



Guideline

Noise Management – Principles of Risk Assessment and Control

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1 Introduction

Management of noise exposure in a manner consistent with the National Code of Practice for Noise Management and Protection of Hearing at Work [NOHSC:2009 (2004)] is a regulatory requirement under Regulation 4F of the Petroleum (Submerged Lands) (Occupational Health and Safety) Regulations 1993.

Since 2005, NOPSA has identified during several of its inspections that a significant number of offshore workers were being exposed to noise levels in excess of the prescriptive exposure standards in force.

NOPSA has found that noise management systems are generally not well documented or implemented to demonstrate compliance with the legislation. Successful noise management requires (Leinster et al 1994):

- Leadership from senior managers,
- The ability of middle management (e.g. facility line supervisors and engineers) to implement noise management practices, and
- Specialist technical knowledge of noise and the legislation. Furthermore, the noise specialist should not only have technical knowledge, but also the interpersonal skills to influence others, such as senior and middle management (Jennings, 1999).

Any deficiency in addressing the above elements of the noise management system will contribute significantly to legislative non-compliance. Operators are legally accountable for ensuring that legislative requirements are addressed adequately.

NOPSA has also identified that a significant number of risk assessments conducted to date on offshore facilities either:

- Do not adequately document workforce noise exposures (i.e. risks),
- Do not consider other known risks to hearing, such as exposure to ototoxins,
- Do not state the requirements of the legislation or whether these requirements are actually being met, and
- Do not evaluate and recommend effective control options, following a hierarchy of controls, to meet the intent of the legislation.

The above deficiencies with risk assessment reports has resulted in many operators being misinformed of who is at unreasonable risk and what needs to be done to reduce risks to as low as reasonably practicable (ALARP).

As part of its ongoing commitment to provide specialist advice on occupational health and safety matters NOPSA has produced this Guideline, to assist operators in complying with the current legislation in force.

2 Scope of this Guideline

The *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (OPGGSA) imposes a legal duty of care on an offshore petroleum operator to take all reasonably practicable steps to ensure that the facility they operate is safe and without risk to the health of any person at or near that facility. This over-arching legal duty extends to the management of noise, which is a widely recognised workplace hazard.

With respect to noise management and without limiting the generality of the above duty, an operator of a facility must, as far as reasonably practicable:

- a. Provide and maintain a physical environment at the facility that is quiet and poses no risk to health,
- b. Implement and maintain a noise management system at the facility to ensure that there is no risk to health,
- c. Provide all members of the workforce, in appropriate languages, with information, instruction, training and supervision necessary for them to carry out their activities in a manner that does not adversely affect their health from exposure to noise at the facility, and
- d. Monitor workforce noise exposures and adverse health effects associated with noise, and keep monitoring records.

NOPSA has developed this Guideline to provide operators with practical steps for identifying noise hazards in the workplace, conducting risk assessments and implementing appropriate controls. This process is intended to assist operators with legislative compliance by demonstrating that noise risks are as low as reasonably practicable (ALARP).

Many of the following risk management principles discussed have been adapted from the OGP & IPIECA document “Controlling Health Risks at Work: A roadmap to Health Risk Assessment in the Oil & Gas industry” (2006). This document forms the basis of much of the following Guideline, which NOPSA believes outlines good risk assessment and control practices.

Compliance with this Guideline is not mandatory; however, the risk management principles outlined should assist operators in complying with existing legislation.

3 Prescribed Legislation

- Offshore Petroleum and Greenhouse Gas Storage Act 2006
- Petroleum (Submerged Lands) (Occupational Health and Safety) Regulations 1993
- National Standard for Occupational Noise [NOHSC 1007(2000)]
- National Code of Practice for Noise Management and Protection of Hearing at Work [NOHSC 2009(2004)]

4 Clarification of Terms

ALARP	As Low As Reasonably Practicable
CBA	Cost Benefit Analysis
CAP	Corrective Action Plan
Consequence	The adverse outcome or impact of a particular undesirable event (AS/NZS 4360). E.g. Hearing loss may be a consequence of exposure to harmful levels of noise and/or ototoxins) (AS/NZS 4360).
Control	An existing process, policy, device, practice or other action that acts to minimise adverse risk when correctly implemented and maintained (AS/NZS 4360).
HRA	Health Risk Assessment

JHA	Job Hazard Analysis
LAeq,8h	An averaged 8-hr equivalent continuous A-weighted sound pressure level, measured in dB(A), referenced to 20 micro Pascals in air. LAeq,8h must be determined in accordance with AS/NZS 1269 (NOHSC 1007).
LC,peak	A C-weighted peak (instantaneous) sound pressure level, measured in dB(C) by a sound level meter with a peak detector-indicator characteristic complying with AS 1259.1 (NOHSC 1007).
Likelihood	<p>The probability or frequency that a particular undesirable event will occur (AS/NZS 4360).</p> <p>E.g. The likelihood of being exposed to harmful levels of noise and/or ototoxins.</p>
NIHL	Noise Induced Hearing Loss. A permanent, compensable industrial disease In Australia.
Ototoxin	Substances that may independently, or in combination with noise, cause hearing loss to exposed people (<i>oto</i> = ear, <i>toxin</i> = poison) (Tillman, 2007)
PTW	Permit to Work
Protected exposure	<p>A worker's exposure to noise, which takes into account the protection afforded by personal hearing protectors. Protected exposure may not under any circumstances exceed the noise exposure standard. The correct notation for protected exposure is L(eff)Aeq,8h</p> <p><u>Note:</u> the noise exposure standard (NOHSC 1007) is based on "unprotected" exposure to noise i.e. LAeq,8h, not L(eff)Aeq,8h.</p>
RAM	Risk Assessment Matrix
Risk	<p>The probability that a particular undesirable event will result in a specific consequence, measured in terms of a combination of the consequences of an event and the likelihood of the event occurring (AS/NZS 4360).</p> <p>E.g. The likelihood that exposure to harmful noise levels and/or ototoxins will result in hearing loss.</p>
SEG	Similar Exposure Group. A work group comprised of individuals who carry out similar tasks and are therefore expected to have similar exposure profiles.
Unprotected exposure	<p>A worker's exposure to noise, measured at the worker's ear position, which does not take into account any protection afforded by person hearing protectors (NOHSC 1007). The correct notation for unprotected exposure is LAeq,8h.</p> <p><u>Note:</u> Measurement at the worker's "ear position" means a measurement taken at a horizontal distance of approximately 10cm to no more than 20cm from the entrance of the external canal of the ear receiving the higher noise level</p>

5 Organising a Health Risk Assessment (HRA) for Noise Hazards

There are four stages in the risk management process. They include Identification, Assessment, Control and Recovery (OGP & IPIECA 2006). The management system responsible for implementing these stages is termed a Noise Management System (NMS).

The NMS evaluates noise risks to determine what actions are necessary to reduce them to ALARP.

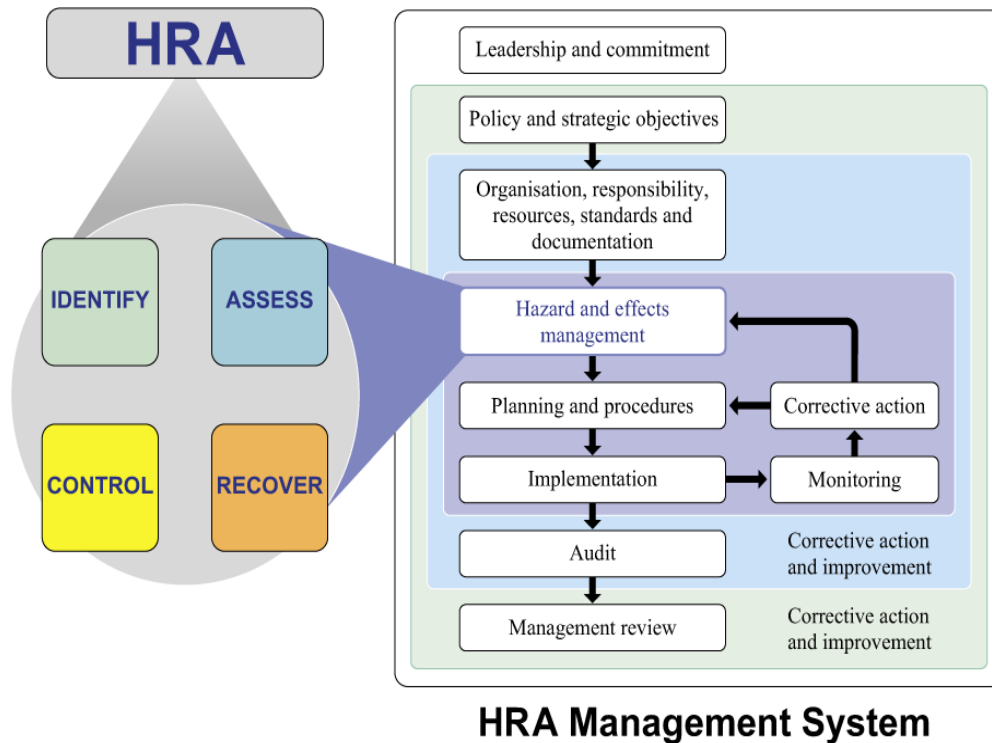


Figure 5.1 – A Risk Management System [diagram extracted from OGP & IPIECA (2006)]

6 Forming a Competent Team for the HRA

Line managers, operational staff and noise specialists all play an important part in carrying out an effective HRA. Those involved should have the collective knowledge, skill and experience to [OGP & IPIECA (2006)]:

- Understand the legislation that applies to noise management,
- Understand the National Code of Practice (NOHSC 2009) and referenced documents,
- Know how to conduct a noise risk assessment (e.g. technical standards, methodologies and instrumentation),
- Understand the plant, equipment and processes at the workplace that create noise risks,
- Gather information systematically and make judgements on noise hazards and risks,
- Understand the methods for controlling noise and reducing noise exposures, and
- Know the limits of their expertise and where to obtain further specialist advice, e.g. occupational hygienists, acoustic engineers, noise officers, audiometrists, audiologists, occupational health physicians, etc

7 Conducting the HRA – Noise Management

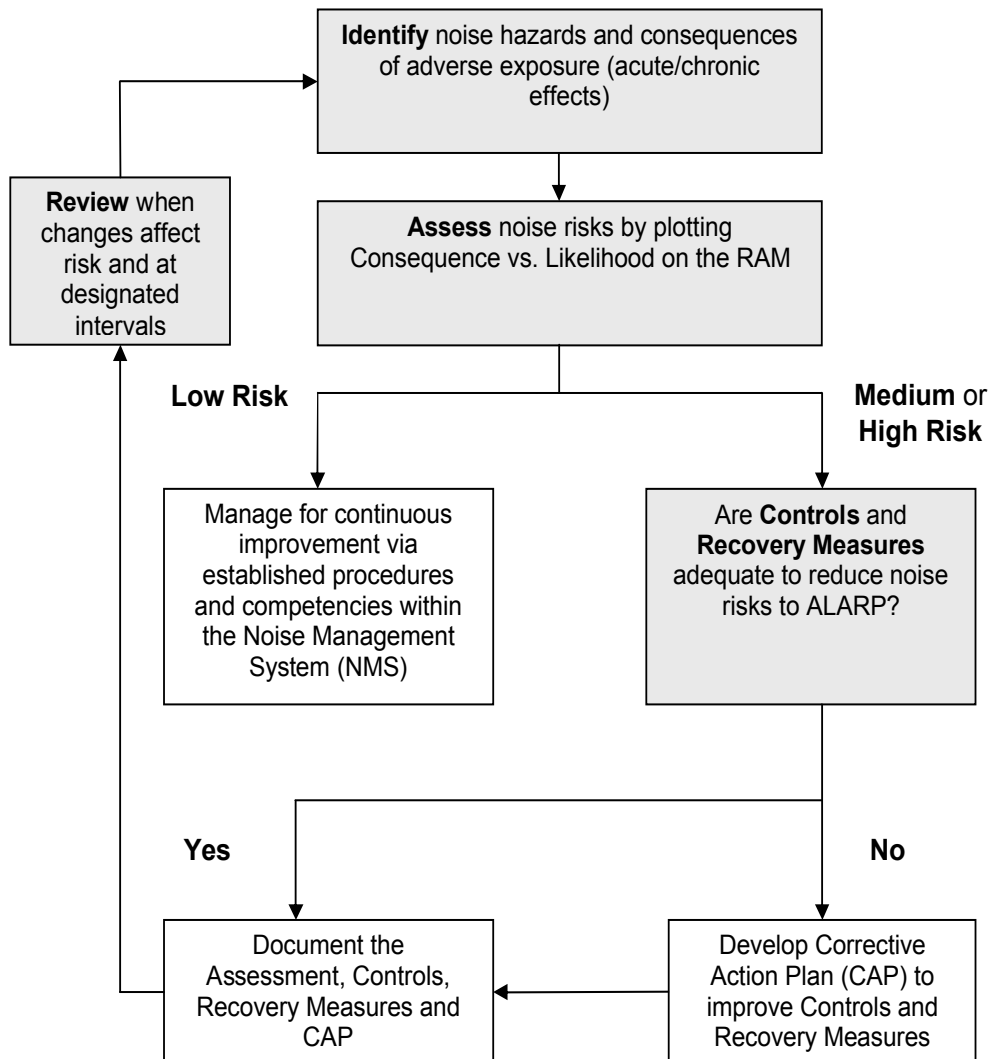


Figure 7 – Flowchart of the HRA process used for Noise Management [adapted from OGP & IPIECA (2006)]

7.1 HRA Prompt Sheet – Appendix A

The steps involved in the HRA are summarised in Appendix A – HRA Prompt Sheet.

8 Identifying Noise Hazards

Noise is a common physical health hazard encountered offshore, with the potential to cause both physiological and psychological impairment in exposed individuals, which in turn may affect their behaviour and performance at work. Offshore facilities are generally compact in nature and contain a relatively high proportion of noisy equipment and processes per area of occupancy.

Equipment and processes generate noise through fluid-dynamics (e.g. gas turbines, high pressure pipework) and mechanical vibration (e.g. diesel engines, reciprocating compressors, portable powered tools).

Noise has the potential to cause acute (short term) and/or chronic (long term) adverse health effects. Noise is one of the most prevalent health hazards faced by offshore workers, and can lead to NIHL and sleep disturbance, with subsequent fatigue and stress (Gardner 2003).

Acute adverse health effects of noise exposure tend to manifest around the time of exposure (i.e. seconds to hours). These effects are generally short-term and often reversible. E.g. temporary threshold shift (reversible hearing loss). Acute effects typically arise from short-term exposures to very high noise levels. High pressure air relief systems used offshore are a source of acute noise exposure. E.g. air dryers for instrument air systems, draw-works on drilling rigs and air start systems.

Chronic adverse health effects of noise exposure are insidious and often less “visible” than acute effects. They are generally longer lasting, if not permanent health effects (e.g. diseases), that typically arise from repeated, long-term exposures to hazardous noise.

NIHL is a common consequence of chronic (long-term) exposure to noise in excess of 85 dB(A), averaged over an 8-hour work shift.

Additionally, acute (short-term) exposure to peak impulse noise in excess of 140 dB(C) can cause acoustic trauma, which may also result in immediate permanent hearing loss (i.e. a chronic health effect).

From experience and exposure data obtained to date, a significant number of work groups on offshore facilities are being over-exposed to noise during both routine and non-routine work shifts, which bears unacceptable long-term risks to their health.

Refer to Section 7 of NOHSC 2009 for further advice on identifying noise hazards in the workplace.

8.1 Identifying Similar Exposure Groups (SEGs)

A similar exposure group is comprised of individuals who might be exposed to noise, and are characterised by the similar tasks they perform, which involves broadly similar exposure profiles [OGP & IPIECA (2006)].

A SEG can normally be established by observing the tasks performed by a work group or through preliminary exposure measurements. A combination of observation and measurements will provide the most accurate information for establishing a SEG (Davies 2006).

It is not always appropriate to assume that members of a particular work group (e.g. Integrated Ratings on marine vessels) will have broadly similar exposures. For example, Integrated Ratings may perform a variety of tasks within their job description over several days; however, there may be a number of smaller SEGs within this broad job description, defined by the specific task performed and the process and equipment used. E.g. deck de-scaling and painting (SEG1), crane operations (SEG2), etc.

8.2 Hazard, Consequence & Control Diagram – Appendix B

Prior to conducting a risk assessment, noisy processes and equipment on the facility should be identified. This should capture all routine and non-routine tasks, which produce continuous and intermittent noise.

Exposure to the noise (Hazard) may result in certain undesirable health effects (Consequences).

The following steps should be documented:

1. Each noisy piece of equipment or process used on the facility represent **inputs** that create noise,
2. The consequences of exposure to noise represent **outputs** (acute and chronic health effects, where applicable)

A “bow-tie” diagram can be a useful way of visualising hazards, consequences and control measures for each SEG – See Appendix B for an example, which uses some engineering noise controls and weaker administrative controls and PPE.

These diagrams may assist an assessor's understanding of what equipment and processes are responsible for noise emission, so that following the risk assessment appropriate controls can be selected to control the inputs to noise exposure and the likelihood of specific outputs.

The diagram is useful for visualising the effectiveness of controls. In general, controls on the left of the hazardous event (i.e. exposure to harmful noise levels) will generally be more effective than controls on the right side of the hazardous event. Therefore, the diagram represents a left-to-right noise control hierarchy distribution, from most effective controls (engineering/substitution) to the least effective controls (administrative/PPE), respectively.

9 Noise Risk Assessment

When a person is exposed to noise there is always some probability of being affected by an adverse health effect (i.e. risk). But how much risk is too much? The risk assessment process should address this question and recommend solutions to assist in demonstrating that risks are ALARP.

The two components of noise exposure are magnitude (frequency-weighted) and duration. Exposure has a positive correlation with the likelihood and consequence of an adverse health effect (risk). Therefore, noise exposure assessments are principally used to provide an estimate of risk, when compared against the defined standard, the National Standard for Occupational Noise (NOHSC 1007).

The National Standard establishes upper tolerable noise exposure limits. Exposure to noise above these limits is expected to increase the likelihood and severity of NIHL in a majority of exposed individuals. This relationship is based on epidemiological evidence that has clearly established a causal link between exposures above these limits and increased incidences of NIHL.

The following offshore exposure standards are established for occupational noise:

- LAeq,8h of 85 dB(A), and
- LC,peak of 140 dB(C)

Note: The LAeq,8h is a time-weighted average exposure, which establishes an upper tolerable limit of 85 dB(A), averaged over an eight-hour work shift. When a worker is exposed to different A-weighted noise levels in his/her workplace, then each level must be individually weighted against the time the worker is exposed to it. The worker's total exposure is added together to determine his/her LAeq,8h exposure, in accordance with AS/NZS 1269. However, if the worker has worked more than an eight-hour work shift then adjustments must be made to the LAeq,8h in accordance with Section 9.2.2 below.

Noise risk management principles are based on eliminating noise, then reducing noise exposure, in that order. In practice, this means reducing the magnitude of the noise or duration a person is exposed to noise. Alternatively, you could remove the noise or remove the person from the noisy environment (i.e. an "unmanned" facility), if it is practicable to do so. Either of these strategies will eliminate exposure to noise.

The risk assessment process should be considered in 2 stages. The first stage is a preliminary step used to illustrate potential levels of risk. Initial risk ratings are qualitatively determined from the inputs provided in Section 8.2 above. This is done using a Risk Assessment Matrix (RAM).

The second stage is a detailed risk assessment (semi-quantitative), which requires calculation of personal exposures to noise, based on routine and non-routine tasks performed by each similar exposure group (SEG).

Refer to Section 7 of NOHSC 2009 for further advice on conducting appropriate noise risk assessments in the workplace.

9.1 Preliminary Risk Assessment

The preliminary risk assessment is qualitative, using words to describe the consequences and likelihoods of exposure to health hazards. According to AS/NZS 4360 (2004) this practice is useful as an initial screening tool to obtain a general indication of risk levels and reveal significant risk areas. Major noise risks can then be prioritised for further detailed evaluation (see Section 9.2 below).

The RAM has been used successfully for years offshore for prioritising “safety” risks for further control, and the same principles may be applied to “health” risks.” Use of a risk matrix approach for prioritising controls for health risks is well understood and accepted by line management. Therefore, it is a useful communications tool for non-OH&S trained personnel who have responsibility for managing these risks (Liew et al 2002).

Using the hazards, consequences and controls identified in Section 8.2 above, it is now possible to determine preliminary risk ratings for each SEG on the facility, by predicting the likelihood that a worker is over-exposed to noise and the consequences of such an event, based on the task performed and controls in place. If historical health records of workers are available, they should be considered during the preliminary risk assessment, so long as they are obtained and used in accordance with applicable privacy laws. This means that the data should not identify individuals without their prior consent being given.

Health hazards may cause ill health, which in turn may lead to compensation claims, enforcement action, production losses, increased insurance premiums and reputation damage. Therefore, RAM consequences should consider ‘harm to people,’ ‘assets’ and ‘reputation’ (OGP & IPIECA (2006).

From experience, NOPSA has identified that noise consequences (e.g. NIHL) are often not assigned reasonable likelihoods; even when historical exposure data indicates increased risks. Therefore, the preliminary risk assessment should consider evidence-based knowledge, where applicable, such as historical LAeq,8h and LC,peak data.

9.1.1 Risk Assessment Matrix – Appendix C

When completing the RAM, Likelihood (vertical axis) should be based on the highest potential exposure scenario for the SEG. The RAM Consequence (horizontal axis) should also be based on a worst case loss, which might involve harm to people, assets or reputation.

Control measures should not be considered at this stage of the assessment, unless they are reliable and inherent in the design and operation of equipment (e.g. engineering controls). Administrative controls and PPE should not be considered when establishing preliminary risk ratings using the RAM.

9.2 Detailed Noise Risk Assessments

The detailed risk assessment is generally semi-quantitative, relying on qualitative inputs from the preliminary risk assessment as well as quantitative estimates of risk from exposure data.

Schedule 7, clause 9 (2)(g) of the OPGGSA imposes a duty on facility operators to monitor the health and safety of all members of the workforce and keep records of that monitoring. Noise should be assessed in all workplaces where it is considered that members of the workforce may be exposed to noise in excess of the National Standard for Occupational Noise (NOHSC 1007).

Affected workforce members should have already been grouped into SEGs, as described in section 8.1 above.

Noise exposures should be determined for each SEG at the workplace, in order to estimate the group risks. AS/NZS 1269.1 details the technical specifications for conducting an appropriate exposure assessment, using a Type 2 or better sound level meter or personal sound exposure meter.

Quantitative exposure data may be obtained from OGP & IPIECA (2006):

- **Baseline monitoring:** Provides an estimate of noise risks with currently applied controls in place (i.e. background exposures). This is used to determine if exposures may exceed the exposure standard under steady state conditions. If so, then detailed monitoring should be conducted.
- **Worst Case monitoring:** Provides an estimate of noise risks, to determine if excursions above the exposure standard are plausible under worst case conditions.
- **Detailed monitoring:** Provides an estimate of noise risks, and seeks to understand the causes of over-exposure so that appropriate controls can be implemented.
- **Routine monitoring:** Provides on-going estimates of noise risks. Used to verify that controls remain effective and that information on trends or changes in exposure patterns is identified so that action can be taken before over-exposures occur.

The following diagram provides an overview of the general process to follow when conducting a detailed risk assessment.

OVERVIEW OF EXPOSURE MEASUREMENT STRATEGIES

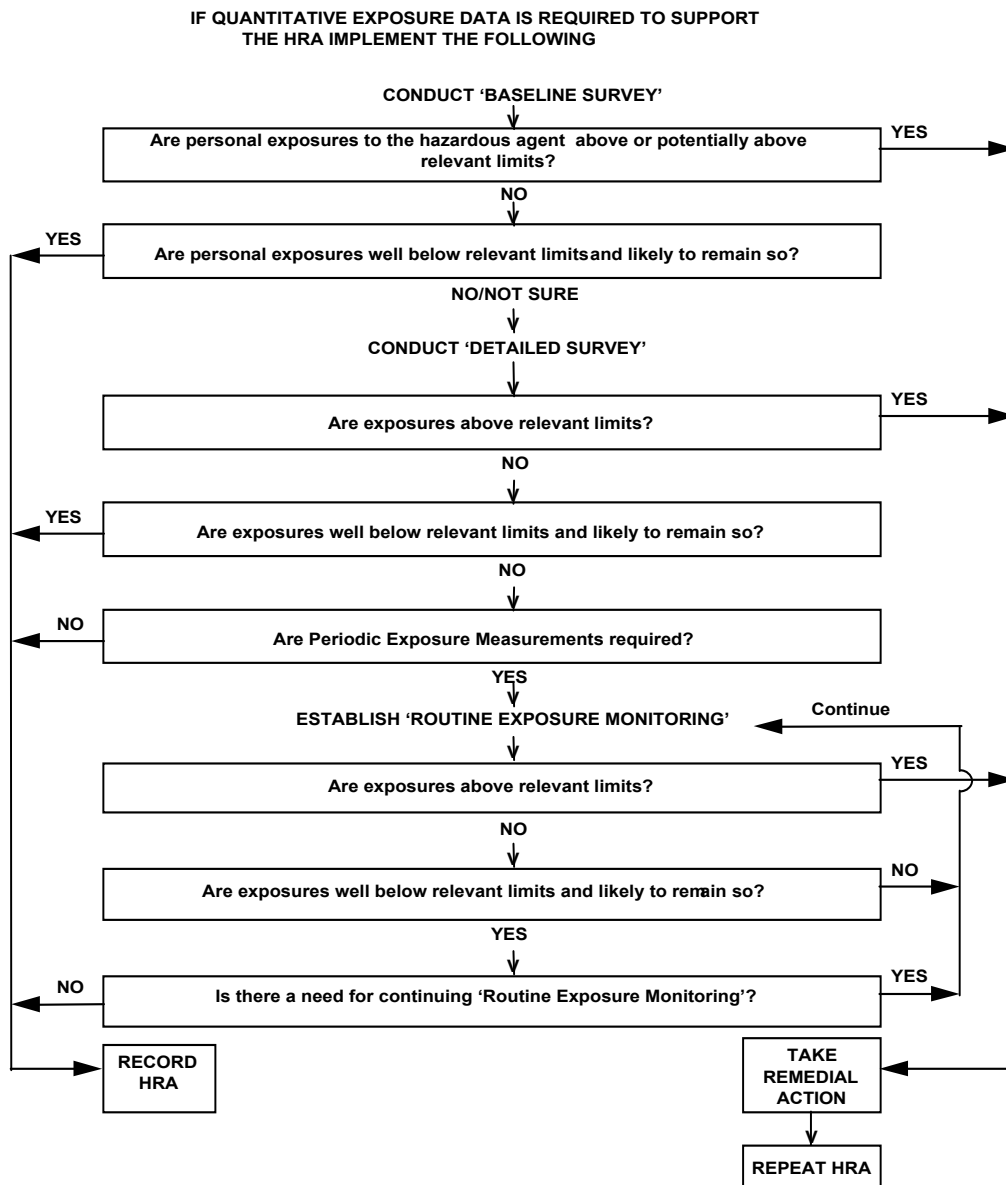


Figure 9.2 – Overview of Exposure Measurement Strategies [extracted from OGP & IPIECA (2006)]

9.2.1 Sampling and Analysis

There are a number of methods used to collect noise exposure data from a target population. This process is termed sampling. Exposure data may be obtained from:

- A single sample (e.g. from an individual),
- Multiple samples (e.g. from an individual or group; improved accuracy over a single sample) or
- Statistically-based samples (e.g. randomly selected samples from a representative number of workers within a group, such as a SEG; most accurate, avoids selection bias, but can be time-consuming) (Davies 2006).

The collected exposure data is then analysed by comparison with a defined exposure standard, usually to determine legislative compliance. Appropriate controls can then be considered.

Currently, the noise legislation in force offshore is based on single sample comparison with the prescriptive exposure standard. If an individual's protected exposure to noise is in excess of the exposure standard, then the legislation has not been complied with.

Single sampling and analysis is used to determine whether an individual's exposure is compliant with the legislation. However, it is not appropriate to assume that an individual's exposure is representative of all members of a SEG!

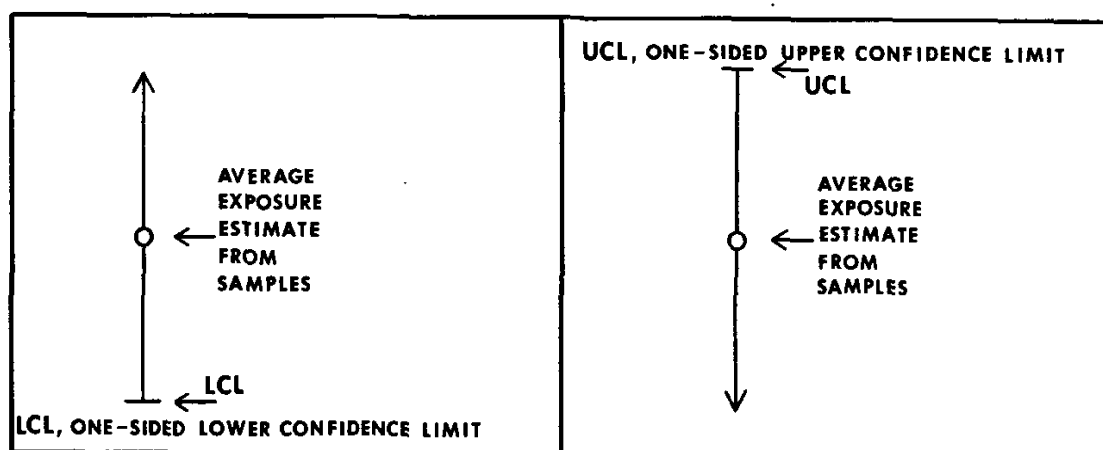
Statistically-based sampling is used when you require a high degree of confidence in the sampling process and assurance that a SEG is not being over-exposed to noise. This occurs when exposure data is collected randomly from within a SEG. Random sampling attempts to minimise selection bias during the risk assessment. A sufficient number of samples must be collected, which is representative of the SEG. An average exposure estimate is then determined for the SEG, which is then analysed to determine "statistical compliance" with the legislation.

The value in using statistical analysis is to determine whether over-exposures are attributable to a SEG, rather than to individual workers within the SEG. This is useful for understanding whether over-exposures are related to the work tasks conducted by a SEG or rather an artefact of individual variation between workers in how they conduct those tasks. Effective controls can then be selected, which benefit entire workgroups (i.e. collective protection) rather than individual workers (i.e. individual protection).

From Figure 9.2.1 below, statistical compliance with the legislation can be demonstrated when the upper confidence limit of exposure (e.g. UCL at 95%) is less than the noise exposure standard. If this isn't the case, then over-exposure is to be expected for a certain percentage of workers. In this case, further controls should be investigated.

Note: Noise exposures should be converted from logarithmic units [dB(A)] to linear units [$E_{A,T}$ or $E_{A,P}$ (Pa^2h)] prior to comparison with the exposure standard in Pa^2h (i.e. $\text{LAeq},8\text{h}$ of 85 dB(A) = 1 Pa^2h).

Commonly used occupational hygiene statistical programs include LogNorm2 (www.lognorm.net) and IH Stats. For further information, see the NIOSH (1977) Occupational Exposure Sampling Strategy Manual.



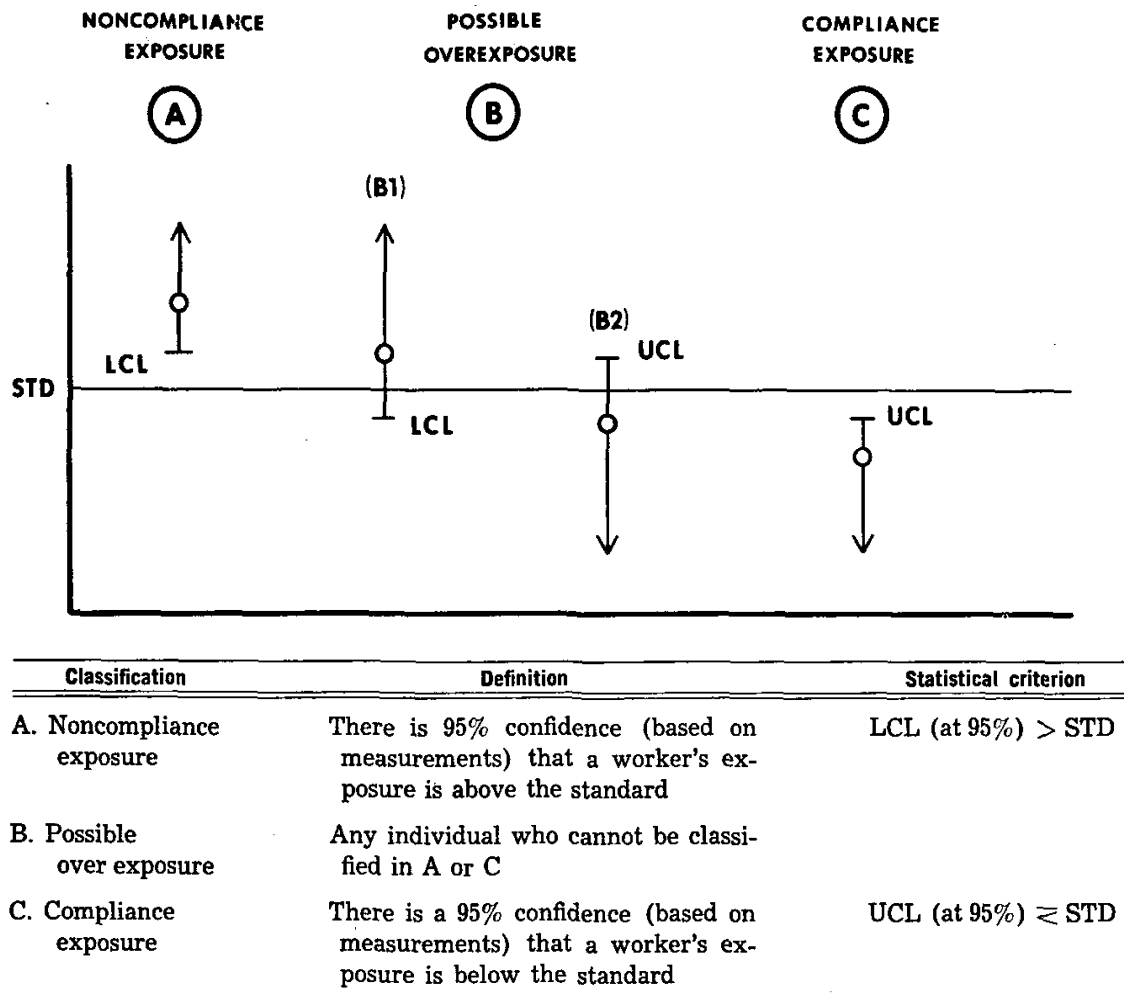


Figure 9.2.1 – Classification System for Employee Exposure to Noise [extracted from NIOSH (1977)]

9.2.2 Adjustments to a Worker's LAeq,8h for Extended Work Shifts

The current daily noise exposure standard of 85 dB(A) predicts noise-induced hearing impairment based on a person working an assumed 8 hour work day, 40 hours per week. This is not appropriate for most offshore operations, where 12 hour or longer work shifts may apply.

Work shifts in excess of 8 hours are associated with increased durations of noise exposure but more importantly, reduced time for recovery from the effects of noise exposure between shifts.

Research conducted by the National Acoustic Laboratories (NAL) (Macrae and Waugh, 1998) was used to propose adjustments to the daily noise exposure standard for extended work shifts. These adjustments were adopted by Standards Australia and are addressed in AS/NZS 1269.1.

The following table outlines adjustments that must be made to LAeq,8h measurements for extended work shifts:

Shift Length (h)	Adjustment to LAeq,8h (dB)
<10	0
≥10 to <14	+1
≥14 to <20	+2

≥20 to 24	+3
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Figure 9.2.2 – Adjustments to normalized noise exposure level LAeq,8h for extended work shifts [adapted from AS/NZS 1269.1 (2005)]

The detailed risk assessment should not simply rely on exposure measurements as estimates of risk but seek to qualify the reasonable potential risk to people by also considering qualitative risk contributors. E.g. Hyper-sensitive individuals and exposure to ototoxins (see below) are both confounding factors which should be considered in the detailed risk assessment.

Applying both quantitative exposure measurements with the above qualitative inputs improves the accuracy of the risk assessment and ensures that the process of recommending controls is built upon the best available evidence.

9.2.3 Health Surveillance monitoring

Individuals may exhibit varied sensitivity to noise. Hyper-sensitive individuals are predisposed (at higher risk) of suffering an adverse health effect from exposure to noise. The amount of noise received by an individual (dose) has a positive relationship with the magnitude of the adverse health effect (response). See Figure 9.2.3 below. This increased risk may be due to several factors, such as genetics, age, sex, personal habits, state of health, and exposure to ototoxins.

Health surveillance programs are used to identify risk contributors prior to an individual's exposure to noise and periodically throughout the course of exposure. Therefore, they should be implemented at pre-employment, at regular periods throughout employment and at the cessation of employment.

According to the National Code of Practice for Noise Management and Protection of Hearing at Work (NOHSC 2009), for some people there is still a small risk of hearing loss from repeated exposure to noise between 75 dB(A) to 85 dB(A).

Audiometric testing may be used to identify changes in hearing levels over time (i.e. threshold shift), however, such testing is not a control measure in itself.

NOPSA believes that health surveillance programmes should identify hyper-sensitive individuals and aim to protect them from increased risk, which is often not addressed adequately through generic risk assessments.

An appropriate testing program should be established in accordance with Section 12 of NOHSC 2009.

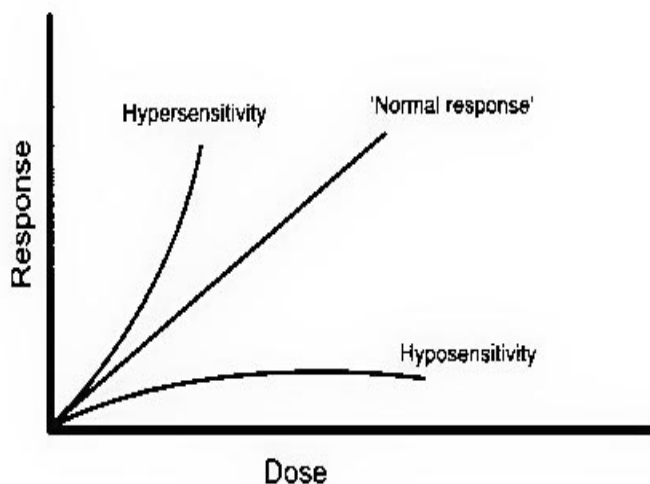


Figure 9.2.3 – Individual Susceptibility

9.2.4 Exposure to Ototoxins

Exposure to certain chemicals, either in concert with noise, or independently may contribute to hearing loss. These chemicals are called ototoxins, or “ear poisons.” Hearing loss is more likely to occur if a person is exposed to a combination of ototoxins and noise, than simply noise alone (Tillman 2007).

Noise induced damage to hearing occurs when loud noise either damages the sensitive hair receptors in the inner ear (cochlear), the ear drum or the delicate bones of the middle-ear. When these components are damaged the ear loses the ability to accurately receive sound.

Ototoxins, on the other hand, act directly on hair cells in the cochlear and/or auditory neurological pathways to the brain. They damage these hair cells, therefore interfering with cellular signal initiation and propagation through the auditory nerve to the brain.

Some examples of ototoxins include solvents (e.g. alcohol, toluene, ethyl benzene and xylene), heavy metals (e.g. lead, mercury and tri-methyl tin), and chemical asphyxiants (e.g. carbon monoxide and hydrogen cyanide).

9.2.5 Risk Rating Charts - Appendix D

Once LAeq,8h and LC,peak exposure measurements have been obtained and compared with the noise exposure standards, the Risk Rating Charts in Appendix D may be used to determine if remedial actions are required.

The Likelihood Rating is based on the effectiveness of actual controls in place, so these should be taken into account at this stage.

Note: The Risk Rating Charts DO NOT consider the additional risk contributions posed to hypersensitive workers or from exposures to ototoxins. These Charts ONLY consider unprotected noise exposures (LAeq,8h and LC,peak) as an indicator of risk. The above risk factors, however, should be considered when determining if risks to hearing are ALARP (see Section 10 below).

10 Controlling Noise Risks

The HRA process described above will help to determine Likelihood Ratings for all identified noise hazards in the workplace. Medium and High risks should be prioritised for further control.

To comply with the legislation in force, controls must be applied as far as reasonably practicable according to a recognised control hierarchy to reduce LAeq,8h and LC,peak exposures, prior to relying on PPE to reduce L(eff)Aeq,8h below 85 dB(A) and LC,peak below 140 dB(C).

Furthermore, additional risk contributions posed to hypersensitive workers or from exposure to ototoxins must be adequately controlled.

For example:

- Elimination - of the noisy equipment or process, and exposure to ototoxins,
- Substitution - of the equipment or process with a less noisy alternative, and exposure to ototoxins,
- Engineering – treatment of the source; and/or noise transmission path to reduce the magnitude of noise, or concentration of ototoxins,
- Administrative – reduce the duration of exposure to noise and ototoxins, and lastly
- Personal hearing protection – for use when the above control options have been implemented as far as reasonably practicable, and unprotected exposures still exceed the prescribed exposure standards.

Refer to Sections 8, 9 and 10 of NOHSC 2009 for advice on applying appropriate Engineering, Administrative and PPE controls respectively, to reduce noise risks.

Document the controls that are currently used in the workplace. Controls can generally be classified as:

- **Preventative** - Proactive barriers that aim to prevent exposure to harmful noise levels (e.g. noise greater than 82 dB(A) for 10-14 hr work shifts) and ototoxins. In practice this involves reducing the magnitude of noise (noise level). Examples mainly include engineering controls such as vibration damping and isolation. However, some administrative controls may also apply here, such as changing the technique employed by a worker to produce less noise, and
- **Mitigative** – Reactive barriers that aim to reduce the length of time and frequency a worker is exposed to noise and ototoxins. Examples mainly include administrative controls and personal hearing protectors.

Note: According to the National Standard for Occupational Noise – NOHSC 1007 (2000) personal hearing protectors are NOT considered to reduce noise exposure and are therefore not appropriate as a long-term strategy to manage noise exposures. They are strictly viewed as short-term (interim) controls until more substantial engineering and administrative controls can be implemented.

Refer to Appendix B – Hazard, Consequence & Control Diagram for visualising preventive and mitigative controls.

10.1 Control Chart – Appendix E

The Control Chart is a planning tool used for assigning priorities to risks that require remedial actions. It may assist the decision-making process to demonstrate that risks are ALARP.

Consequence Ratings are plotted against Likelihood Ratings to give an indication of how effective controls are at controlling LAeq,8h and LC,peak noise exposures.

The position on the chart represents a qualitative interpretation of the priority for improved controls to ensure health risks are minimised. Risks can be reduced by moving the Likelihood Rating from right to left and the Consequence Rating from bottom to top by improving controls. The coloured shading divides the need for action to improve controls into three priorities - First, Second and Third, with a Fourth priority level not requiring immediate action (OGP & IPIECA (2006)).

10.2 Evaluating Control Options

The noise management legislation in force offshore requires that noise risks are ALARP and NOPSA may challenge the process followed by an operator for demonstrating this.

The term reasonable practicability refers to the lowest achievable level of risk below the “tolerable level” of risk, after which it is no longer considered reasonable to control noise risks further (see Figure 10.4 below). This requires a demonstration that risk reduction is balanced against the time, trouble, difficulty and cost of achieving it [OGP & IPIECA (2006)].

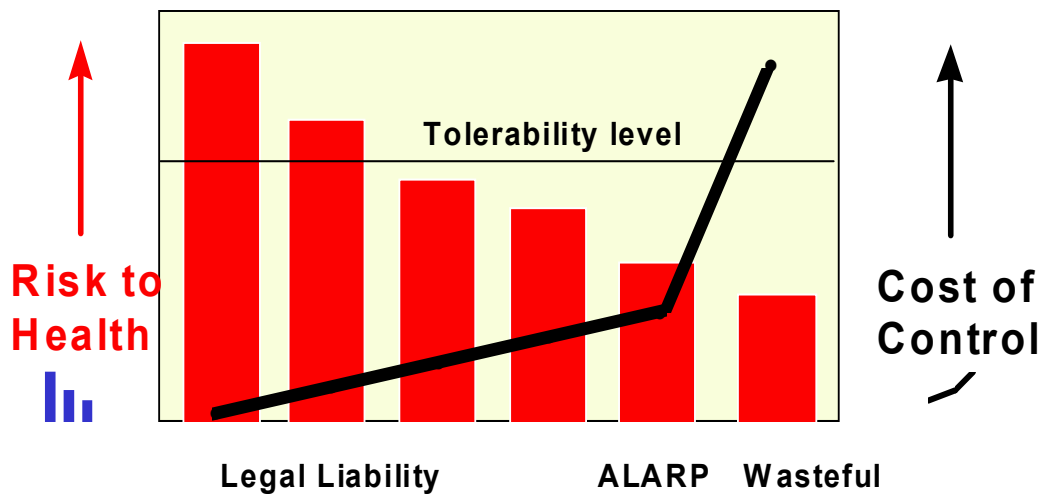


Figure 10.4 – ALARP Demonstration [extracted from OGP & IPIECA (2006)]

The “tolerable level” of risk is set by the noise exposure standards set out under Regulation 4F of the P(SL)(OHS) Regulations. “Protected” noise exposures above these levels are not acceptable under any circumstances.

However, even if “unprotected” noise exposures are below the “tolerable level,” if it is reasonably practicable to reduce them further, then this must be done to meet the ALARP principle.

Incidentally, the principle that OH&S risks must be ALARP originates from the general duties of care, specified in Schedule 3 to the OPGGSA.

Control Options may be evaluated using a number of the following techniques to ensure that the ALARP option is identified more reliably [OGP & IPIECA (2006)]: The NOHSC (1991). Control Guide – Management of Noise at Work provides guidance for comparing the effectiveness and cost of engineering noise control measures.

- **Tiered Challenge Approach**

A team of operations and noise specialists work through a hierarchy of noise controls, identifying all possible control options in each category. Starting at the top of the hierarchy the team challenges if and why the control cannot be applied before moving down to the next control option

- **Good Practice**

Good engineering and procedural noise management practices that have found success in industry should be considered, such as benchmarking. Additionally, government, industry and research publications may define good practice.

- **Codes and Standards**

Code and standards embody lessons learnt over past years and in the case of occupational noise specify appropriate controls.

- **Engineering Judgement**

Engineering judgement involves the application of sound scientific principles and methodology for noise management (e.g. acoustic engineering).

- **Stakeholder Consultation**

Stakeholders should be involved in decision-making. Consultation with the affected members of the workforce, health and safety representatives, supervisors, managers and regulators (e.g. NOPSA) is an important part of the process of demonstrating that noise risks are

ALARP. Consultation is particularly important when the views, concerns or perceptions of each stakeholder are not aligned.

HAZID and HAZOP Studies

Hazard Identification (HAZID) and Hazard and Operability (HAZOP) studies are structured brainstorming techniques used to ensure that all potential noise hazards and threats are identified, understood and controlled.

- **Quantitative Risk Assessment (QRA)**

A mathematical tool used extensively for major accident hazards, but is not normally applied to health risks. From a noise management perspective, the prescribed noise exposure standards may represent a threshold below which an acceptable level of risk can be defined, based on noise exposure alone, or in combination with other risk factors, such as ototoxins.

E.g. If a person worked a 12-hr shift, with an average exposure of 80 dB(A), then his/her exposure would be less than LAeq,8h of 85 dB(A). If it was not practicable to reduce his/her exposure any lower then this level of risk might be considered ALARP. However, if the worker was also exposed to ototoxins, then his/her new combined exposure might result in a risk that is no longer ALARP. Therefore, assumptions should be defined for meeting ALARP criteria.

- **Cost Benefit Analysis (CBA)**

A mathematical tool used for major accident hazards that balance costs against safety improvements to derive “implied costs of averting a fatality.” It is possible to apply the principles of a CBA to noise management and NOPSA has already seen preliminary examples of how this can be achieved in practice. Therefore, operators should define reasonable CBA processes and acceptance criteria.

10.3 Training

Education of the workforce, through the provision of information, instruction, training and supervision may help to reduce noise risks. Section 11 of NOHSC 2009 describes the elements that should be addressed in a suitable training program. The training program should also discuss the risks posed by ototoxins in the workplace, where they exist in the workplace, who is affected by them and how these risks should be controlled.

Training should meet the needs of each SEG and convey clear, easily understood messages which can be implemented efficiently. E.g. through the use of Step-back 5x5, JHA and PTW risk assessment processes, on-the-job training and competency assessment, information posters, presentations, and monitoring supervision, etc

10.4 Maintenance of Controls

Controls will only remain effective if they are correctly maintained. For example (OGP & IPIECA (2006)):

- **Engineering controls:** implement a regime of preventive maintenance including routine inspections, examinations and tests to ensure plant and equipment continues to operate at design specifications and any modifications are assessed,
- **Procedural controls:** implement procedures that will ensure adequate maintenance of controls, e.g. record systems, staff information, instruction and training, supervision, safe systems of work, emergency arrangements, etc, and
- **Personal hearing protection:** as with engineering controls, reusable earplugs also require routine inspection and maintenance.

11 Establish Recovery Measures from Adverse Health Effects

Recovery (preparedness) measures are required to mitigate the consequence of adverse health effects of noise exposure, should control measures fail to prevent noise related incidents. E.g. emergency response arrangements, post incident audiometry/audiological examination to identify threshold shift, acoustic trauma counselling, treatment options.

12 Establish a Corrective Action Plan (CAP)

Where the HRA has identified that noise risks are not ALARP and further controls should be implemented, these should be documented in a CAP. The CAP should detail the required action to take, action priorities, responsible persons and target dates for implementation. Corrective Actions in the CAP should be tracked to ensure that they carried out efficiently, effectively and on time [OGP & IPIECA (2006)].

13 Auditing the Noise Management System

The noise management system should be audited at regular intervals by a competent person to determine whether the system addresses all applicable elements outlined in AS/NZS 4801 and complies with NOHSC 2009.

14 Record Keeping

Records should be maintained to trace decision-making processes and demonstrate that noise risks are ALARP. Records may include:

- Strategic Noise Management Plans (NMP),
- JHAs, PTW system records,
- Health surveillance records,
- Equipment design specifications (e.g. acoustic properties),
- Equipment maintenance records (e.g. acoustic controls),
- Calibration records (e.g. monitoring equipment)
- Noise exposure assessment reports,
- Health Risk Assessment reports (e.g. RAM, detailed risk assessment reports),
- Training records (incl. competency records of all persons involved in the HRA),
- Control Charts for each SEG,
- Control evaluation reports,
- Incident reports,
- Workers' compensation records,
- Audit reports, and
- Corrective Action Plans (CAP)

15 References

1. Offshore Petroleum and Greenhouse Gas Storage Act 2006
2. Petroleum (Submerged Lands) (Occupational Health and Safety) Regulations 1993
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APPENDIX A HRA Prompt Sheet

GUIDELINE SECTION	ACTION
6	<ul style="list-style-type: none"> ▪ Establish a competent HRA team
8.1	<ul style="list-style-type: none"> ▪ Define SEGs, based on job description, similar job tasks or through statistically-based sampling
8.2	<ul style="list-style-type: none"> ▪ Complete the Hazard, Consequence & Control Diagram – Appendix B for each SEG
9.1.1	<ul style="list-style-type: none"> ▪ Complete the RAM – Appendix C for each SEG
9.2	<ul style="list-style-type: none"> ▪ Determine exposure measurement strategy
9.2.1	<ul style="list-style-type: none"> ▪ Determine sampling methodology (e.g. single, multiple or statistically-based sampling techniques). ▪ Conduct exposure monitoring in accordance with Section 7 of NOHSC
9.2.2	<ul style="list-style-type: none"> ▪ If applicable, adjust exposures in accordance with AS/NZS 1269.1
9.2.3	<ul style="list-style-type: none"> ▪ Identify hypersensitive workers ▪ Establish an audiometric testing program in accordance with Section 12 of NOHSC 2009 <p><u>Note:</u> Health surveillance is an ongoing monitoring process, which begins at pre-employment, continues throughout employment and ends with exit monitoring upon cessation of employment.</p>
9.2.4	<ul style="list-style-type: none"> ▪ Assess the impact of exposure to ototoxins on overall risk profiles
9.2.5	<ul style="list-style-type: none"> ▪ Complete the Risk Rating Charts – Appendix D for each SEG
10.1	<ul style="list-style-type: none"> ▪ Complete the Control Chart – Appendix E for each SEG
10.2	<ul style="list-style-type: none"> ▪ Evaluate control options using a combination of applicable techniques, and apply those that reduce LAeq,8h and LC,peak as far as reasonably practicable, prior to using PPE
10.3	<ul style="list-style-type: none"> ▪ Establish a training program in accordance with Section 11 of NOHSC 2009
10.4	<ul style="list-style-type: none"> ▪ Ensure that engineering controls are maintained ▪ Ensure that procedural controls are maintained ▪ Ensure that personal hearing protection is maintained in accordance with AS/NZS 1270
11	<ul style="list-style-type: none"> ▪ Establish recovery measures
12	<ul style="list-style-type: none"> ▪ Establish a CAP
13	<ul style="list-style-type: none"> ▪ Develop and implement an Audit Schedule

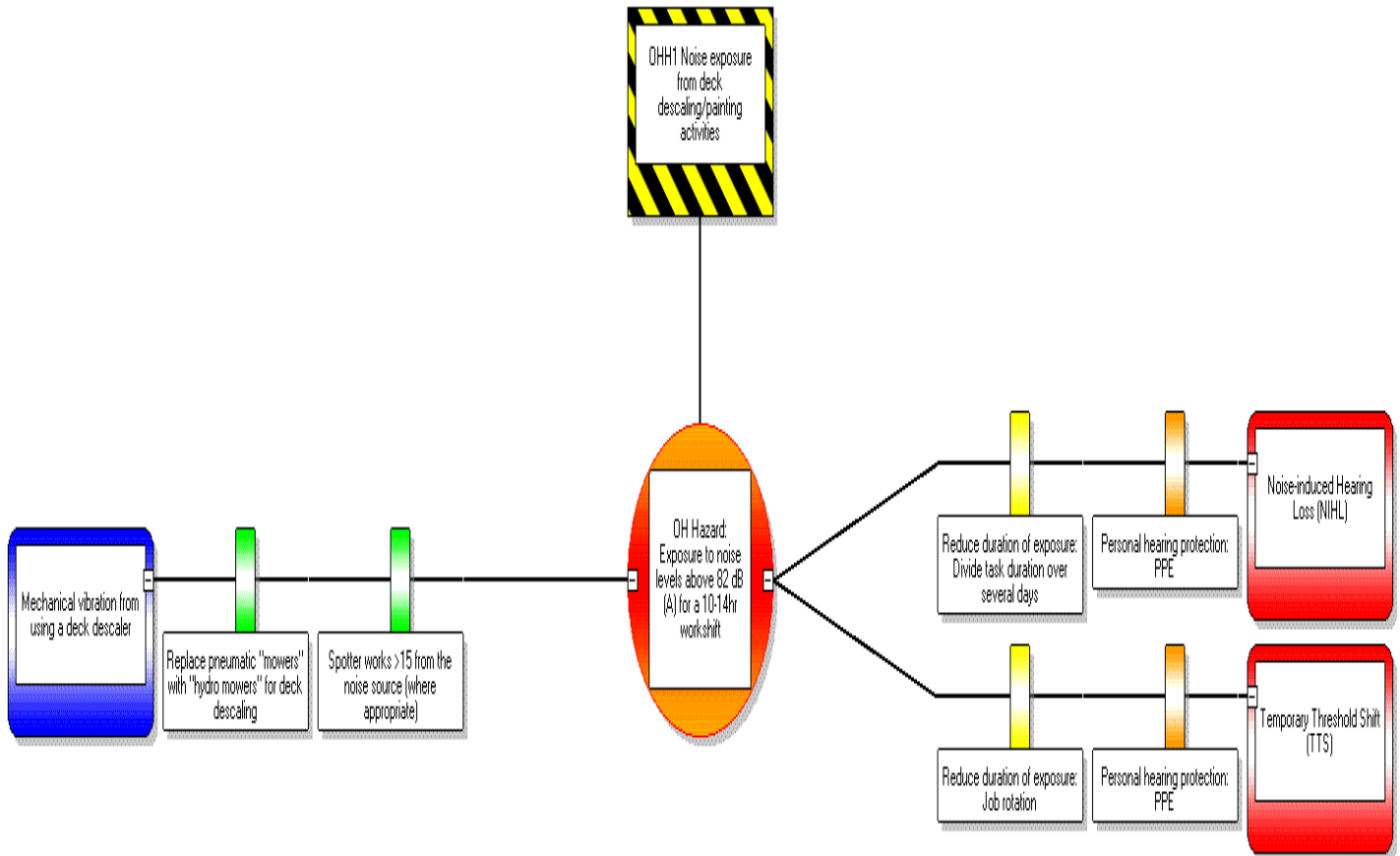


Guideline

Noise Management – Principles of Risk Assessment and Control

APPENDIX B Hazard, Consequence & Control Diagram (example only)

1. Activity = Deck de-scaling/Painting
2. SEG = Painters
3. Hazard = noise from deck de-scaler
4. Hazard Event = Exposure to noise levels above 82 dB(A) for a 10-14hr work-shift
5. Consequences = NIHL, TTS
6. Controls = Substitution, Administrative & PPE





Guideline

Noise Management – Principles of Risk Assessment and Control

APPENDIX C Risk Assessment Matrix (RAM) – (preliminary risk assessment)

		CONSEQUENCE			
		Negligible 1	Minor 2	Significant 3	Major 4
LIKELIHOOD	Very Low A	A1	A2	A3	A4
	Low B	B1	B2	B3	B4
	Medium C	C1	C2	C3	C4
	High D	D1	D2	D3	D4

APPENDIX D Risk Rating Charts – (detailed risk assessment)

CONSEQUENCE RATING	DEFINITION (Consequence Category: Harm to People)
1. Negligible	Negligible health effects: Not affecting work performance or causing disability
2. Minor	Minor health effects: E.g. Minor sleep disturbance, minor communication impairment
3. Significant	Significant health effects: E.g. Temporary threshold shift, temporary tinnitus, significant communication impairment
4. Major	Major health effects. E.g. Permanent threshold shift, such as NIHL, acoustic trauma, permanent tinnitus, major communication impairment

LIKELIHOOD RATING (Based on assessed effectiveness of controls in place)	EXPOSURE EVENT (Use adjusted LAeq,8h or LC,peak, as applicable)	DEFINITION
A. Very Low	<10% of Exposure Standard (ES)	Exposures are negligible
B. Low	10% ≤ 50% of ES	Exposures are controlled well below ES and are likely to remain so in accordance with standards
C. Medium	>50% – 100% of ES	Exposures are currently controlled below ES to meet standards but control may be reliant on less robust measures such as personal protective equipment
D. High	>ES	Exposures are not adequately controlled to meet standards and continuously/regularly exceed ES, indicating unreasonable risk to exposed persons

Tables adapted from OGP & IPIECA (2006)

APPENDIX E Control Chart

		LIKELIHOOD RATING →			
CONSEQUENCE RATING ↓		A Very Low	B Low	C Medium	D High
1 Negligible		No Immediate Action Required		Third Priority	Second Priority
2 Minor					
3 Significant		No Immediate Action Required	Third Priority	Second Priority	First Priority for Action
4 Major					
Exposure Event →		<10% ES	10% ≤ 50% ES	>50% – 100% ES	> ES

Table adapted from OGP & IPIECA (2006)