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Noise Reduction Interventions in the Norwegian Petroleum Industry

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Abstract

Noise exposure is still an important challenge to a safe and healthy work environment, both offshore and onshore. Studies over the last 10 years show that the noise exposure (expressed as the “average noise indicator”) remains mainly unchanged with no significant reduction in the past decennium. Furthermore, several reports indicate that workers in the petroleum industry are exposed to high noise levels and the risk of developing noise-related hearing loss can’t be neglected. Noise induced hearing loss is the most frequent reported work-related illnesses / injury reported to the Norwegian Petroleum Safety Authorities (PSA). Although the industry has taken a number of measures and established action plans for noise mitigation in offshore facilities, the potential for further noise-reduction is substantial.

However, to be able to implement adequate risk reducing measures, monitoring the above parameters (the average noise indicator and noise induced hearing damages) is not sufficient. We suggest further focus on low-noise design and modification of installations and facilities, development of low-noise technology, implementation of noise exposure in cost-benefit analysis, and dissemination of knowledge related to noise induced hearing loss.

This paper presents a study designed to develop such best practices of interventions aimed to reduce noise induced injuries in the petroleum industry.

One key area is the use of handheld tools used for operations like rust removal, sand blasting, grinding etc. Other key areas are noise from process plants, noise related to off-shore helicopter transport and noise exposure during subsea operations. Individual susceptibility to noise induced injuries is addressed as well as noise protection (barrier control) and use of personal protective equipment.

The study is performed in cooperation between the Norwegian Oil Industry Association (on behalf of the operators on the Norwegian continental shelf), the Federation of Norwegian Industries (NI) as well as the major unions in the Norwegian petroleum industry organised as a tri-partite project.

Introduction

Noise, present in the working environment in the offshore as well as land-based industry, may affect hearing.

A number of reports, including the annual PSA report “Trends in risk level in the Norwegian petroleum activity (RNNP)”, indicate that a substantial fraction of workers in the petroleum sector are exposed to high levels of noise which may affect hearing (See table 1).

TABLE 1-REGISTERED NEW AND AGGRAVATED CASES OF HEARING DAMAGE

<u>Period</u>	<u>Number of cases</u>
1995-2006	150-200
2007	595
2008	623
2009	397
2010	605
2011	710

Hearing damage (injury causing reduced hearing acuity) caused by noise represents the most frequent occupational health injury reported to the Petroleum Safety Authority Norway (PSA).

Over a 10-year period, the annual RNNP reports reveal that the noise exposure, expressed as the “average noise indicator” (See figure 1) remains mainly unchanged without clear signs of reduction. The average noise indicator is calculated on the basis of noise level measurements and time spent in the noisiest areas, as well as the contribution from noisy work operations. The numerical value of the average noise indicator is generally considered to reflect the noise exposure expressed in dBA. Assuming that the noise indicator reflects actual noise exposure, data from the RNNP show that most of the job categories (embraced by the RNNP) have a noise exposure above 83 dBA, which is the upper limit specified in the facilities regulations issued under the Petroleum Activities Act. Similar findings have been observed in the land-based plants.

Although the industry has adopted a number of measures and established action plans aimed at reducing noise risk in the facilities, the experience gained by the PSA through its contacts with the industry, case management and audits is that the potential for further measures to reduce exposure is large.

In particular the potential to reduce noise produced by handheld tools is expected to be significant (used e.g. for needle scaling, angle grinding and so forth). A need for innovative thinking has been identified here, suggesting alternative work processes, along with a requirement to influence the development of new types of tools which reduce noise and vibration exposure.

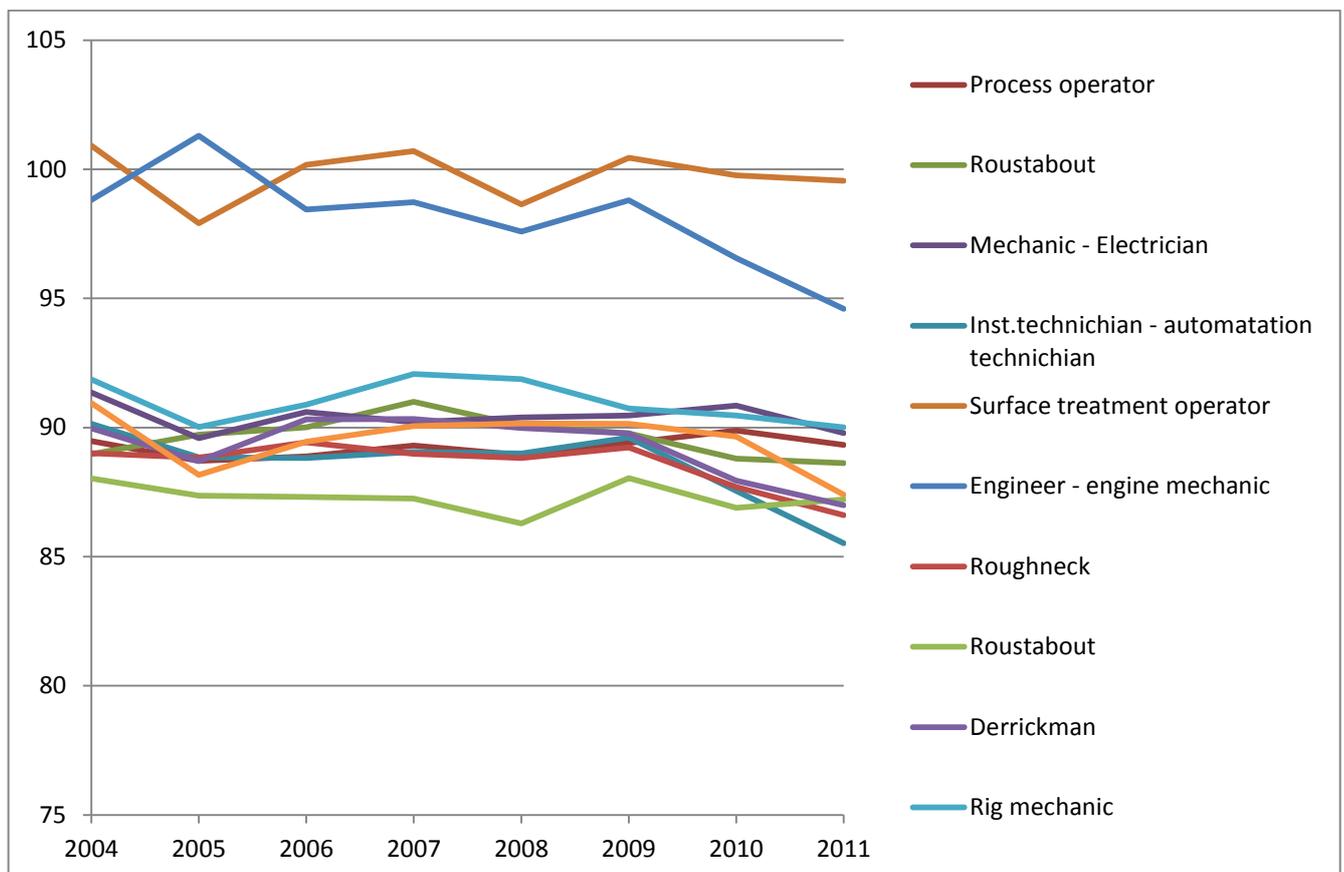


Fig. 1-Average noise indicator (Y-axis) for job categories offshore – 2004 to 2011

Noise exposure limits and the role of hearing protection

The upper limits for personnel noise exposure for the petroleum industry in Norway are in line with those of the EU noise directive. The daily exposure shall not exceed $L_{ex} = 83$ dBA for a 12 hour day (equivalent of 85 dBA for an 8 hour day). In addition, one should aim, if possible, to satisfy 80 dBA (50% of norm).

For peak levels, the requirements are somewhat stricter than the EU noise directive (limit of $L_{peak} = 130$ dBC).

However, what makes the handling of noise in the Norwegian petroleum industry stand out is that these exposure levels are to be achieved mainly without considering the effect of hearing protection. In general, personal hearing protection is not considered by the Norwegian petroleum authority to be a long-term solution to the control of noise exposure. The only exceptions are activities where hearing protection can be seen as the only possible solution.

This enforcement can be seen as a natural extension of the generally accepted safety philosophy: There should always be more than a single barrier to prevent an unwanted incident. Therefore, the attention is on low-noise design and administrative measures rather than optimizing hearing protection.

In spite of good work, several groups of workers have exposure levels exceeding the limits. As a consequence, hearing protection does currently play an important role in noise exposure control, but at a fairly modest level. Standard values used for attenuation are 12 dB for single (mainly helmet-mounted ear muffs) and 18 dB for double (plug + muff). Slightly higher values may be used for some activities, mainly the use of hand held tools.

Further noise control must be achieved by limiting the noise at source and/or limiting the time spent in noise. General time limitations exist for noise levels exceeding 90 dBA. This means that a worker may only spend for instance 6 hours of a 12 hour shift in a noisy area, even if the work task calls for a longer time.

Obviously, such restrictions may significantly reduce productivity. This is intentional and the related “cost of noise” hopefully will encourage other means for noise control than relying on personal hearing protection.

What do we want to achieve?

The petroleum industry’s ambition is to be characterised as:

- A pioneer for HSE results
- In control of noise exposure offshore and at land-based plants – compliant with regulatory requirements
- Applying objective (allowing measurement) HSE targets – that may be used to predict future reduction in noise induced hearing loss

Dissemination of knowledge to other industries

Noise is not a problem specific to the petroleum industry. However the offshore industry is faced with facts such as work processes in the height or operations constrained on a single platform. This challenges isolation of the noise source on an offshore facility. In contrast, at a land-based plant, opportunities may exist for positioning the noisiest processes in the most remote spot on the industrial site.

Dissemination of knowledge from other land-based industries is considered important for the project. It is also important for the project that its deliveries can be used by other industrial sectors.

One example would be the need to identify and contribute to develop hand operated tools with low noise and vibration.

Ensuring that equipment manufacturers and suppliers can contribute their expertise to the project is important. In addition, this sector will represent an important recipient of the project’s deliveries.

The offshore petroleum industry is supported by a large number of manufacturers and suppliers of services e.g. rig fabricators, shipbuilders, engineering and construction companies etc. This project may support the petroleum industry to co-operate with industrial partners that develop new and less noise technology and work processes. These industrial partners may transfer knowledge beyond the petroleum business and contribute to a safer and healthier working environment on-shore as well.

International co-operation

Though the present project is a significant effort by the Norwegian oil and gas industry to reduce noise exposure and noise induced hearing injuries, we recognize that a national initiative have definite limitations on what we can achieve.

We would welcome co-operation with international partners - industrial, governmental and R&D establishments. Sharing work tasks and responsibilities will allow faster progress and avoid duplication of work. We welcome approaches both during and after the conference to discuss such opportunities for collaboration.

Organisation

Collaboration between employers, unions and government as well as worker participation is important to establish and further improve a high level of HSE in the petroleum industry in Norway. From an ethical perspective, it is crucial that people exposed to risk participate in decision-making processes. The Norway's Working Environment Act stipulates a number of provisions on the right and duty of workers to participate in ensuring a fully acceptable working environment in an enterprise.

The same requirements for participation also apply when government agencies develop risk-based regulations and regulatory regimes based to a great extent on functional specifications. Applying this functional approach means that these collaborative players themselves can decide to a great extent how the regulations are to be applied in practice.

The industry accordingly has more freedom to choose between alternative solutions than would be the case with detailed regulations. This freedom of action imposes great demands on the quality of decisions and decision-making processes – including the ability to ensure that workers have the necessary level of involvement before solutions are chosen.

The PSA chairs the Safety Forum, the central collaborative forum for cooperation among the parties in the industry and the authorities related to HSE in the petroleum activities. This project has been reviewed in the Safety Forum.

The management committee for the project comprise representatives from the Safety Forum's members – the OLF, the NI, the Norwegian Confederation of Trade Unions (LO), IndustryEnergy, the Norwegian Union of Energy Workers (Safe), the Norwegian Organisation of Managers and Executives (Lederne) and the Norwegian United Federation of Trade Unions (Fellesforbundet).

The Federation of Norwegian Coating, Insulation and Scaffolding Contractors (KIS) have also been invited to participate in the project.

The PSA and the Norwegian Labour Inspection Authority (Atil) sit on the committee as observers.

The project is structured as shown in figure 2 with a steering committee, project leader and seven sub-projects/action teams.

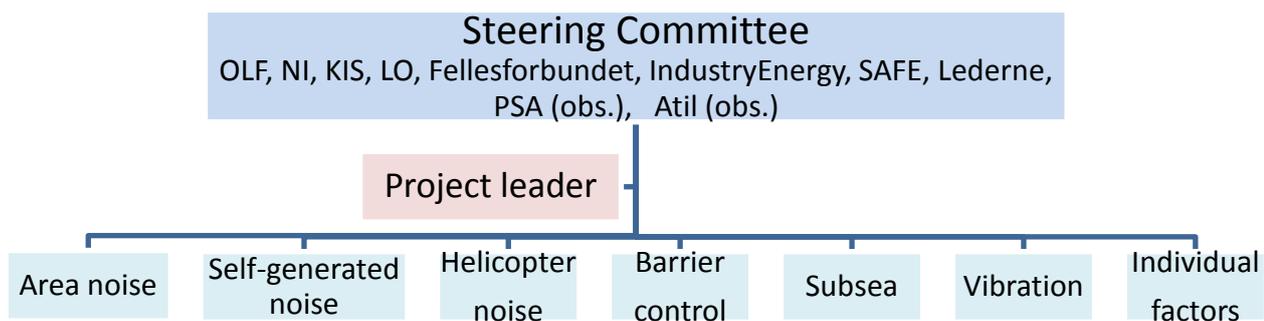


Figure 2-Project structure

Activities relevant for all action teams

Each action team assess the need to establish activities and develop documents related to:

- Identifying or developing **best practice**
- Assessing current **work processes**
- Assessing the need to initiate **research and development** activities
- Presenting proposals on new **low-noise work practices**
- **Benchmarking**
- Undertaking **analyses** of available data and assessing the possible need to acquire additional data
- Deciding on **knowledge dissemination** to the petroleum sector and other industries
- Submitting proposals for **improvement of industry standards**
- Assessing **health monitoring**/screening and hearing checks, and registering changes in hearing

Budget

The backbone of the project is a contribution from OLF member companies who dedicate specialists/experts to part-time work in the project. As of today approx. 40 persons are engaged in the sub-projects.

In addition the project budget over the project period is two million US dollars financed by OLF (main contributor), the Federation of Norwegian Industries and the Confederation of Norwegian Enterprise NHO/ the Working Environment Fund.

Schedule

The Noise in the Petroleum Industry project was established in March and the Management committee constituted in May 2011. Tentative conclusion of the Noise in the Petroleum Industry project is 31 December 2013.

Methodological approach

Various subject areas are covered by the project. These are organised as sub-projects/action teams, each with a professional manager and a team of specialists.

Sub-project/action teams

Area noise

Area noise relates to noise from the permanent part of the facility (facility-wide processes, compressors, turbines and so forth). The area noise contributes to high noise exposure to offshore personnel. Good planning and follow-up of noise related issues in all engineering phases of installations are essential to reduce potential noise risks in operations.

Self-generated noise

Self-generated noise comes from sources which are not a permanent part of the facility, but related to work processes/tasks. It includes noise from hand tools used for such purposes as rust removal (needle scaling, water jetting, sandblasting, angle cutting, grinding and so forth). Self-generated noise is often related to jobs done by contractors. For many employees this is the major noise source during the work and levels for many operations may be extremely high.

Helicopter noise

Helicopter noise makes a substantial contribution to total noise exposure for personnel working offshore. Helicopters are used for all personnel transport to and from offshore facilities. The subject covers noise exposure of passengers and offshore helideck crew, but pilots, Search and Rescue (SAR) personnel and onshore heliport crew will also be covered.

Barrier control

Barriers in this context are 1) physical screens to reduce noise from the source 2) time restriction and 3) hearing protection. The project will highlight examples of noise screening and insulation. It will also critically look at how the industry practices time limitation of activities. Finally, new types of ear protection and the limitations of the various types of such equipment will be studied.

Subsea

Diver assistance is used for various subsea construction, repair and maintenance assignments. Underwater noise during certain jobs (such as the use of angle grinders) can be considerable; even noise from communications and breathing equipment may contribute significantly to the dose received.

Vibration

Many noisy work operations and facilities also generate vibrations. The project will assess vibration and anti-vibration measures and conditions related to ultrasound, low-frequency noise and structural noise.

Individual factors

The susceptibility to hearing injuries can vary between individuals. The project will identify and distribute knowledge of factors known to affect individual susceptibility, including ototoxic chemicals, medications and the like.

Work scope

Area noise

Risk management with respect to noise throughout the engineering phase of new constructions and modifications of installations is essential to ensure that the area noise is kept as low as possible. Standards, procedures and corporate

specifications specify noise related requirements. Still, there are engineering projects that have not contributed to noise reduction during operational phase; in some cases these projects have deteriorated the situation.

This part of the project has the ambition to:

- Assess and evaluate the current status of how the noise is risk managed in engineering of new constructions and modifications.
- Assess and evaluate the suitability of engineering standards that regulate noise and propose improvements.
- Find, describe and share best practice examples of permanent noise reducing measures and technology development processes.
- Describe how noise should be included in risk assessments of exposed personnel.

Particular focus points will be:

- Evaluation of the noise requirement in Norsok S-002. This standard stipulates design requirements related to the working environment of installations as well as requirements regarding systematic management of working environment issues in project development and the design process in Norwegian petroleum industry.
- Evaluate risk evaluation method for prioritizing projects. Today there is no specific criteria's for prioritizing noise measurements.
- Describe phase in engineering project where noise issues must be highlighted, as well as need for noise competence for relevant project personnel.
- Describe specific examples of technology that reduce noise from installations.

Self-generated noise

Self-generated noise is the noise that is radiated from handheld tools used for construction, maintenance/surface treatment, cleaning operations etc. This applies to for instance to grinders, saws, sandblasting equipment and ultra-high pressure blasting equipment.

The scope is to reduce noise levels to meet legal requirements.

The aims are to:

- Create a database of operations and tools with the purpose to:
 - Make choices of low noise tools and less noisy operations easier.
- Encourage development of new technology.
- Clarify responsibility between equipment vendors, service companies and oil companies.

The data base will be made in cooperation with the "Vibration" action team and will include both noise data and vibration data. The database is planned to provide an overview of alternative solutions to the same achievement, for example: cutting can be made with saws, grinders, gas burners and UHP water. These approaches will have different noise levels and efficiency. The base should contain vendor data as well as field measured data. Further data from different vendors of the similar equipment will be gathered.

New technology will be studied and/or tested. Such includes for instance vacuum cleaning instead of conventional sandblasting. The vacuum cleaning, with an enclosed "head", is around 20 dB more silent than traditional sand blasting. Remote controlled operation is another example of new technology that may be tested.

Clarification, of which responsibility the various parts of the contract should take, is expected to highlight use of low noise tools and encourage choices of low noise operations.

Methods for noise level measurements will be handled and presented within this sub project.

Helicopter noise

This part of the project has the following main ambition: Establish routines to reduce risk of hearing damages during helicopter transportation and handling.

Particular focus points:

- Evaluate the current status of helicopter noise and to compare this with the main ambition.
- Clarify the noise exposure and risk for hearing damage for helicopter passengers and offshore helideck crew by gathering information from existing studies and by performing new studies / measurements.
- Improve the knowledge of noise exposure and risk for hearing damage for pilots, SAR personnel and onshore heliport

personnel.

- Establish a list of situations which creates the highest risk for hearing damage, both inside and outside helicopter.
- Evaluate possible technical measures to reduce noise levels inside and outside helicopters.
- Evaluate possible types of hearing protection for helicopter passengers and offshore helideck crew together with the “Barrier control” action group.
- Agree on recommendations and highlight «best practices” for helicopter transportation and handling.

Barrier control

It is important that noise barriers have the expected effect, in order to ensure that personal noise exposure is kept at an acceptable level.

In the present project, Barriers to noise means:

- 1) Temporary screens etc. to protect personnel
- 2) Limitation of time spent in a noisy environment
- 3) Use of personal hearing protection

This part of the project has the ambition to:

- Improve the knowledge about barriers in general – possibilities and limitations.
- Agree on recommendations and highlight «best practices”.
- Provide end users with some real changes.

Particular focus points are:

- Showcasing successful examples of temporary screening.
- Discuss and provide tools to plan noisy events (noise calculator).
- Assess need for general information and training – for hearing protection and ear plugs in particular.
- Evaluate various types of hearing protection – pros and cons, new products.
- Evaluate the use of double hearing protection – what are the cons?
- Measure attenuation of typical ear muffs in the field (to assess the effect of other personal protection equipment (PPE) (like safety glasses), tear and wear and non-ideal use).

Highlights of the work so far are:

- Use of ear plugs is particularly critical, requiring much better training, motivation and wider selection of products than is currently provided.
- The implementation of time restriction has up to now been inconsistent and often ignored due to lack of knowledge as well as lack of suitable tools for planning. A main problem is to consider several activities in combination.

Great transfer value exists to other industries where noise represents a problem.

Subsea

In 2011, the OLF's network for underwater operations initiated a project to document the typical noise levels that divers are exposed to during offshore underwater work.

Instrumentation has been developed to measure at the ear and outside the helmet whilst the diver is working, including a hyperbaric container to protect the portable recording equipment. Measurements will look at tool noise penetration, communications and breathing equipment noise levels. The significance of heliox in the helmet will be assessed.

These will be interpreted with respect to identifying risk to hearing and assessed against the current Norwegian and European legislation. Suggestions will be made on how setting of exposure levels can help reduce the risk of injury.

The work is funded by BG, BP, ConocoPhillips, Marathon, Statoil and Total, and started in September 2011. The final report is expected in late 2012.

Hand-held vibration

The use of hand-held power tools, hand-guided powered equipment, are not only challenging regarding noise exposure (“self-generated noise”) but also hand-arm vibration exposure needs to be assessed.

The industry is in need of more knowledge related to vibration exposure. In cooperation with the group working on self-generated noise an important goal is to create a database of tools holding manufacturer's data and field measurements.

About 10% of the workers in the petroleum industry use hand-held tools, mostly contractors. Appropriate risk assessments, field measurements and use of vibration dose calculators are important to make sure that workers are not excessively exposed (EU Directive 2002/44/EC).

Individual factors

The subgroup working with individual factors are occupational physicians and occupational hygienists and the subgroup focus on physiological and medical aspects of individual susceptibility to noise induced hearing injury.

Hearing injury secondary to noise exposure is frequently reported in Norwegian employees. Noise induced hearing injury is expected to be affected by various intra-individual and external factors termed "Individual factors" in this project: Genetic disposure, environment, lifestyle, ototoxic chemicals or drugs and noise exposure at home. It is questioned whether knowledge on such factors is sufficient amongst professionals and the workers themselves.

Early detection of noise injuries and implementation of individual corrective measures may prevent further progression of hearing injuries and preserve quality of health. Improved routines for health surveillance of noise exposed workers may contribute to this. Surveillance of reported hearing injuries at the worksites may provide knowledge on mechanisms and prevent further cases. Routines for investigation of hearing injuries are not well established in the industry.

This part of the project has the ambition to:

- Facilitate early detection of hearing injuries and measures to be taken when signs of hearing injury are detected.
- Improve follow-up routines to avoid further progression.
- Disseminate knowledge on how to prevent hearing injuries at work – including information to the employees themselves.

Conclusion

Deliveries

The project will suggest measures for the petroleum and land based industry, to be implemented on a continuous basis, to reduce noise exposure and diminish noise induced hearing injuries within the end of the project period.

The project will propose cost/benefit analyses of various noise-reducing measures.

The project will collate knowledge from the industry (industrial projects and public standards) and achieve new knowledge through research programs. It will contact national and international centres of expertise.

The project will disseminate knowledge in established industrial fora and support the development of guidelines and best practice documents.

Evaluation of effects – how are these to be measured?

The short-term effect of this project can be evaluated by the production of the generated recommendations and documents/standards. In the long term, the effect of this project is expected to affect the extent of hearing injuries and thus be traceable through HSE statistics, RNNP reports and PSA injury reports.

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