss?</li> </ul>			
<ul style="list-style-type: none"> <li>Are follow up actions arising from the evaluation of the audiometric results implemented and documented?</li> </ul>			

7. Record Keeping	Yes	No	Remarks
<ul style="list-style-type: none"> <li>Are all records related to the HCP activities (such as noise monitoring records, risk assessment forms, training records, noise control plans, documents on hearing protector issue and fitting, audiometric related records, etc) properly documented, maintained and available for review?</li> </ul>			
8. Programme Evaluation	Yes	No	Remarks
<ul style="list-style-type: none"> <li>Is a thorough evaluation of the HCP conducted on a periodic basis to determine the effectiveness of the programme in preventing noise-induced hearing loss?</li> </ul>			
<ul style="list-style-type: none"> <li>Does the evaluation involve a team effort?</li> </ul>			
<ul style="list-style-type: none"> <li>Are audiometric database analysis used to evaluate the programme's overall effectiveness in preventing noise-induced hearing loss?</li> </ul>			
<ul style="list-style-type: none"> <li>Are employees encouraged to provide feedback on the merits or shortcomings of the programme and to offer suggestions on possible improvements to the HCP?</li> </ul>			
<ul style="list-style-type: none"> <li>Are appropriate steps taken to address the deficiencies identified promptly?</li> </ul>			

# 11. Useful References

Workplace Safety and Health Act and Subsidiary Legislation

<http://www.mom.gov.sg/legislation/occupational-safety-health/Pages/default.aspx>

## International Resources

Canadian Centre for Occupational Health and Safety. Hearing Protectors

[http://www.ccohs.ca/oshanswers/prevention/pppe/ear\\_prot.html](http://www.ccohs.ca/oshanswers/prevention/pppe/ear_prot.html)

Health and Safety Executive. Noise at Work

<http://www.hse.gov.uk/noise/index.htm>

National Institute for Occupational Safety and Health. Noise and Hearing Loss Prevention

<http://www.cdc.gov/niosh/topics/noise/>

Occupational Safety and Health Administration, U.S. Department of Labor. Hearing Conservation. 2002 (Revised)

<http://www.osha.gov/Publications/OSHA3074.pdf>

Singapore Standards can be purchased from:

Toppan Leefung Pte. Ltd.

1 Kim Seng Promenade

#18-01 Great World City East Tower

Singapore 237994

Tel: (65) 6826 9600

Fax: (65) 6820 3341

General enquiries: [enquiries@toppanleefung.com](mailto:enquiries@toppanleefung.com)

## 12. Acknowledgements

This guideline was developed with inputs from Mr Tan Kia Tang, Dr Lucy Leong and Mr Ng Zhihan from the Noise Induced Deafness Prevention Programme Team, Occupational Safety and Health Division, Ministry of Manpower.

We also, acknowledge SPRING Singapore for allowing use of sections from the Singapore Standard *SS 549 : 2009 Code of practice for selection, use, care and maintenance of hearing protectors*.



# 13. Amendments

This set of guidelines replaces the Workplace Safety and Health Guidelines: Hearing Conservation Programme published by the WSH Council in November 2010.

The key amendments in this second edition January 2014 are:

Page	Amendments
39	Removed 'hard copy' method of submission for Noise Monitoring Reports.
40	Included column for capturing date of last calibration for equipments.
43	Reflected changes to example tables according to electronic submissions templates.





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