# Noise Control Methods for Shipbuilding

## Final Report

NSRP Subcontract Agreement No. 2012-424

Presented To:

**National Shipbuilding Research Program**

Operated by

**Advanced Technology Incorporated**

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November 1, 2012

## Abstract

Noise control has always been a big issue in shipyards. OSHA regulations for Occupational Exposure to Noise in 29CFR 1910.95 define specific requirements for shipyard employment, including surveillance, audiometric testing, training and use of approved PPE for exposures exceeding 85 dBA over a full shift. Experience has demonstrated that uncontrolled exposure represents a major loss-control issue by contributing to Noise-Induced Hearing Loss (NIHL), citations, lower productivity and costly compensation claims.

A wide variety of equipment and operations commonly found in shipbuilding have the potential to produce excessive noise levels requiring OSHA compliance action and the use hearing protection unless employers have sampling data to document their equipment operates below the action thresholds. The goal of this project was to accurately measure and characterize representative noise levels generated by common shipyard manufacturing and maintenance processes, to define both representative exposure levels and to evaluate and describe the most effective control methods which are currently in place. This work is designed to promote effective and beneficial technology transfer, so that techniques and processes that may have been proven in one or two locations may be passed along to other sites to promote noise exposure reduction, where possible, with reduced trial-and-error, better innovation and ultimately, reduced exposure time before implementation.

Field work in this project included site visits to four participating shipyards to perform full-shift personal noise dosimetry and sound-level surveys during selected “high noise” shipyard processes. Each visit was three days in length and hosted by the participating Health and Safety Manager, who selected the site specific noise-producing tools and manufacturing operations to be included in this study. The testing represented a comprehensive cross-section of equipment and processes commonly used in shipbuilding, including metalworking (welding, grinding, cutting), painting and surface preparation (to include blasting, needle guns) and transportation services (including trucks, forklifts and material movers). This data indicates that high noise operations remain to be widespread in shipyard work. Full shift dosimeter testing was completed in accordance with three different measurement parameters corresponding to the criteria established for OSHA PEL compliance, OSHA Hearing Conservation Program thresholds and the ACGIH Threshold Limit Values for Noise.

Of the 30 full shift dosimetry results recorded during the Task 2 Field Work, 13 (43%) exceeded the OSHA PEL Criteria of 90 dBA, 22 (73%) exceeded the OSHA Hearing Conservation trigger level of 85 dBA, and 27 (90%) exceeded the ACGIH TLV criteria of 85 dBA. While many sources of high noise exposure remain in the industry, each participating shipyard demonstrated some site-specific and innovative noise control strategies, which are presented in this report. In addition, based upon the input of participating organizations, there are recommendations for future action steps to further improve noise control in shipyards.

## Introduction

A wide variety of equipment and operations commonly found in shipbuilding have the potential to produce excessive noise levels requiring OSHA compliance action and the use hearing protection unless employers have sampling data to document their equipment is below the action level. Examples include:

1. Pneumatic tools (grinders, compressors, needle guns, drills, chippers, hammers, impact wrenches, etc.).
2. Welding, cutting, burning, carbon arc gouging and other operations generating sparks or molten metal, not to include manual and automatic gas tungsten arc welding (GTAW) and submerged arc welding.
3. Abrasive blasting, vacuveyors, etc.
4. Power tools (grinders, planers, saws, jointers, etc.).
5. High impact equipment/operations (plate hammering, power stud guns, concrete breaking, pile driving, etc.).
6. Pressurized cleaning equipment (steam, air, water, etc., except compressed air less than 30 psi).

Research and evaluation on this topic has been ongoing for many years.

- The ALLIANCE (OSHA, SCA, NSRP) have recognized the need to provide updated industry-specific guidance, producing the ***Tool Box Talks: Hearing Conservation In The Shipbuilding Industry*** document in 2009. This document has stated that some work in the shipbuilding industry may produce full-shift noise exposure exceeding 100 dBA.
- OSHA has recently worked with the shipbuilding industry to produce the Safety and Health Injury Prevention Sheets (SHIPS) series (pages A8-A9), which address the importance of the proper use of hearing protection.
- NIOSH has also completed a series of noise evaluations in shipyards: Project 921Z6PE and Project 927Z1LB.

While the presence and cost of noise exposure in the shipbuilding industry is well-recognized, we have been lacking an evaluation of current practices in practical and beneficial noise control measures. For example:

- Tool selection – Is there a model of tool that does the same job with lower noise levels?
- Maintenance and Repair Practices – Does effective upkeep reduce noise?
- Vibration reduction - Can simple, low-cost methods like clamps or foam pads deliver big results?
- Isolation or scheduling of some tasks to reduce number of exposed employees
- What are other shipyards doing to tackle this problem?

This study is designed to meet that need, so that techniques and processes that may have been proven in one or two locations may be passed along to other sites to promote noise exposure reduction, where possible, with reduced trial-and-error, better innovation and ultimately, reduced exposure time before implementation.

**Project Goals and Objectives:**

a. Collect noise exposure monitoring data during representative shipyard processes
b. Define operating parameters and working conditions which may contribute to the reduction or challenges in shipyard noise exposure, and
c. Present a report with a summary of conditions, challenges, and practical and proven controls existing in today's shipyard working environment.

**Task 1- Technical Background Summary**

The project started with preliminary research and coordination efforts to:

- Finalize the areas of top priority focus to include operational breadth (new construction and repair) and technological breadth of tools and equipment in use in today's American shipyards
- Work with our participating shipyard team members to refine project goals and finalize tasking and schedule for in-field testing
- Review available literature to take advantage of prior work and avoid duplication
- Based upon the availability of responsive historical data, define scope and methodology for collection of new noise sampling and analysis data, as needed, to fill gaps and measure the effectiveness of current noise control methods.

Evaluation of Current Activity in Noise Assessment and Research:

This project evaluated the status of other ongoing efforts in noise assessment and control in order to identify information resources which may provide additional value to the shipbuilding industry. In addition, industry-specific outreach efforts were intiated to promote project participation and encourage collaborative input. Several resources and ongoing studies were identified, with descriptive summaries below:

**Occupational Safety and Health Administration (OSHA)** - OSHA conducted a Stakeholder Meeting, "Preventing Occupational Hearing Loss," held in Washington, DC on November 3, 2011. The purpose of this meeting was to present and summarize OSHA's regulatory and enforcement processes, and to provide a forum for many organizations, across several industries, to promote their products, performance history and preferred approaches to regulatory control. Some innovative and effective technical applications were presented. A Meeting Summary Report is provided as Appendix 1.

In addition, during Task 1, the research team sought information on historical noise monitoring data collected by OSHA to see if it was possible to apply to characterize specific sources of noise exposure in the shipbuilding and ship repair industries. According to Richard Fairfax, Deputy Assistant Secretary of Labor, OSHA does not, at this time, have the data sorting capability to retrieve and present their noise monitoring data, by industry, to provide any type of summary or analysis. This capability does exist for their historical air monitoring data for chemical exposures in their Integrated Management Information System (IMIS).

**National Institute for Occupational Safety and Health (NIOSH)**

At NIOSH, a research team led by Dr. Mark Stephenson has been working to evaluate methods to improve the fit and protection provided by hearing protection equipment, with the development of **The NIOSH HPD Well Fit System. Dr. S**tephenson has written that occupational hearing loss is among the most common occupational illnesses in the manufacturing sector. When engineering controls have not yet eliminated hazardous noise exposures, or are not feasible, using personal hearing protection devices is the only means of protecting the worker from hazardous noise. Unlike respirators, there is no requirement that hearing protectors be fit tested. In part, this is because hearing protector fit testing technology was impractical for use outside of laboratory testing environments. To address this need, NIOSH scientists have developed a hearing protector fit testing

system that is fast, accurate, and can be used as part of the annual audiometric monitoring program in any hearing conservation program. Upon the conclusion of their research it is their goal to offer the NIOSH HPD Well Fit system to improve the effectiveness of hearing protection and prevent work-related hearing loss.

Navy Safety and Environmental Training Center (NAVSAFENVTRACEN)
Delivered a presentation on the goals and objectives of this project for a technical audience as part of the 20th Annual Safety Professional Development Conference (PDC) hosted by Navy Safety and Environmental Training Center (NAVSAFENVTRACEN) for Army, Army Corps of Engineers, Marine Corps, Navy, Air Force and Coast Guard. It was held March 14, 2012, at the Hampton Convention Center, Hampton, VA. This conference was attended by over 1000 safety and occupational health professionals from around the world. . This effort was highly beneficial, resulting in assistance provided during subsequent field work at Norfolk Naval Shipyard, technical research services and producing a network of highly engaged and supportive technical professionals.

**Defense Safety Oversight Council (DSOC) Initiative High Noise Source Reduction**
A program led by the Naval Safety Center at The Pentagon has brought together participants from all branches of the military, Coast Guard, NIOSH and OSHA to identify methods to reduce noise throughout the Department of Defense. A descriptive summary of the DSOC Initiative is provided as Appendix 2.

One aspect of this ongoing program is the **Noise Exposure Assessment Tool (NEAT)**
The Defense Safety Oversight Council Acquisition and Technology Task Force sponsored a project to help evaluate life-cycle costs and risk of noise exposure for military personnel. It provides acquisition programs and their reviewers with a tool to estimate the cost and risk avoidance associated with implementing noise controls in the design phase. The Noise Exposure Assessment Tool "NEAT" also describes personnel exposure risk in terms of Military Standard 882 System Safety categories and indicates the management risk acceptance level required for a given noise exposure and its reduction through control measures. The tool provides a method for calculating the effective protection provided by given types of protective equipment and de-rating their effectiveness according to accepted methodology. This discourages the use of protective equipment alone as the sole "control" for noise exposures. A related component of the tool estimates speech interference level, including some conditions which may be below occupational exposure limits, but still impair mission performance and safety due to communication issues.

**NSRP Safety and Health Advisory Committee(SHAC)**
In order to finalize the field testing plan for this project, the Program Manager attended the NSRP Risk Management Panel Meeting held in Norfolk, VA on November 16, 2011 and presented a summary of the project to the Safety and Health Committee (SHAC), outlining the purpose, goals and schedule of the project. NSRP-SHAC members are health and safety professionals from shipyards located throughout the United States. The goal of this committee is to explore efforts to reduce injuries and illnesses to industry workers and the associated costs related to these injuries. Operating within the framework of the DOD-funded NSRP, which is established to help reduce the cost of shipbuilding and ship repair for both private and public shipyards, the committee is composed of representatives from labor, management, consultants, and academia. Part of this presentation included

a request for responsive historical noise monitoring data to effectively characterize priority exposure categories in our industry.

Following this request, the research team received and reviewed a substantial body of historical noise monitoring data from project participants. The noise data received may be summarized as follows:

a. Dates of Testing: Covers 21 years, from 1986-2007
b. Total Number of Samples Received: 3277 noise dosimetry results were provided, ranging from 54 minutes to 869 minutes, with an average of 394 minutes.
c. Number of Facilities Represented: Six different facilities were represented in the testing.
d. Number of Processes Represented: Since the raw data did not use consistent descriptive terms, 750 different noise sources were cited in the information submitted. A review of this testing data has identified pneumatic hand tools, abrasive blasting, welding and ventilation equipment as predominant sources represented.
e. Range of Results: Dosimetry results ranged from 25.6dBA to 119.0 dBA, with a 4dB Exchange Rate. There were 844 samples above 85 dBA, or slightly more than 25%.

**Task 2 – Field Work**

Upon completion of the outreach and evaluation of the historical data, the Field Testing Plan was then prepared to include:

- Personal full-shift noise dosimetry and sound-level measurement during selected shipyard processes, such as grinding, cutting, welding, abrasive blasting and surface preparation, painting and cleaning.
- Evaluation of new or innovative noise control measures presented by participating shipyards.

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Site Visits:

The research team completed site visits to each of the four participating shipyards to perform full-shift personal noise dosimetry and sound-level surveys during selected “high noise” shipyard processes. Each visit was three days in length and hosted by the participating Health and Safety Manager, who selected the site specific noise-producing tools and manufacturing operations to be included in this study. Sites visited included:

a. BAE Southeast Shipyards, Jacksonville, FL; February 20-22, 2012
b. Norfolk Naval Shipyards, Portsmouth, VA; March 19-21, 2012
c. Bath Iron Works, Bath, ME; March 26-28, 2012
d. Vigor Shipyard, Seattle, WA; April 9-11, 2012

Methods and Equipment

Quest NoisePro personal noise dosimeters and sound level meters were used for the data collection phase of this project. In order to minimize potential sources of variability, the same set of dosimeters were used for all shipyard evaluations. A technical data sheet, describing the features of the dosimeters used for this study, is provided as Appendix 3

Since historical data and comparative data from other studies includes testing from a variety of exchange rates and dosimetry thresholds, the dosimeters used in this study were adjusted to collect noise measurements in accordance with the following three settings:

**Measuring Parameters:**

| DOSIMETER | 1 |
|---|---|
| Setup Name: | OSHA HC |
| Criterion: | 90 dB |
| Exchange Rate: | 5 dB |
| Threshold: | 80 dB |
| Upper Limit: | 115 dB |
| Weighting: | SPL:A Pk:Z |
| Time Constant: | Slow |
| Alert Level 1: | 85 dB |
| Alert Level 2: | 0 dB |

| DOSIMETER | 2 |
|---|---|
| Setup Name: | ACGIH |
| Criterion: | 85 dB |
| Exchange Rate: | 3 dB |
| Threshold: | 80 dB |
| Upper Limit: | 115 dB |
| Weighting: | SPL:A Pk:Z |
| Time Constant: | Slow |
| Alert Level 1: | 85 dB |
| Alert Level 2: | 0 dB |

| DOSIMETER | 3 |
|---|---|
| Setup Name: | OSHA PEL |
| Criterion: | 90 dB |
| Exchange Rate: | 5 dB |
| Threshold: | 90 dB |
| Upper Limit: | 115 dB |
| Weighting: | SPL:A Pk:Z |
| Time Constant: | Slow |
| Alert Level 1: | 90 dB |
| Alert Level 2: | 0 dB |

This permitted comparative review and analysis of the noise data collected in accordance with criteria specified by OSHA Hearing Conservation, OSHA Permissible Exposure Limit or ACGIH Threshold Limit Value specifications.

Noise surveys were conducted in accordance with standard protocol defined by OSHA Noise Standards (29 CFR 1910.95 ) and Chapter 5 of the Navy Industrial Hygiene Technical Manual – Noise Surveys, Section 4 – Sampling Protocol, provided as Appendix 4.

Results of Testing:
Each participating location was able to identify tools and operations capable of producing significant noise levels. For each operations tested, the goal of this evaluation was to provide full-shift dosimetry in accordance with the 3 specified criteria ranges and to collect sound level meter readings in and around the work area and record sufficient observations to identify effective noise control practices, where applicable. A complete summary of the dosimetery field testing results is provided as Appendix 5. A complete summary of the sound-level meter results are provided as Appendix 6.

The tools and processes tested during this evaluation included:

- Abrasive Blasting with Steel Shot in shop
- High Pressure Water Jetting on Ship Hulls in Drydock
- Flux Core Arc Welding
- Pneumatic grinders on steel plates in shop
- Shipfitting and Assembly of steel panels in shop
- Hydroblasting in Paint Shop Bay
- Orbital Sander on Fiberglass for Painting Surface Preparation
- Pulse-Arc Welding
- Automated track grinder on Steel plates
- Forklift operation
- Truck driving for in-yard material deliveries
- Shielded Metal Arc Welding
- Needle Guns on steel; shipboard work

Of the 30 full shift dosimetry results recorded during the Task 2 Field Work, 13 (43%) exceeded the OSHA PEL Criteria of 90 dBA, 22 (73%) exceeded the OSHA Hearing Conservation trigger level of 85 dBA, and 27 (90%) exceeded the ACGIH TLV criteria of 85 dBA, as shown in Figure 1, Comparison of Noise Measurement Criteria , below.

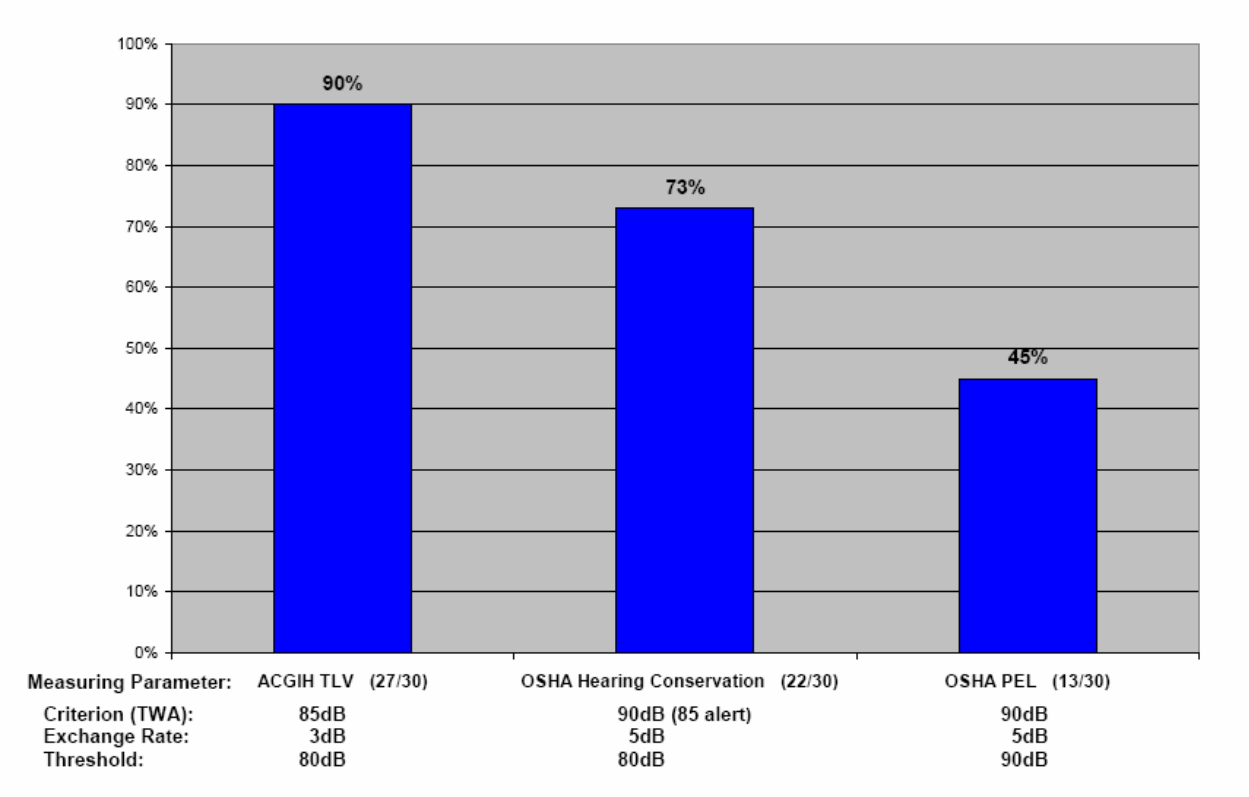



Figure 1 - Comparison of Noise Measurement Criteria

Discussion of Results:
As shown in the summary of dosimetry results presented in Figure 1 the industrial processes and tools used in shipbuilding present substantial noise control challenges.

Noise control methods typically used throughout industry include a hierarchy of controls including:

Engineering controls - involve modifying or replacing equipment, or making related physical changes at the noise source or along the transmission path to reduce the noise level at the worker's ear. In some instances the application of a relatively simple engineering noise control solution reduces the noise hazard to the extent that further requirements of the OSHA Noise Standard (e.g., audiometric testing (hearing tests), hearing conservation program, provision of hearing protectors, etc…) are not necessary.

- Choose low-noise tools and machinery (e.g., Buy Quiet Roadmap (NASA)).
- Maintain and lubricate machinery and equipment (e.g., oil bearings).
- Place a barrier between the noise and employee (e.g., sound walls or curtains).
- Enclose or isolate the noise source.

Administrative controls - are changes in the workplace that reduce or eliminate the worker exposure to noise. Examples include:

- Operating noisy machines during shifts when fewer people are exposed.
- Limiting the amount of time a person spends at a noise source.

- Providing quiet areas where workers can gain relief from hazardous noise sources (e.g., construct a sound proof room where workers' hearing can recover – depending upon their individual noise level and duration of exposure, and time spent in the quiet area).
- Restricting worker presence to a suitable distance away from noisy equipment.

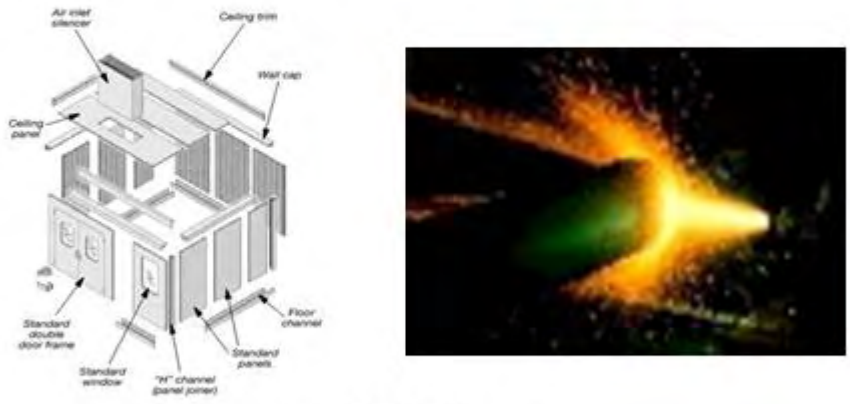
Controlling noise exposure through distance is often an effective, yet simple and inexpensive administrative control. This control may be applicable when workers are present but are not actually working with a noise source or equipment. Increasing the distance between the noise source and the worker, reduces their exposure. In open space, for every doubling of the distance between the source of noise and the worker, the noise is decreased by 6dBA.

Personal Protective Equipment – Hearing protection devices (HPDs), such as earmuffs and plugs are considered an acceptable but less desirable option to control exposures to noise and are generally used during the time necessary to implement engineering or administrative controls, when such controls are not feasible or when worker's hearing tests indicate significant hearing damage.

Reference: OSHA Quick Takes – Occupational Noise Exposure;
**http://www.osha.gov/SLTC/noisehearingconservation**

The effective control methods observed during this study represented a combination of approaches, demonstrating an innovative application of practical measures. Each participating shipyard was able to demonstrate unique solutions to their noise challenges. Four of these control methods are presented below:

**1. Isolation of Noise Source – Plasma Jet Flame Spray Operator Booth**




**38 dB Reduction**
In Booth vs FS Room

Plasma Jet Flame Spray applies a metallic coating to prepared surfaces using heat under high pressure. The abrupt expansion of the plasma jet exiting the spray nozzle is a significant source of

noise generation. Since the process could be automated and controlled by an operator in a nearby booth, enclosure provided a substantial noise reduction. This enclosure was fabricated by shipyard personnel using materials already available in the shipyard. It was not an off the shelf solution.

Sound level meter at source: 116dBA
Sound level meter in Operator's Booth: 78 dBA

2. **Distance from Noise Source – HPWJ Operator Console**


**8 dB Reduction**

At 10ft vs At Nozzle

High pressure water jetting is widely used for coating removal and surface preparation in shipyards. According to industry research, (NSRP 0439, 1995) – The waterjet process is inherently superior to conventional marine coating removal methods such as grit blasting, shot peening, sanding, chipping, scraping or brushing; it offers the major advantages listed below:

- Paint is the only waste product,
- No dust or airborne contaminants,
- Requires no containment structures,
- Does not subject workers or the environment to hazardous waste.

As with other surface preparation processes, it also creates high noise levels for equipment operators. One solution to reduce this noise exposure, in part, has been to employ a remote console to control the blast jets from a distance, while maintaining visual contact with the blasted surface.

During this field evaluation, use of the operator console provides distance of about 10 feet with measureable reduction of noise exposure for the operator.

Sound level meter at source = 106 dBA
Sound level meter at 10 ft distance (operator's console) = 98 dBA

### 3. Distance from Noise Source – Track Angle Grinder

**11.2dB Reduction**

Operator Dosimetry, OSHA PEL Scale

Angle grinders and other pneumatic power tools are widely used in shipbuilding and repair. Hand held grinders, with close contact to the cleaned surface creates substantial noise exposure to the operator. A track-grinder, with an automated control system has been applied to ensure a uniform metal surface with the added benefit of removing the equipment operator several feet from the noise generation.
Based upon an evaluation of two employees in the same shop on the same day, the full-shift dosimetry results demonstrated an 11.2dB lower noise exposure for the operator using the track grinder.

### 4. Locate Compressors & Air Handlers Outside of Blast Room

**8dB Reduction**

Inside PotTender ⇆ Outside

Paint Department Blast House operations contain many pieces of equipment capable of generating high noise levels, including blast pots and dust collectors. While some of this equipment may be located indoors, there is the potential for significant noise reduction if this equipment is isolated from blasters and other shop employees. A comparison of shop areas where this support equipment was located outside of the work area demonstrated an 8dB noise reduction.

Based upon the field studies, observation and data analysis, these control methods represent effective solutions that were developed and applied to solve a unique, site specific challenge. Hopefully, this type of continued analysis and the application of practical innovations will be able to provide additional noise control solutions in the future.

**Conclusions and Recommendations**

This study has met the defined goals of:

- Collection of current noise data representative of shipyard work
- Summarize the sources of noise that pose significant control challenges, and
- Identify some practical control solutions and information resources that can demonstrate immediate benefit in reducing noise exposure in shipyards.

While many noise control challenges remain, shipyards are demonstrating innovative solutions to address this problem, with measureable results. Although some progress is being made, additional tools and resources could allow greater implementation of practical and cost-effective noise control programs, while maintaining cost-competitive productivity. Based upon input from participating organizations, these recommendations include:

- Develop “Buy-Quiet” specifications for the shipbuilding industry, comparable to the programs established for aerospace (NASA) and the mining industry to provide clear instructions and selection criteria for new or replacement tools and equipment with proven noise reduction ability;
- Include noise control considerations in maintenance and repair work, where sound damping pads, lubrication, mounting systems or other minor adjustments could provide immediate benefit, and
- Include noise control considerations in the design and construction of new facilities and capital improvement projects, at an early stage to ensure the most cost-effective implementation without disruption or last-minute modifications.

## REFERENCES

1. Occupational Safety and Health Administration (OSHA), 29 CFR 1910.95, Occupational Noise Exposure (http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=9735 )
2. American Conference of Governmental Industrial Hygienists (ACGIH), Threshold Limit Values; Physical Agents – Noise (http://www.acgih.org/home.htm)
3. US Navy, Industrial Hygiene Field Operations Manual, Chapter 5 – Noise (http://www-nehc.med.navy.mil/downloads/ih/ihfom/IHFOM_CH5.pdf )

## ACKNOWLEDGEMENTS

This work was possible due to the support and many contributions of the NSRP Risk Management Panel Safety and Health Advisory Committee (SHAC) and the participating staff of BAE Southeast Shipyard, Norfolk Naval Shipyard, Bath Iron Works, Vigor Shipyards and the Navy and Marine Corps Public Health Center.

# Appendix 1

Appendix 1



# Stakeholder Meeting on Preventing Occupational Hearing Loss Washington, D.C.

## November 3, 2011

## Meeting Summary Report

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### 1. Introduction

This report summarizes key discussion points made during an informal stakeholder meeting that the Occupational Safety and Health Administration (OSHA) convened to provide a forum and gather information on the best practices for noise reduction in the workplace. The meeting included a discussion on personal protective equipment, hearing conservation programs, and engineering controls. The four-hour meeting was held from 9:00 a.m. to 1:00 p.m. EDT on November 3, 2011, at the U.S. Department of Labor (DOL) Frances Perkins Building in Washington, D.C. The purpose of the meeting was to elicit the views of employers, workers, and noise control and safety and health professionals about the hazards of occupational exposure to noise and how best to control them. OSHA held this stakeholder meeting as part of its commitment to work with stakeholders on approaches to prevent hearing loss.

On October 19, 2010, OSHA published in the *Federal Register* a proposed interpretation titled "Interpretation of OSHA's Provisions for Feasible Administrative or Engineering Controls of Occupational Noise." The proposed interpretation clarified the term "feasible administrative or engineering controls" as used in OSHA's noise standard. Comments were due December 20, 2010; however, in response to several requests from the regulated community, OSHA extended the comment period by 90 days to March 21, 2011. Over 90 comments were received. OSHA stated that it would review all of the comments before making its final decision. On January 19, 2011, the proposal was withdrawn: OSHA decided to suspend work on it in order to conduct an education, outreach, and consultation initiative on preventing work-related hearing loss. As part of this initiative, OSHA committed to holding a stakeholder meeting on preventing occupational hearing loss.

An announcement of the stakeholder meeting was published in the Federal Register on October 6, 2011, and explained that parties interested in attending and participating should register in advance. This meeting had 30 participants, representing industry, trade organizations, academia, unions, and government agencies, as well as consultants, attorneys, and other parties. All participants were given the opportunity to provide verbal comments at the meeting. Members of the general public were allowed to observe the meeting (but not participate) on a first-come, first-served basis as space permitted. Approximately 50 people attended the meeting as observers, either in person or by teleconference.

This report captures the main discussion points that stakeholders raised during the meeting, but is not a verbatim transcript of the meeting. Its content reflects stakeholders' remarks at the meeting and does not represent the opinions of OSHA.

### 2. Opening Remarks

William Perry, Deputy Director, Directorate of Standards and Guidance, welcomed the stakeholders and gave the following remarks.

Good morning everyone. I'm William Perry, Deputy Director of the Directorate of Standards and Guidance. I would like to thank you for taking the time to talk to us today on this important issue. I know that many of you have very busy schedules and that some of you have had to travel a long distance. We truly appreciate your taking the time to be here, to share your expertise and your concerns, and to help us move forward to continue working with stakeholders on approaches to preventing occupational hearing loss.

Today's stakeholder meeting is an important step in helping us to assure that we get the best available information. The panel will be presenting four questions today on which we are seeking your input and comments. This meeting will give us an opportunity to establish a constructive dialog that will build trust and facilitate the flow of information, not only today, but as we move through the process.

Before we begin our discussion today, I would like to introduce the members of OSHA's panel. Debbie Berkowitz, Chief of Staff for the

## Appendix 1

Occupational Safety and Health Administration; Richard Fairfax, Deputy Assistant Secretary of Labor; Nancy Hauter, Director, Office of Health Enforcement in the Directorate of Enforcement Programs; Audrey Profitt-Henry, Senior Industrial Hygienist, Directorate of Enforcement Programs; Brian Liddell, Health Response Team, Directorate of Technical Support and Emergency Management; and Bryan Seal, Senior Industrial Hygienist, Directorate of Standards and Guidance. And joining us later will be Dorothy Dougherty, Director of the Directorate of Standards and Guidance.

I want to emphasize that stakeholders should consider this meeting an informal discussion to help OSHA identify best practices, rather that a formal meeting or hearing. We are not transcribing this meeting; however we will be taking notes and placing a summary in the docket and on our Web site.

I am very pleased to see this turnout and I look forward to what I know will be a very productive meeting. Thank you again for being here with us today. I look forward to working with you in the future as we move through the process.

Deborah Berkowitz, Chief of Staff, OSHA, gave the following opening statement. I also want to welcome everybody and let you know how grateful we are that you are here. We know how busy everyone is, and I want to thank you on behalf of the full agency for your time and your interest in being here. I especially want to thank those that have come in from around the country to discuss this important issue.

We are here to discuss preventing occupationally-related hearing loss. From 2004-2009, the BLS has reported that over 125,000 workers suffered significant, permanent hearing loss from work. We are all here today because we care about this issue, and we are looking to share information and ideas on how best to move the ball forward on protecting workers. OSHA is committed to working with our stakeholders –you – on finding approaches to reduce this toll.

OSHA is here today to listen. Last January, we announced that we would hold this stakeholder meeting to elicit the views of employers and their representatives, workers and their representatives, noise control experts and public health professionals on preventing occupational hearing loss. And that is who is here today.

We are also committed to continuing our education and outreach effort to provide enhanced technical information on preventing occupational hearing loss. I hope you have visited our new webpage on Occupational Noise Exposure. We are looking forward to updating this page with new information and ideas gleaned from today's meetings.

We have a series of questions we asked in the Federal Register notice to help in guiding this discussion. But before we begin, I want to introduce Rich Fairfax, our Deputy Assistant Secretary, who has a few opening remarks.

Richard Fairfax, Deputy Assistant Secretary of Labor, explained that many in the regulated community are misinformed about how OSHA approaches noise reduction in the workplace. Many believe that OSHA requires every employer to lower noise levels below 90 decibels (dB). This is the target noise level, but OSHA is most concerned with achieving a significant reduction in noise—which could be a reduction of only 3 dB in some workplaces As far as noise control goes, the Agency has always worked fairly and cooperatively with employers and we will continue to do so – our procedures for evaluating noise exposure I think you will find, at least in my opinion, quite fair and reasonable.

The Agency has always followed the same principles in citing and requiring an employer to implement noise controls. And we have always accepted the use of a combination of controls that include: engineering controls, work practice controls, and administrative controls. While engineering controls are always the preferred control method – OSHA does not require employers to implement 100% engineering controls – again we allow and accept a combination of control methods.

I am assuming most all of you are familiar with noise energy and the fact that we are actually measuring the energy in the form of sound pressure levels – like an earthquake, noise energy is expressed on a logarithmic scale. For noise measurement, there are a several logarithmic scales used – the most common ones revolve around what is referred to as an exchange rate of either 3 dB or 5 dB. Under these scales, the noise energy doubles with every 3 or 5 dB increase in the noise level. For measurement and enforcement purposes, OSHA uses a 5 dB exchange rate – meaning the sound energy to which a worker is exposed is considered to double with every 5 dB increase in the noise level. However, it is generally accepted that use of a 3 dB exchange rate for assessing noise exposure is more appropriate – which means the sound energy doubles with every 3 dB increase in the noise level. What this means in simple terms is that with a 5 dB exchange rate, the exposure one gets for 8 hours of exposure at 90 dB(A), is equivalent to 4 hours of exposure at 95 dB(A); or using a 3 dB exchange rate, the exposure to 90 dB(A) for 8 hours is equivalent to 93 dB for 4 hours.

As I said earlier, OSHA has never said that one needs to reduce the noise levels down to 90 dB(A) or lower for a average 8 hour exposure to noise. OSHA has always looked at what we call a "significant reduction in the noise level." And for OSHA purposes that significant reduction is a 3 dB exchange rate NOT the 5 dB exchange rate we use for measurement and citation.

So, the noise levels at a facility averaged 100 dB(A) OSHA would: 1) measure the noise levels and determine an 8 hour time weighted average exposure; 2) conduct an octave band analysis to determine the frequency range and predominate noise frequency; 3) review the engineering, work practice, and administrative controls that would be applicable, based upon the circumstances at the facility; and 4) calculate the expected noise reductions and examine what options are available for reducing the noise levels.

Then, if the combination of noise reduction options and the calculations in noise reduction levels achieved a 3 dB reduction or more – we would cite and require a combination of controls. If we could not show a minimum of 3 dB we would not cite for controls and the employer could rely on hearing protection and a hearing conservation program.

If an employer has been cited for controls, the Agency has always been very flexible with the time allowed for abatement. We have typically worked with employers on abatement schedules that can last a year with the opportunity to extend the abatement period further. I can recall one mill in Georgia where the employer was given a 10 year abatement period.

3. **Administration of the Meeting**

The meeting facilitator provided the stakeholders with an overview of the meeting format, which was an informal discussion with stakeholders, not a formal meeting or hearing. The facilitator explained that OSHA was not there to answer questions; rather, the purpose of the meeting

was to listen to stakeholder input on four topics related to the prevention of occupational hearing loss. The facilitator also presented an overview of the agenda, including the specific questions that OSHA was asking the stakeholders to address. Each of the four questions was discussed for approximately 45 minutes, with a 20-minute break after the second discussion. Participants introduced themselves by giving their names and organizations when called upon to speak for the first time.

4. **Points of Discussion**

OSHA sought stakeholder input on the four questions regarding occupational hearing loss prevention: 1) What are the best practices regarding hearing conservation programs? 2) What are the best practices for, as well as concerns with, using personal protective equipment for noise control? 3) What are the best practices for using feasible engineering controls? 4) What are companies' experiences with effective noise control programs and what are the key elements of their programs?

The following is a summary of the key stakeholder comments made during the meeting. Comments are grouped together by topic, without reference to the identity of the commenter.

*4.1 What are the best practices regarding hearing conservation programs?*

Nancy Hauter, Director, Office of Health Enforcement, thanked everyone for coming to the meeting and provided an introduction to hearing conservation programs and their elements.

Hearing conservation programs include the following elements: 1) monitoring noise in the workplace to identify employees at or above an exposure of 85 dB for an eight-hour time-weighted average (TWA); 2) notifying these employees that they are exposed; 3) allowing those workers to observe the monitoring that was conducted; 4) establishing and maintaining an audiometric testing program; 5) informing workers of the results of their hearing tests; 6) providing adequate hearing protection to workers; 7) training exposed workers on the effects of noise, the use of hearing protection, and the purpose of audiometric testing programs; 8) posting OSHA's noise standard in the workplace; and 9) keeping records of noise exposure measurements and audiometric testing results.

Many companies rely heavily on hearing conservation programs to protect employees. The effectiveness of these programs is determined by the results of the hearing tests. The goal of a hearing conservation program is to prevent hearing loss. OSHA compliance officers sometimes encounter problems with audiometric testing. Audiometric testing is often conducted improperly, or is not conducted in a timely fashion. In fact, the audiometric testing paragraph of the noise standard is the most frequently cited paragraph in the standard. The second most frequently cited paragraph is the hearing conservation program itself.

Stakeholders provided the following comments and recommendations regarding best practices for hearing conservation programs:

- **Audiometric testing:**

  – A best practice is to ensure that the background noise level is low enough during audiometric testing that it does not interfere with obtaining an accurate threshold measurement.

  – A baseline hearing test for employees should be performed sooner rather than later. Under the current noise standard, employers have a year to perform baseline hearing tests for employees. Employees should not be exposed to noise for 14 to 20 hours before a baseline hearing test. Simply wearing hearing protection during the period before a baseline test does not always prevent exposure to noise, since hearing protectors may not work if worn incorrectly.

  – Everyone who performs hearing testing in an occupational context should be certified by the Council for Accreditation in Occupational Hearing Conservation. This organization provides standardized and uniform training.

  – Audiometric testing does not save hearing by itself. Testing needs to be followed up with counseling and training, or else the hearing conservation program simply serves as a way to document hearing loss. Many companies believe they are complying with the noise standard just by performing audiometric testing.

  – Employees in some industries tend to move from job to job. Someone should create a credential that workers can carry with them that lists their results from a baseline hearing test. This would establish a worker's baseline on the first day of a new job.

- **Construction industry:**

  – Best practices for hearing conservation programs are in their infancy in the construction industry, because the OSHA hearing conservation standard does not apply to construction. There is a provision that says construction companies have to have a program, but the specific elements are not spelled out, as in the general industry standard. The result is that the only practice on construction sites is to hand out ear plugs. A comprehensive hearing conservation program requirement should be included in the construction noise standard. OSHA should think of ways to raise the bar as to what is required for the construction industry to be in compliance with the noise standard.

  – The construction industry is different than the manufacturing sector. What works for large, wealthy companies may not work for small construction companies, which dominate the construction industry and struggle with the regulatory burden. OSHA should focus on ways to help small businesses reduce noise levels, through rulemaking or guidance documents, not simply by listing best practices.

- **Hearing protectors:**

  – It is a best practice to provide a variety of hearing protectors. This will make it more likely that a worker will find the hearing protector to be comfortable, which will increase the chance that the worker will wear it.

  – If employers make a good faith effort to reduce noise through noise controls, it should be an incentive for workers to wear hearing

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protection.

– Fit-testing is an important best practice in having effective hearing protection, but if workers do not wear the hearing protection or wear it incorrectly, it is still ineffective. Effective fit-testing is important, but does not replace noise controls or other elements of the hearing conservation program. An OSHA alliance document identifies fit-testing as a best practice in hearing protection.

– Attenuation is a secondary issue for hearing protection. Hearing protector use is the primary issue, since workers need to wear personal protective equipment (PPE) in order for it to work. This means that enforcement of PPE use by employers is a best practice.

– Relying on workers to use PPE shifts responsibility from employers to workers. This is contrary to the Occupational Safety and Health Act, which places the burden on employers. The noise standard has been a failure, because hearing conservation programs have not prevented occupational hearing loss as intended.

– Hearing protection devices can interfere with speech and alarm detection for workers. This is especially true for many older workers, who already have noise-induced hearing loss. Hearing protectors often attenuate higher frequencies, which is the range in which speech and information is often conveyed. Making hearing protection devices compulsory puts some workers in danger. In fact, many workers find ways to sabotage hearing protection in order to communicate.

– In response to the previous statement, another stakeholder said that there are solutions for being able to communicate and wear hearing protection at the same time.

- **Training and education:**

– Training offered to employees should be motivational, rather than just providing education.

– Many maritime workers believe they cannot use hearing protection, because it will inhibit their ability to communicate and hear warning sounds. Better training is needed to combat this attitude.

– Anytime we rely on workers to protect themselves, training becomes a crucial part of a hearing conservation program, even though the training is often inadequate. There is a standard from the American National Standards Institute (ANSI), A10.46-2007, *Hearing Loss Prevention for Construction and Demolition Workers*, which is relevant and may contribute ideas for hearing conservation programs for other industries.

– Since sometimes 15 languages are represented in a workplace, consideration should be taken to effectively communicate training materials to employees.

– In the food industry, the amount of time devoted to hearing protection and other safety issues is being reduced. A best practice, therefore, is to ensure that adequate time is spent on hearing protection training.

– Changing personal behaviors so that workers wear hearing protection will solve a lot of hearing loss problems. Sometime the victim has to take responsibility for their own behavior. Dr. Shulz has an article in the March 2011 edition of *The Synergist* that does a good job of discussing conservation and prevention ("From Conservation to Prevention: Metrics for Moving From a Traditional Compliance-Based Hearing Conservation Program to One More Firmly Based in Best Practices").

– Many hearing conservation education materials are difficult to find. The stakeholder encourages OSHA to make these materials easier to access.

– Employees should be retrained regularly, since one-time training is not effective.

– A stakeholder discussed two studies from the University of Washington that examined hearing protector behavior change and non-occupational hearing loss. The first study found that the one-time training and "toolbox" training approaches to motivate proper use of hearing protectors were ineffective in changing worker behavior. The only workers to change their behavior were those who received real-time feedback. The second study found that non-occupational noise exposure caused virtually none of the hearing loss experienced by the vast majority of construction workers.

- **Awards and model programs:**

– The Safe and Sound Award recognizes innovative hearing conservation programs. OSHA should find a way to recognize successful programs. Sharing success stories would help other companies develop model hearing conservation programs.

– Washington's Division of Occupational Safety and Health has a comprehensive hearing conservation requirement, including enforcement and noise controls.

– NASA has implemented a noise control program that involves a process for purchasing Buy Quiet and Quiet by Design products. If the agency is spending money on retrofit noise control, it makes more sense to spend the money up front to design out the noise.

– Retrofitting is often more expensive and less technically feasible.

- **Noise monitoring and exposure assessment:**

– OSHA should require employers to upgrade noise exposure monitoring to the extent that individuals and groups who are exposed to noise hazards can be identified. Current monitoring efforts are rarely done to the degree and accuracy necessary.

– A best practice is for companies to form a joint employee-management committee that is assigned noise control responsibilities. This

committee helps to find and reduce noise levels. It can also review major purchases and new processes to ensure they will not expose workers to noise hazards.

– Understanding sources of noise exposure is the first step in reducing noise levels.

– It is important to track individual workers' job responsibilities, to better understand which workers are exposed to which noise hazards. This would help identify the "low-hanging fruit" in a facility, which would be the easiest to lower noise levels. The Council for Accreditation of Occupational Safety and Health is developing a new noise measurement program that will provide instruction on how to perform noise measurements.

– The use of real-time monitors on workers will often trigger workers to wear their hearing protection. If a worker sees in real-time that he or she is over a certain noise threshold, a correction can be made.

- **Noise controls:**

– Noise controls should be OSHA's primary focus. Noise controls will encourage employees to participate in other elements of the hearing conservation program.

– Every one of the Safe and Sound Award winners had a noise control element to some degree in their program.

- **Noise exposure threshold levels:**

– OSHA currently uses two threshold levels: one is a Permissible Exposure Limit (PEL) threshold of 90 dB and the other threshold, for hearing conservation inclusion, is 85 dB. Employers have to have two TWAs per worker, which is confusing. A best practice is to eliminate the higher threshold, or eliminate both thresholds. With developments in technology, two TWAs are no longer necessary.

- **Non-occupational hearing loss:**

– There is a lot of data backing the assertion that the worker population, particularly the younger population, is suffering hearing loss from non-occupational sources. Therefore, a best practice in hearing conservation programs is to look at the worker in a holistic way in order to identify sources of hearing loss.

- **Program evaluation:**

– Companies should not simply be compliant, but need to show that their hearing conservation program is effective. OSHA should include program evaluation as a key element in these programs. One metric in evaluating program effectiveness is to measure whether hearing protectors are lowering noise exposure below 90 dB.

– A regular audit for compliance and effectiveness should be a part of hearing conservation programs. Companies should also use incidence documentation to figure out the sources that caused the shift in noise.

- **Using an 85 dB exposure limit:**

– Many global companies are using an 85 dB TWA with a 3 dB exchange rate, which is more stringent than the legal requirements in the United States. There is scientific evidence that shows there will be occupationally caused hearing loss between 85 and 90 dB.

– Studies at the University of Washington have documented hearing loss occurring at sounds levels of 85 dBA, and even slightly less. A standard of 90 dBA is not stringent enough.

- **Other discussion points:**

– Rotating employees in and out of high-noise areas should not be a best practice. This exposes workers to noise hazards who would otherwise not be exposed.

– When considering exposure levels, OSHA should consider the growing body of evidence that suggests concurrent autotoxic exposures augment the effects of noise exposure on workers. Additionally, the Department of Defense is keenly interested in engineering controls, since exposure levels are exceeding protection capacities.

– OSHA needs to find out what works, not what stakeholders think. The National Institute for Occupational Safety and Health (NIOSH) has not looked into this question for 30 years either. The noise standard will need to be changed in order to adopt many of the best practices suggested today. Changes will need to be supported by scientific data and substantial evidence.

– Another stakeholder responded to the previous comment by pointing out a 2010 international study by Dr. Thais Morata, in which NIOSH participated, that examined what is working and what is not for preventing occupational hearing loss. NIOSH has established a strategic plan with a goal of developing evidence-based best practices.

*4.2 What are the best practices for, as well as concerns with, using personal protective equipment for noise control?*

Audrey Profitt-Henry, Senior Industrial Hygienist, Directorate of Enforcement Programs, briefly introduced the next topic and explained some of the comments that OSHA had received in response to its notice in the *Federal Register* last fall.

Some of the comments received were simply statements, while others were accompanied by studies or surveys. One commenter pointed out that there are workers who have worn hearing protection their entire careers but still experienced hearing loss. Another commenter said that hearing protectors create problems that noise controls avoid. Another asserted that hearing protection can interfere with sound localization,

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which is more of an issue for workers who already have some hearing loss. Another complained that hearing protection is ineffective in the workplace, due to misuse and a lack of supervisory enforcement. The final commenter mentioned that it does not make sense to control sound with engineering controls when workers can simply wear ear plugs and ear muffs at a much lower cost.

Stakeholders responded with the following discussion points and recommendations regarding best practices for, and concerns with, the use of PPE for noise control:

- **Reporting PPE use:**

  – Several studies have documented that workers and supervisors are not always accurate when reporting whether they used PPE on the job. Workers and employers cannot be relied upon to accurately report PPE use.

- **Use of punitive measures:**

  – In many plants, the use of punitive measures against employees for failing to wear PPE can actually serve as a deterrent to wearing PPE. A best practice would be to ban all punitive programs that might deter workers from using PPE.

  – In response to the above comment, another stakeholder emphasized the importance of punitive measures against employees as a tool in enforcing hearing protection rules. The following steps were suggested as a best practice: the employer 1) develops a rule; 2) communicates the rule through training, toolbox meetings, and other means; 3) audits the program at different levels; and 4) resolves problems in a proactive manner when identified.

- **Employee inclusion:**

  – A best practice is to include employees in the process of identifying barriers preventing workers from wearing hearing protection.

- **Fit-testing:**

  – There are substantial training benefits to fit-testing beyond compliance. Fit-testing provides real-time reinforcement to workers on how PPE is supposed to feel and how it provides protection.

  – During training, a hearing protection fitting practicum should be included.

  – In a study by Carl Johnson, the results of several thousand fit tests were examined. The study found that 60 percent of employees with no coaching were receiving adequate hearing protection and needed no additional training. 15 to 20 percent were not receiving adequate attenuation, but were able to achieve better results after a short training session. Another 15 to 20 percent had to change to a different size or another type of hearing protector to receive adequate hearing protection. Less than 5 percent could not wear any of the ear plugs and needed ear muffs or another device. This shows the importance of employers providing a variety of hearing protector sizes and models.

  – Another stakeholder pointed out a study in which 75 percent of workers could accurately say how much protection they were receiving from hearing protectors after a few rounds of real-time fit-testing feedback.

- **Construction industry and task-based hearing protector requirements:**

  – A lot of the noise exposure on construction sites is due to impact noise, which may not increase the noise level beyond the TWA, but has been shown to often be more harmful than sustained noises near the TWA. When developing its standard A10.46-2007, *Hearing Loss Prevention for Construction and Demolition Workers*, ANSI created task-based hearing protector requirements. In this system, workers wear hearing protection when performing certain tasks, or when in certain areas. Workers do not have to wear hearing protection at all times and employers are not permitted to choose protectors that provide overprotection or reduce noise exposure below 70 dB.

  – Another stakeholder reinforced the idea that instantaneous exposure levels are often easier for employees and employers to understand than TWAs. In addition, instantaneous exposure levels are often equivalent to or more conservative than TWAs. NASA already uses instantaneous exposure levels. It is important to remember that TWAs do not cover visitors to loud areas, whereas instantaneous exposure levels do. Another benefit is that hearing protector requirements for specific tools or tasks are more easily translated to non-occupational use.

- **In-ear dosimetry:**

  – This is a relatively new technology that allows measurements of the noise exposure beneath hearing protectors. This provides a more accurate measurement of the noise level to which a worker is exposed while wearing certain hearing protectors.

- **Hearing protection for flight attendants:**

  – The Federal Aviation Administration has asserted jurisdiction for the safety and health of flight workers in the cabins of aircrafts but has not addressed the exposure of flight attendants to noise hazards. NIOSH has made recommendations, but these have not been adopted.

- **Color coding and standardized labeling of hearing protection:**

  – Small contractors need an easy way to identify noise reduction rates for hearing protection equipment. One possible way to accomplish this is to develop a standardized labeling or color coding system.

  – Another stakeholder responded to the previous comment by pointing out that the EPA may change the way hearing protectors are

labeled, which may actually require more education for small employers. The International Safety Equipment Association and other groups have laid the groundwork for an outreach document to explain to small employers what a new labeling system may look like. A document with few words and numerous pictures would be ideal.

– Labeling requirements in the European Union are more stringent, allowing consumers to compare machines by their labels in the store. A lot of equipment is manufactured for European export only. There needs to be motivation for companies to offer quiet products in the United States.

– The current noise reduction rating does not accurately estimate the noise exposure to a worker in the field, since it is based on results from a laboratory. A new label would be simpler, since it would be field-based and would not have a noise correction factor. To take advantage of new hearing protector technologies, such as sound restoration devices and active noise reduction, the new labeling procedures being considered by the EPA are needed.

– The EPA has completed the proposed labeling rule, but there is not much promise for it to move forward in the foreseeable future.

- **Developments in hearing protector technology:**

  – In recent years there have been significant technological developments in hearing protection devices, which allow ambient noise cancelation and enhanced communication. These technologies will be on display at next year's National Safety Congress.

  – Another stakeholder explained that there are now devices to help workers communicate using flat attenuation, in which everything is attenuated to the same level across frequencies. These devices help when workers have normal hearing, but are less effective for workers with existing hearing loss. Additionally, some devices for communication cost $50 per set, but others cost as much as $1,000 per set, which is very expensive for smaller businesses.

- **Demonstrating the effectiveness of PPE at a threshold shift:**

  – Employers are required to demonstrate that the PPE provided to employees is adequate whenever an employee demonstrates any kind of threshold shift. Neither of the following formulas demonstrates that hearing protection is adequate:

  Estimated Exposure (dBA) = TWA (dBC) - NRR
  Estimated Exposure (dBA) = TWA (dBA) - (NRR-7)

  An employer can demonstrate the adequacy of hearing protection in a low-tech way by using occluded and un-occluded audiograms. This would emphasize the importance of the requirement for employers to demonstrate the adequacy of their hearing protection after a demonstrated threshold shift.

- **Developing a noise attenuation training tape:**

  – One effective tool in demonstrating the effects of hearing loss would be a video that shows what happens when noise is attenuated at different frequencies. This can emphasize the serious nature of hearing loss to workers in a memorable way.

  – In response to the above comment, another stakeholder pointed out that NASA has produced a CD that demonstrates the effects of hearing loss at various levels.

- **Multiple layers of protection:**

  – In food processing plants, workers are wearing various types of PPE. There are concerns that this combined use may have hazards. Additionally, in many food processing plants, workers do not have an opportunity to adjust their hearing protector during their shift if it is uncomfortable or does not fit properly.

  – In response to the above comment, a stakeholder mentioned that there are known solutions to the concerns that were raised.

- **Additional comments and concerns:**

  – Currently, there is no guidance from OSHA on how companies can use the results of fit-testing to comply with 1910.95. It also makes sense to allow the use of a personal attenuation rating to demonstrate compliance with the hearing protection section of the noise standard.

  – For the past 20 years, OSHA has allowed employers to rely on PPE too heavily. This is a failed enforcement policy and puts too much of the burden on one solution.

  – The availability of hearing protectors to employees in the workplace would significantly increase their use. Employers should provide access to hearing protectors, even in areas where the use of hearing protection is voluntary.

*4.3 What are the best practices for using feasible engineering controls?*

Brian Liddell, Health Response Team, Directorate of Technical Support and Emergency Management, provided a brief overview of engineering controls in the context of controlling sources of noise. Mr. Liddell also posed several questions concerning engineering controls that are of interest to OSHA.

OSHA inspectors see many examples of engineering controls in the field, in many different industries. Some engineering controls are simple, such as installing pneumatic silencers on compressed air exhausts or adding damping materials to vibrating surfaces. Engineering controls can be added in three places to reduce noise: at the source, along the transmission path, and at the receiver. Even a 3 dB reduction in noise is

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significant, and a 5 dB reduction reduces a worker's exposure to noise by half when utilizing an exposure standard with a 5 dB exchange rate.

Mr. Liddell then posed several relevant questions: What are the main issues in the design and implementation of engineering controls? What are the best approaches to be used when assessing noise control programs? What issues exist in the identification, design, and implementation of noise controls? How can these be addressed? Given that European manufacturers are well ahead of the United States in designing quieter equipment, how can OSHA work with industry and other associations to encourage the development of new noise control technologies? What helpful resources can OSHA provide?

Stakeholders responded with the following discussion points and recommendations regarding best practices for using feasible engineering controls:

- **Emphasizing engineering controls:**

  The OSHA field manual, which is instruction and not a regulation, says that an inspector can count on hearing protection devices up to 100 dB before issuing a citation. This seems to discourage the use of engineering controls in favor of hearing protection. The stakeholder also drew attention to *Technology for a Quieter America* and the *The Bridge*, a magazine that has published papers by Bob Bruce about best practices.

  Why is it that there is quieter equipment available in other countries that is not available here in the U.S.?

- **Noise control best practices database:**

  – The Institute of Noise Control Engineering has 50,000 papers about noise control posted online, classified by subject. It would be useful if experts in the field went through these papers to distribute those relevant to best practices.

- **Buy Quiet and Quiet by Design programs:**

  – The International Institute of Noise Control Engineering has empowered a study committee to define best practices in Buy Quiet programs. The study is expected to be finished in approximately two years.

  – The federal government could require a Buy Quiet element for all federal construction projects without any new regulations. This would serve as a major driver for quieter equipment in the private sector. It might also give equipment manufacturers an incentive to be transparent about the noise levels of their equipment.

  – A best practice for these programs is to quantify the long-term costs of exposure and compare them to the purchase costs of quiet equipment.

  – Another best practice is to develop a structured program with a process to follow, including data on available equipment, approval forms, and verifications required at the shop and in the field. A structured program will document an informed purchasing decision and will force management to justify occasions when quiet equipment is not purchased.

  – Buy Quiet programs should be tailored to the company's culture and operations. If protocols and communication channels for other safety issues exist, a company can also use these for Buy Quiet and Quiet by Design programs.

  – Large companies can partner with suppliers to design large equipment. Noise labeling for off-the-shelf products would make it easier for consumers to choose quiet equipment.

- **Outreach materials and useful resources:**

  – An old OSHA booklet with cartoons of principles and applications of noise control has been updated and is now available in the public domain. It would be useful to have this document posted on OSHA's website.

  – There are several reports from other countries regarding noise control: the British Health and Safety Executive published 60 case studies on noise reduction techniques, British Columbia has a report on controlling construction noise, Singapore's Department of Environmental Protection has a practical guide on reducing noise from construction sites, and the European Union has a noise control guide. It would be helpful if OSHA put together a simple solutions book regarding noise control.

  – The Cochrane Report found that traditional hearing programs that did not include noise controls were not effective.

  – OSHA or NIOSH should prepare materials that assess what is known about the effectiveness and limitations of hearing conservation approaches.

- **Return on investment (ROI) for engineering controls:**

  – There are often concerns regarding the costs associated with engineering controls versus their effectiveness. OSHA should prepare a document that describes the ROI for engineering controls.

  – Another stakeholder explained that, before attempting to convince the business community to use engineering controls, OSHA needs to use concrete facts to demonstrate why they are the most effective solution. This can be done by measuring the outcomes of engineering controls currently in place in real workplaces, using either standard threshold shifts or occupational hearing loss to determine recordability. Providing this proof to the business community is necessary because money spent on engineering controls is money that cannot be spent on something else.

  – A stakeholder responded to the previous comment by stating that the cost-effectiveness of noise controls has been shown for a long

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time. Relying on hearing conservation programs is ineffective, as shown by the number of cases of occupationally caused hearing loss in the United States.

– It costs 10 times as much to abate an existing noise problem with a retrofit as to take care of it during the design and manufacturing of the machine. Designing quiet equipment typically adds about 5 to 10 percent to the cost. Additionally, designing quiet machines often produces more efficient machines that require less maintenance.

– One stakeholder has calculated the cost of hearing conservation programs for several companies. The average cost per employee per year is between $300 and $350. This should be compared to the cost of engineering out the noise and eliminating the need for hearing conservation.

– Compressed air is the most significant noise exposure in many plants, and there are proven solutions to reduce noise. The ROI for quiet design devices is nine to 12 months, due to the energy savings realized. Maintenance is another easy way to reduce noise emissions.

– Cost needs to be a consideration. In a foundry, engineering controls would have a high cost and would not reduce noise levels to the point where PPE would not be required.

– Smaller companies do not have in-house programs and have to rely on mobile services for hearing conservation programs, which are more expensive. These programs become more expensive per employee as the cost is calculated for smaller companies. For companies with between one and 19 employees, the cost might be $700 to $800 per employee per year.

– If companies have limited resources and have to choose between a large fine from the EPA and a smaller fine from OSHA, a company will choose the smaller fine. OSHA should use the ROI of noise controls as a selling point to convince executives to put money towards protecting employee hearing.

– A study by the International Social Security Association reported that for every dollar the United States spends on occupational safety and health programs, $2.20 will eventually return.

– The enormous cost of hearing loss to the employee is often not accounted for in ROI calculations. This is especially true in transient industries, such as construction **(Scott Schneider)**.

- **Overexposure to noise in manufacturing:**

  – Using a 90 dB threshold, less than 10 percent of workers in the manufacturing industry are overexposed to noise. When the original OSHA regulation was promulgated, this estimate was closer to 19 percent, but many of these jobs have since moved outside the United States.

- **Employee participation:**

  – A best practice in engineering controls is for employees trained in safety and health to participate in the purchase of new equipment and in the design of new industrial processes.

- **Economic and technical feasibility:**

  – Engineering controls are often not transferrable between industries, and the economic and technical feasibility for these controls needs to be determined on a case-by-case basis. The idea of installing a process and making it a criterion for demonstrating compliance might be a good substitute for questions of determining economic feasibility.

- **Metrics for determining the effectiveness of engineering controls:**

  – "Effectiveness" should be defined and tools should be developed to help determine effectiveness of engineering controls. Not all engineering controls are effective 100 percent of the time. NIOSH found that cabs on heavy equipment were not preventing operators from being overexposed to noise, since the operators kept the cab door open.

- **Incremental improvements:**

  – Improvements in engineering controls are often incremental, though this still represents a reduction in risk. OSHA should emphasize the approach outlined by Mr. Fairfax at the beginning of the meeting, which characterized a 3 dB noise reduction as significant even if it does not reduce the noise level below 90 dB.

- **Hierarchy of controls:**

  – Most of the stakeholders viewed the hierarchy of controls as an effective system to aid in prioritizing controls to choose. A stakeholder brought up the point, however, that the premise of the hierarchy of controls should be reviewed to document whether it is still true, given the technological developments over the past 30 years.

- **Engineering control process:**

  – The first best practice is for a well-trained person to take noise measurements. If a noise problem is detected, the facility needs a detailed written noise control plan to identify the "low-hanging fruit." The noise problems need to be quantified and the options to remedy the problems need to be evaluated. If the best option is to buy new equipment, quiet products should be considered. It may be possible to use engineering controls while still realizing cost savings, an increase in productivity, and increased profit.

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- **Leadership:**

  – The person controlling the money in a company needs to support protecting employee hearing. If a manufacturer develops a noise control treatment for a plant and the plant ultimately does not want to spend the money, this sends a message to the manufacturers that industry is not interested in buying quiet equipment.

- **Small business considerations:**

  – Engineering controls can be simple, such as placing a sheet of plywood in front of a generator, or may be expensive, such as purchasing a quiet generator. Additionally, roofers may be exposed to variable levels of noise, depending on the day. It is very difficult to engineer the noise out of this industry. In this situation, hearing protection may be the most effective and least expensive solution. Small contractors, who buy tools from retailers like Home Depot or Sears, do not have the option to buy quieter equipment if manufacturers do not sell it.

- **Case law regarding engineering controls:**

  – Over the past 30 years, the case law has been consistently in favor of using PPE unless engineering controls are less expensive. Hearing loss declined by 27 percent between 2005 and 2009; it now affects less than 1 percent of the workforce in the United States. Trying to convince the regulated community to implement engineering controls will be met with resistance.

*4.4 What are companies' experiences with effective noise control programs and what are the key elements of their programs?*

Bryan Seal, Senior Industrial Hygienist, Directorate of Standards and Guidance, introduced the final discussion topic by outlining his experience implementing a noise control program at a book bindery.

Mr. Seal worked with a book bindery company with approximately 120 employees. He evaluated the company's hearing conservation program, assessed the noise levels and TWA exposures, and ensured that all workers were trained to recognize noise levels and hazards and how to protect themselves from these hazards. The major sources of noise in the bindery were identified and engineering controls were installed. Noise levels were reduced to below 85 dB and an effective noise control program was maintained. The company oriented its efforts on the results of annual exposure assessments and measured noise levels, not on the TWA exposures.

Stakeholders responded with the following discussion points and recommendations regarding companies' experiences with effective noise control programs and their key elements:

- **NASA's Buy Quiet program:**

  – NASA had been spending money on retrofit noise controls while still buying new loud equipment. It was decided that a two-pronged approach was needed: buying new quiet equipment while continuing to fix old noisy equipment.

  – NASA's Chief Health and Medical Officer implemented a Buy Quiet and Quiet by Design requirement for the agency. This required noise emissions to be considered equally with other considerations when buying equipment near an 80 dBA threshold.

  – This policy was designed to be adaptable to NASA's many field sites, and covered the purchase of major equipment and off-the-shelf items.

  – The Buy Quiet Process Roadmap is an online tool developed to help procurement employees through the process of purchasing quiet equipment. The roadmap is publically available and is generic enough to be adapted to other organizations. It can be found online at http://adl.amygelfand.com/buy-quiet-purchasing/buy-quiet-process-roadmap/.

  – Four steps were identified in the process of procuring quiet products: 1) use publically available information to identify an achievable noise emission criterion for a piece of equipment, starting with an 80 dBA assumption; 2) identify the simplest procurement vehicle available (GSA schedule, bank card purchasing, simplest allowable procurement); 3) develop the specification, unless it is an off-the-shelf item; and 4) quantify and evaluate the long-term costs of noise exposure for the candidate products being considered for purchase.

  – The roadmap includes authorization forms, calculation worksheets, test verification forms to document rationale if loud equipment is chosen, PowerPoint presentations for generic use, and links to online databases of sound levels for various items.

- **Examples of companies with effective noise control programs:**

  – Shaw Carpeting won a Safe and Sound Award for its hearing conservation program, which used engineering controls and fit-testing. More information can be found at http://www.hearforever.org.

  – The Army Hearing Program focuses on combat effectiveness, which can translate to other industries as mission effectiveness. The Army's program is enhanced with a better ability to communicate. ALCOA has been successful with its efforts in fit-testing and in ear dosimetry. Companies in the Voluntary Protection Programs Participants' Association have successful programs. OSHA needs to develop better ways to highlight and share these successful programs.

  – General Motors and Ford show reductions in employee noise exposures year after year in their annual facility surveys. These successful programs have two common components: 1) joint employee and management committees tasked with noise control and 2) employee upstream participation in the review of new equipment and processes before they are introduced into the plants.

  – The auto industry turns over equipment more frequently than other industries, because it continually makes new car models. This allows the industry to reap the benefits of new Buy Quiet equipment. The percentage of employees exposed to 90 dBA has been dramatically reduced in the past 20 years.

# Appendix 1

**Common denominators of companies with effective noise control programs:**

– Clear identification of the interrelationship between noise sources and what composes a worker's noise exposure is needed. Once the noise sources are identified, a company can prioritize where to spend money to achieve the biggest dB reduction for employees. Employers can then work with manufacturers to determine cost information to incorporate into an ROI calculation.

– Companies with effective hearing conservation programs are using common metrics as well. On the noise control side, these companies measure the decrease in dB for a certain number of employees over time, and the number of employees removed from the hearing conservation program. Additionally, audiometric testing should be done toward the end of a work shift: this measures temporary threshold shifts, which are a leading indicator of hearing loss, as opposed to measuring the lagging indicator of permanent threshold shifts.

– Another crucial component of an effective program is to investigate the cause of a standard threshold shift or OSHA recordable injury. Many employers record the shift and move on, but it makes more sense to understand why the shift occurred, which allows the employer to take actions to prevent standard threshold shifts in the future.

- **Proactive companies:**

– A lot of what companies do is proactive, not motivated by compliance. For example, 3M has set its exposure limit at 85 dB, which is lower than OSHA's required 90 dB.

– Some company cultures achieve more than is required for compliance for all safety programs. This points to the importance of a strong safety culture at the top levels of a company.

– When employers who implement an 85 dB threshold with a 3 dB exchange rate are asked why they went beyond OSHA's requirement, many respond that the science supports this threshold as being more protective for workers. The stakeholder encourages OSHA to move in the same direction.

– Another stakeholder asked if OSHA has already unofficially adopted a 3 dB exchange rate, since the agency is considering 3 dB to be a significant reduction.

– A stakeholder pointed out that there seemed to be general consensus that an 85 dB threshold with a 3 dB exchange rate is a best practice.

– A stakeholder highlighted an article written by Alice Suter about the benefits of an 85 dB exposure level with a 3 dB exchange rate. This article can be found online at http://hearinglossprevention.org/default.aspx.

– These companies are providing more protection than is required, but NIOSH found that an employee exposed to 90 dB for his or her entire working life has a one in four chance of hearing loss. This is too high a percentage, given that the Supreme Court considers a significant risk for occupation-related illness or injury to be 1 in 1,000. Higher standards ought to be the norm within industry.

– A stakeholder responded to the previous comment by clarifying that the Supreme Court considers 1 in 1,000 a significant risk for an outcome that results in death.

- **Enforcement by OSHA:**

– It is important for OSHA to gather examples of effective programs to be communicated to the regulated community, but it is also important to identify the bad actors in industry and to use them as examples to deter the same behavior in other companies. Employers that are trying to avoid penalties will be more likely to seek out success stories and to model their own programs on them.

– A stakeholder pointed out that Section 5 of the Occupational Safety and Health Act has two parts, one that places responsibilities on employers and another that places responsibilities on employees. There is a need to have some sort of enforcement mechanism for employees that violate their duties.

– A stakeholder believes that OSHA has been using a command and control approach to enforcement for too long. OSHA needs to help small businesses understand the issues in their facilities, as well as specific changes to fix these issues.

5. **Wrap-Up and Next Steps**

Dorothy Dougherty, Director, Directorate of Standards and Guidance, thanked everyone who had participated in and observed the meeting. She also thanked those who had helped plan the meeting, and thanked the facilitator. She communicated OSHA's desire to have further contact with the stakeholders regarding his important issue. The notes will be posted on the OSHA website, and will be advertised on OSHA QuickTakes (http://www.osha.gov/as/opa/quicktakes/) when posted. Ms. Berkowitz concluded with a reminder that OSHA has a toll-free phone number, 1-800-321-OSHA (6742). OSHA provides free on-site visits and can help small businesses with noise issues.

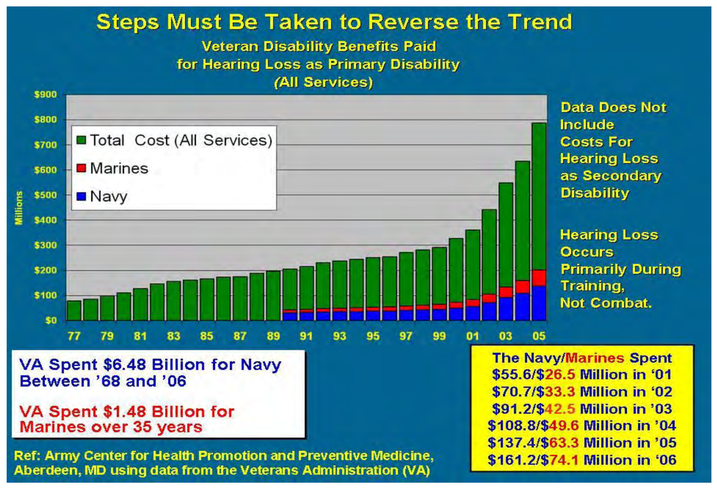
# Appendix 2

# High Noise Source Reduction Initiative

## Background

Noise is the only known occupational hazard within DoD with exposures exceeding protection capability (i.e., willful exposures). Noise is one of the leading causes for DoD worker compensation and is the most prevalent service-related disability with over 1.2 million veterans receiving hearing loss disability payments for fiscal year 2009. Tinnitus and hearing loss are the diagnoses for over 16% of the veterans who began receiving compensation during fiscal year 2009. The number of service-connected hearing loss disabilities has increased 53% from FY 2005 to 2009. (Ref: Department of Veterans Affairs, "Annual Benefits Report FY 2009"). Where DoD personnel work in these ultra-high noise environments, passive hearing Protection alone cannot reduce the noise to a safe level.

Department of Veterans Affairs (VA) spends over a billion dollars a year on compensation for hearing loss. The costs of hearing loss claims among veterans has been increasing every year for the past decade. Identifying locations of hearing loss and job descriptions provides an opportunity for interventions to prevent occupational noise-induced hearing loss.




## Objectives/Implementation Activities

1. Focus on DoD areas and equipment (e.g., aircraft, tactical vehicles, engine rooms) where noise levels may exceed 112-115 decibels, the upper limit for double hearing protection (both earmuffs and earplugs). Exposure above 115 decibels causes permanent hearing loss.
2. Identify and review the top/significant 10 noise sources
3. Work with Service leads and acoustical engineers to develop noise source reduction plans based on the best available engineering control methods. Noise source reduction plans shall be a roadmap to help the Services' efforts to reduce installation and operational high noise sources.

## Status

- The 10 noise sources/issues have been identified
- Available noise source data has been reviewed
- Evaluation of define engineering sources has begun
- Development of noise source reduction plans has begun

| Noise Sources/Issues to be Evaluated in this Initiative Noise Range – dB(A)Source/Receiver – Upper Estimate Source/Receiver – Lower Estimate | |
|---|---|
| Shipboard diesel propulsion and genset (generator set) induced noise120 in Machinery Space/90 in Enclosed Operating Space (EOS) (Upper estimate)90 in Machinery Space/65 in EOS (Lower estimate) | Tracked vehicles (tanks, assault vehicles, bulldozers) 118 inside (Upper estimate)93 inside (Lower estimate) |
| Shipboard gas turbine (GT) induced noise95 near GT enclosure/70 in EOS (Upper estimate)80 near GT enclosure/65 in EOS (Lower estimate) | Wheeled vehicles [Mine Resistant Ambush Protected (MRAP), High Mobility Multi-purpose Wheeled Vehicle (HMMWV), etc.]109 inside (Upper estimate)89 inside (Lower estimate) |
| Noise on high-speed craft [e.g., Landing Craft Air Cushion (LCAC), Joint High Speed Vessel (JHSV)] 128 in LCAC aft cargo area/95 in pilot house (Upper estimate)118 in LCAC fwd cargo area/90 in pilot house (Lower estimate) | Shipboard equipment: waterjet stern/bow thruster hydraulic Power Unit (HPU) HVAC120 dB source (Upper estimate)85 dB source (Lower estimate) |
| Jet take-off and landing on aircraft carriers-CVN and amphibious craft [landing helicopter dock (LHD), landing platform dock (LPD), etc.]145 on deck/110 in compartment below or in Island (Upper estimate)130 on deck/95 in compartment below or in Island (Lower estimate) | Sandblasting Operations (nozzle noise) 119 dB source (blast nozzle) (Upper estimate)90 dB air compressor (Lower estimate) |
| Capsule (Pod) Hotel technology for shipboard berthing areas 35 dB noise reduction (Upper estimate)15 dB noise reduction (Lower estimate) | Cockpit and interior aircraft noise (jet, helicopter, etc.)115 dB interior noise (Upper estimate)85 dB interior noise (Lower estimate) |

## Next Steps

- Complete noise source reduction plans
- Develop transition plan with stakeholder input
- Develop final report and brief

## Contacts

The DSOC-Installation and Industrial Operations Task Force/Acquisition Technology Programs Task Force co-sponsored this effort.


- Ms. Joy Erdman, DSOC IIO TF Liaison Naval Safety Center Liaison Office, joy-erdman@navy.mil
- Ms. Jennifer Glenn, DSOC ATP TF Liaison Department of the Navy (DON)/ODASN (Safety), Jennifer.glenn@navy.mil
- Ms. Linda Byrnes, CTC Initiative Lead, 703-310-5695, byrnesl@ctc.com





DSOC
Defense Safety Oversight Council

# Appendix 3

Technical Data Sheet


# NoisePro™ Series
## Personal Noise Dosimeters
### "Moving Beyond Compliance"

## Introduction

Why settle for noise dosimeter systems that merely document exposures for compliance when the latest innovations from Quest will assist you in proactively reducing or preventing them altogether? Afterall, the risk and cost of compensable hearing loss is typically far greater than the risk and cost of a regulatory violation.

The new ***NoisePro*** Series dosimeters and latest QuestSuite® Professional Applications Software provide "The System Solution" for professionals responsible for occupational hearing conservation. More than just a recorder of history, "The System Solution" from Quest serves hearing conservationists needs on three unique fronts. An **Optional Vibrating Belt Clip** promotes the usage of hearing protection and/or self-management of daily noise exposures. The convenient **Go/No-Go Screen Icons** provide technician and worker-friendly indications of exposure status. Powerful QuestSuite Professional Application Software enables the user to perform **Engineering and Administrative Controls Simulation** prior to their purchase or implementation. This includes task-based assessments using dosimetry and/or sound level meter studies. But the benefits don't end there.

QuestSuite's **Virtual Docking Station** allows you to effortlessly and automatically program and retrieve data from an entire group of dosimeters via wireless infrared link. No more time wasted manually connecting and transferring information one dosimeter at a time. The ***NoisePro*** DLX's **Data Shuttle** carries results from multiple dosimeters in the field or on the plant floor back to your computer. Now you can easily turn dosimeters around between work shifts and quickly get them on the next group of workers to be monitored. An **Optional Boom Microphone** instantly transforms your ***NoisePro*** dosimeter into a handheld sound level meter for a fraction of the cost of an additional stand-alone meter.

The ***NoisePro*** Series consists of four advanced instruments for occupational noise exposure assessment. They have many programmable settings to serve a variety of applications. Settings can be auto-configured to meet specific regulatory standards by simply selecting the standard's name from a list of pre-defined setups. User-specified setups may also be defined and deployed. Multiple Virtual Dosimeters in each instrument permit assessments against more than one standard simultaneously. A large, backlit, graphical display shows measured and calculated parameters in an easy-to-understand format. The datalogging capability of the ***NoisePro*** DL allows tremendous insight into the profile of noise exposure by providing 1-minute time history interval data throughout the duration of a test. The ***NoisePro*** DLX provides even more data per time history interval, intervals as fine as one second in duration and a host of additional programmable features. The ***NoisePro*** DLX-1 is a Class 1 version of the ***NoisePro*** DLX. The base ***NoisePro*** model is a powerful but lower cost unit presenting summary noise exposure data and a reduced feature set.

QuestSuite® Professional QSP COMPATIBLE

Now UL cUL ATEX Approved

While not required for use, QuestSuite Professional, "The System Solution" software application, will greatly enhance the value of your investment in any of the instruments in the series. Beyond the Virtual Docking Station and Engineering and Administrative Controls Simulation already identified, QuestSuite maintains a record of your instrument inventory, schedules and reminds you of annual calibrations and maintains a running history of each. All of this capability comes in addition to the charting, reporting and data editing functions you expect from professional software applications. This software suite also serves many other applications such as octave band analysis, community and environmental noise, hand-arm and whole-body vibration, heat stress, thermal comfort, confined space entry and indoor air quality.

You can be assured this latest addition to "The System Solution" will provide you with the same Red, Rugged and Reliable performance you have come to expect from Quest for more than 30 years.

QUEST®
"THE SYSTEM SOLUTION"

# Features:

## For *Noise*Pro / *Noise*Pro DL / *Noise*Pro DLX


- Class / Type 2 Accuracy
- IP-65 Rated, Industrial-Grade Cast Aluminum Case
- Large, Backlit Liquid Crystal Display
- Auto-Configuration to Standards
- Real-Time Compliance Indicator
- High-Speed Infrared RS-232 Communications
- High Capacity Non-Volatile Data Storage
- Listed Intrinsically Safe
- Up to 2 Virtual Dosimeters in One
- Real-Time Clock & Calendar
- Programmable Twice Daily or (1) One-Time Scheduled Runs
- English, Spanish, German, French & Italian Languages
- Optional Vibration Alarm
- Optional Boom Microphone
- Optional Multilingual QuestSuite® Professional PC Software
    - English, Spanish, German, French, Italian & Portuguese
    - Reporting & Recordkeeping
    - Virtual Docking Station
    - Calibration Management
    - Exposure Recalculation
    - Administrative/Engineering Controls Assessment

## For *Noise*Pro DL, add:

- Time History and Statistical Distribution Profiling via QuestSuite® Professional

## For *Noise*Pro DLX, add:

- Up to 4 Virtual Dosimeters in One
- Infrared Retrieval of Data From Other *Noise*Pro Monitors
- Expanded Time History Data
- Programmable Twice Daily or Up to (4) One-Time Scheduled Runs

## For *Noise*Pro DLX-1, add:

- Class / Type 1 Accuracy

## Common Specifications

| | |
|---|---|
| Measurement Range: | 40 to 110 dB RMS, 70 to 140 dB RMS, 115 to 143 dB Peak |
| Dynamic Range: | 70 dB RMS, 28 dB Peak |
| Amplitude Resolution: | 0.1 dB |
| Dose Resolution: | 0.001% to 9999%, auto-scaling always shows 4 digits |
| Statistical Distribution Resolution: | 0.1 dB increments for Fast & Slow |
| Number of Channels: | (1) RMS, (1) Peak |
| Frequency Weighting per channel: | RMS A or C, Peak A, C or Z |
| Time Constant per dosimeter: | Slow or Fast for each or Impulse for all |
| Exchange Rate per dosimeter: | 3, 4, 5 or 6 dB |
| Criterion Level per dosimeter: | 40 to 140 dB in 1 dB increments |
| Criterion Time per dosimeter: | 1 to 24 hours in 1 hour increments |
| Personal Noise Exposure Level Times per dosimeter: | 1 to 18 hours in 1 hours increments |
| Threshold Level per dosimeter: | 40 to 140 dB in 1 dB increments |
| Upper Limit Value per dosimeter: | 40 to 140 dB in 1 dB increments |
| Ceiling Limit Value per unit: | (1) FastMax and (1) Slow Max, 40 to 140 dB |
| Data Labels: | ISO/IEC or Basic (U.S.) nomenclature |
| # of Setup Files in Memory: | (5) Factory-defined and (4) User-defined |
| Date & Time: | DD/MMM/YYYY; HH:MM:SS AM/PM or 24-hr clock |
| Data Available Via Display: | Setup Filename, Pre-calibration date & time, Post-calibration date & time, SPL, Lavg/Leq, Peak, SlowMin, SlowMax, FastMin, FastMax, TWA, Projected TWA, Dose, Projected Dose, SEL, Exposure, Run Time |
| Keypad Combination Lock: | (2) User-defined 4-digit codes, (1) for Run/Stop Access, (1) for Setup Access |
| Display: | Backlit 128 x 64 pixel graphical LCD |
| Languages: | English, Spanish, German, French & Italian |
| Size: | 2.7" x 5" x 1.5" (68.6mm x 127mm x 38.1mm) |
| Weight: | 14 ozs., (369g.) |
| Power: | Optimally (70) hrs from (2) AA disposable alkaline batteries |
| Mechanical: | Industrial-grade cast aluminum, IP-65 rated case. Removable belt clip with tripod mounting adapter. |
| Operating Temperature Range: | -10 to +50 C, +14 to +122 F |
| Storage Temperature Range: | -25 to +60 C, -13 to +140 F |
| Humidity Range: | 0 to 95% non-condensing |
| Intrinsic Safety Agency Listing: | UL, cUL, Ex, ATEX, MSHA (pending), SIMTARS (pending) |
| Product Standards: | CE Mark, EN 61252, ANSI S1.25 |
| Software Compatibility: | QuestSuite® Professional |
| Optional Features: | Vibrating Alarm Belt Clip and Boom Microphone |

**Specifications subject to change without notice**
**For the most current specifications and additional information about Quest Technologies and the *NoiseProSeries* visit our web site at www.Quest-Technologies.com**

| Model-Specific Specifications | NoisePro | NoisePro DL | NoisePro DLX | NoisePro DLX-1 |
|---|---|---|---|---|
| **Accuracy:** | | | | |
| Class/Type 2 | ✔ | ✔ | ✔ | - |
| Class/Type 1 | - | - | - | ✔ |
| **Time History Resolution:** | | | | |
| 1 minute | - | ✔ | ✔ | ✔ |
| 1, 5, 10, 15, 30 seconds | - | - | ✔ | ✔ |
| 1, 5, 10, 15, 30 minutes | - | - | ✔ | ✔ |
| 1 hour | - | - | ✔ | ✔ |
| **Number of Virtual Dosimeters:** | | | | |
| Two | ✔ | ✔ | - | - |
| Four | - | - | ✔ | ✔ |
| **Time History Statistics:** | | | | |
| Lavg/Leq, FastMax & SlowMax | - | ✔ | ✔ | ✔ |
| FastMin, SlowMin, Fast Ceiling Count, Slow Ceiling Count, Lpeak | - | - | ✔ | ✔ |
| **Time History Statistics Selection:** | | | | |
| Each Statistic can be turned on or off | - | - | ✔ | ✔ |
| **Data Available Via PC Download:** | | | | |
| Same as via Display | ✔ | ✔ | ✔ | ✔ |
| Statistical Distribution | - | - | ✔ | ✔ |
| Time History | - | ✔ | ✔ | ✔ |
| Recalculated Exposure Data | ✔ | ✔ | ✔ | ✔ |
| **Alarm Set Points:** | | | | |
| Overall TWA value of dosimeter #1 | ✔ | ✔ | ✔ | ✔ |
| Any time history interval Lavg/Leq for dosimeter #1 | - | ✔ | ✔ | ✔ |
| **Auto-Run Activators:** | | | | |
| (1) or (2) daily runs with choice of days of week | ✔ | ✔ | ✔ | ✔ |
| (1) One-time run | ✔ | ✔ | ✔ | ✔ |
| Up to (4) One-time runs | - | - | ✔ | ✔ |
| **Auto-Stop:** | | | | |
| Any HH:MM:SS duration | ✔ | ✔ | ✔ | ✔ |
| **Data Storage:** | | | | |
| Non-volatile memory retention with batteries removed | ✔ | ✔ | ✔ | ✔ |
| Minimum (40) hrs time history capacity with all data saved | - | ✔ | ✔ | ✔ |
| Receive data from other dosimeters in series | - | - | ✔ | ✔ |
| **Data Communications:** | | | | |
| Infrared Serial Interface @ 115kbps | ✔ | ✔ | ✔ | ✔ |
| Remotely retrieve data from any unit in series | - | - | ✔ | ✔ |



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ISO 9001:2000 Registered Company
ISO 17025 Accredited Calibration Lab
Employee Owned Company



98-545
Rev. B
02/04

# Appendix 4

**SOURCE:**

## Chapter 5, Navy Industrial Hygiene Technical Manual

## NOISE SURVEYS

4. **SAMPLING PROTOCOL.**

a. Types of surveys.

(l) General survey - conducted to determine the locations and boundaries of hazardous noise areas and equipment. This survey is usually done with the Type 2 sound level meter.

(2) Noise control survey - a Type 1 sound level meter with an octave band filter is used to obtain engineering-type data to aid in selecting a course of action for noise control or to certify audiometric testing booths.

(3) Noise dosimeter survey - dosimeters are used to assess individual noise exposure. Noise dosimeters with a datalogging capability may be used to determine which processes during the workshift are the major contributors to noise exposure so noise control efforts can be focused where the most benefit will be derived.

b. Sound level meters. Sound pressure level measurements should be taken following the manufacturer's instructions. For practical purposes, the procedure below should be followed for all sound pressure level measurements:

(l) The sound level meter should be set to slow response. Measurements should be taken using the "A" weighting network.

(2) The microphone should be held in the person's hearing zone and oriented in accordance with the manufacturer's recommendations (i.e., either perpendicular or parallel to the noise source). Select the ear closest to the noise source. Repeated measurements are required during a single day and/or different days of the week to account for the variation in noise levels produced by changes in operation schedules and procedures. Dosimeters are the instruments of choice for monitoring personal noise exposure.

(3) When noise levels measured at each ear for a single individual are different, the higher level should be used for compliance purposes.

(4) Note sound level meter measurements during the different phases of work performed by the employee during the shift, taking enough measurements to identify work cycles. Remember that noise levels will vary during the day and work operation. Sufficient measurements will have to be obtained to determine an actual exposure.

(5) Obtain sound pressure level measurements at the noise source. Record locations of sources on a diagram. If sound pressure level measurements at the noise source exceed 85 dB(A), determine the distance from the noise source where the sound pressure level falls to 85 dB(A). Repeat several times and record on the diagram. This is the hazard radius. If sound pressure level measurements at the noise source exceed 104 dB(A), the distance from the noise source to where the sound pressure level falls to 104 dB(A) should also be measured in addition to the hazard radius to 85 dB(A).

c. Noise dosimeters. Always follow the manufacturer's instructions. For practical purposes, the procedure below should be followed for all dosimeter measurements:

(l) The microphone should be in the person's hearing zone (defined as a sphere with a two foot diameter surrounding the head). Considerations of practicality and safety for each survey location will dictate the actual microphone placement.

(2) When the dosimeter is positioned (normally in the shirt pocket or at the waist), clip the microphone to the employee's collar at the top of the shoulder, as close as possible to the employee's ear that is closest to the noise source. Care should be taken to ensure that the microphone is in a vertical position. Placement of ear clips should be in accordance with the manufacturer's instructions.

(3) Position and secure any excess microphone cable to avoid snagging or any inconvenience to the employee. The cable can be taped directly to the employee's outer clothing.

(4) Inform the employee that the dosimeter should not interfere with normal duties, and emphasize that the employee should continue to work in a routine manner.

(5) Explain to each employee being surveyed the purpose of the dosimeter and that it is not a speech recording device.

(6) Instruct the employee being monitored not to remove the dosimeter unless absolutely necessary, and not to cover the microphone with a coat or other garment. Inform the employee when and where the dosimeter will be removed.

(7) Make sure that the dosimeter is in recording mode before starting the survey. The dosimeter should be checked periodically to ensure that the microphone is oriented properly.

# Appendix 5

# SHIPYARD NOISE DOSIMETRY RESULTS

| | DOS # | RUN TIME METER Hrs:Minutes | LOCATION | JOB | TOOLS | OSHA-PEL | | OSHA-HC | | ACGIH | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | dbA TWA | % Dose | dbA TWA | % Dose | dbA TWA | % Dose |
| **1** | 075 | 7:11 | Blast House | Pot Tender | Blast Pot, Compressor | 84.9 | 49.53 | 87.4 | 69.43 | 91.7 | 470 |
| **2** | 045 | 9:07 | Dry Dock | HPWJ | 5-Head Nozzle | 103.4 | 640 | 103.6 | 654.7 | 105.6 | 11,613 |
| **3** | 003 | 9:07 | Dry Dock | HPWJ | 5-Head Nozzle | 104.3 | 725.2 | 104.4 | 740 | 106.6 | 14,370 |
| **4** | .002 | 7:17 | Blast House | Blaster | Blast Nozzle Steel Shot | 96.5 | 244.6 | 96.6 | 248 | 99.7 | 2,925 |
| **5** | 045 | 7:57 | Bay 1 | Welder | FCAW Grinder | 88.1 | 76.7 | 89.8 | 97.1 | 94.7 | 924.7 |
| **6** | 002 | 7:57 | Bay 1 | Fitter | FCAW Grinder | 87.1 | 67 | 89.2 | 89.5 | 94.6 | 909 |
| **7** | 003 | Void | Mod 23 | Welder Fitter | FCAW Grinder | EQUIPMENT FAILURE | | | | | |
| **8** | 004 | 7:59 | Mod 23 | Welder Fitter | FCAW Grinder | 95.3 | 207.1 | 95.7 | 220.3 | 99.6 | 2,859 |
| **9** | 003 | 4:13 | Shop 11 | Welder | Angle Grinder | 73.4 | 10 | 73.7 | 10.4 | 84.9 | 97.7 |
| **10** | 002 | 5:57 | Shop 11 | Welder | Forge, Saw, Grinder | 64.3 | 2.8 | 72.7 | 91 | 79.3 | 26.9 |
| **11** | 045 | 6:04 | Shop 11 | Welder, Ship Fitter | Grinding, Fitting | 83 | 37.9 | 84.4 | 46 | 90.8 | 376.7 |

# SHIPYARD NOISE DOSIMETRY RESULTS

| | DOS # | RUN TIME METER Hrs:Minutes | LOCATION | JOB | TOOLS | OSHA-PEL | | OSHA-HC | | ACGIH | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | dbA TWA | % Dose | dbA TWA | % Dose | dbA TWA | % Dose |
| **12** | 075 | 6:29 | Shop 11 | Ship Fitter | Grinding, Fitting | 94.7 | 191.3 | 95.1 | 201.5 | 102.8 | 7,392 |
| **13** | 004 | 6:03 | Bldg 1499 Hydroblast Booth | HPWJ | 5-Head Nozzle | 98.9 | 345.6 | 99 | 348.7 | 104.7 | 9,353.90 |
| **14** | 075 | 6:03 | Bldg 1499 Hydroblast Booth | HPWJ | 5-Head Nozzle | 94.1 | 176.3 | 94.3 | 182.1 | 98.3 | 2,140.90 |
| **15** | 002 | 4:48 | Bldg 369 X64 Spray Booth | Fabric Worker | Orbital Sander | 78.7 | 20.8 | 79.5 | 23.2 | 85.2 | 105.1 |
| **16** | 045 | 4:48 | Bldg 369 Spray Booth | Painter | Orbital Sander | 90.7 | 110.1 | 90.8 | 111.9 | 95.2 | 1,053.90 |
| **17** | 004 | 6:45 | Assembly Bldg | Welder | Pulse-Arc Welder | 85.9 | 48.1 | 88.3 | 66.4 | 91.8 | 477.9 |
| **18** | 002 | 6:45 | Assembly Bldg | Fitter | Cubitron Track Grinder | 77.9 | 15.8 | 84.7 | 56.7 | 88.2 | 206.7 |
| **19** | 075 | 6:45 | Assembly Bldg | Welder | Miller Pulse-Arc | 82.8 | 36.8 | 87 | 65.7 | 89.8 | 304.2 |
| **20** | 045 | 6:45 | Assembly Bldg | Fitter | Cubitron Grinder | 89.1 | 88.3 | 90.9 | 113.2 | 94.7 | 924.5 |
| **21** | 004 | 8:04 | Throughout Shipyard | Forklift Operator | 4-Ton Hyster Forklift | 82.3 | 34.4 | 86.7 | 63.7 | 89.8 | 300.1 |
| **22** | 002 | 8:02 | Throughout Shipyard | Forklift Operator | 8-Ton Hyster Forklift | 69.5 | 5.8 | 77.5 | 17.6 | 82.1 | 51 |

# SHIPYARD NOISE DOSIMETRY RESULTS

| | DOS # | RUN TIME METER Hrs:Minutes | LOCATION | JOB | TOOLS | OSHA-PEL | | OSHA-HC | | ACGIH | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | dbA TWA | % Dose | dbA TWA | % Dose | dbA TWA | % Dose |
| **23** | 075 | 7:55 | Throughout Shipyard | Truck Driver | Freightliner Tractor | 76.4 | 15.2 | 81.7 | 31.8 | 87.2 | 167.4 |
| **24** | 045 | 8:07 | Throughout Shipyard | Forklift Operator | 4-Ton Hyster Forklift | 79.5 | 23.4 | 86.4 | 60.4 | 88.2 | 207.4 |
| **25** | 002 | 8:20 | Dyrdock Under BARGE | HPWJ | 16-Head Nozzle | 96.7 | 253.8 | 96.9 | 261.7 | 99.4 | 2,749 |
| **26** | 075 | 8:20 | Drydock in ManLift - Side of BARGE | HPWJ | HPWJ Gun | 91.4 | 120.8 | 92.3 | 137.5 | 97.2 | 1,648 |
| **27** | 004 | 8:20 | Drydock in ManLift - Side of BARGE | HPWJ | HPWJ Gun | 96.1 | 232.4 | 96.5 | 246.1 | 99.8 | 2,997 |
| **28** | 045 | 8:20 | Drydock in ManLift - Side of BARGE | HPWJ | HPWJ Gun | 94.1 | 176.2 | 94.9 | 197.7 | 100.2 | 3,318 |
| **29** | 002 | 8:44 | Shaker Room | Grinding Welding | Needle Gun, SMAW | 87.9 | 74.8 | 89.5 | 93.9 | 94.3 | 857 |
| **30** | 075 | 8:36 | EPOD Area | Surface Prep | Needle Gun | 82.7 | 36.2 | 84.3 | 45.2 | 90.8 | 383 |
| **31** | 004 | 8:34 | EPOD Area | Fire Watch | Needle Gun | 83.3 | 39.6 | 85.1 | 54.2 | 90.9 | 391 |
| **32** | 045 | Void | Shaker Room | Fire Watch | Observing | EQUIPMENT FAILURE | | | | | |

# Appendix 6

# Sound Level Meter Readings

| Location | Process | dBA |
|---|---|---|
| Blast House | Pot Tender Room while blasting | 76-80 |
| Blast House | Ventilation Running outside building | 88.4 |
| Drydock | Manlift positioning Water Blaster (off) | 75-80 |
| Blast House | Outside closed door while blasting | 93-96 |
| Blast House | No blasting, compressors off | 65 |
| Blast House | Pot Tender Room, compressors down | 78.4 |
| Blast House | Pot Tender Room, during break | 69 |
| Drydock | HPWJ on Hull, at 100 feet | 85 |
| Steel Fab Shop | Ship Fitters at work; corner of shop | 78 |
| Steel Fab Shop | Welding, Set-up, Grinding at 10 feet | 84.5 |
| Steel Fab Shop | Fitting steel | 81-85 |
| Outdoors | Cranes in Motion | 76 |
| Outdoors | Material Storage Area | 71.8 |
| Ship SubSection | Using torch, cutting steel | 82 |
| Steel Fab Shop | Bay 1, ambient sound | 79-103 |
| Steel Fab Shop | Building Entrance, ambient | 80- 96 |
| Steel Fab Shop | Bay 1, Grinding and Fitting | 81-91 |
| Ship SubSection | Outdoors, Open End, Welding, Grinding | 99.6 |
| Ship SubSection | Outdoors, Closed End, Welding, Grinding | 73.3 |

| Location | Process | dBA |
|---|---|---|
| Shop 26 | Flame Spray Operator Booth, Vent off | 66 |
| | Flame Spray Operator Booth, Vent. On | 78 |
| | Flame Spray Plasma Unit-Operating | 114-118 |
| | FS Op.Booth-Door Open & Operating | 100 |
| | FS Op Booth-DoorClosed&Operating | 81 |
| Building 163 | Welders and ShipFitters, ambient level | 80 |
| Building 234 | Sheet Metal Shop, Ambient Level | 66-73 |
| Building 234 | Outside at Dust Collector; On | 75 |
| Drydock 4 | Outdoors, topside railing | 75 |
| Drydock 3 | Outdoors, topside railing, HP WaterBlast | 83 |
| Building 1499 | Paint Dept; Ambient Level | 66 |
| | HPWJ in open bay; doors up,test at edge | 95-100 |
| | HPWJ stopped, ambient level in work bay | 60 |
| | HPWJ on, closed bay, outside front | 86-89 |
| | HPWJ on, closed bay, outside rear | 88-91 |
| | HPWJ on, closed bay, outer side wall | 79-82 |
| Building 369 | Outside door to spray booth, 2 grinders on | 71 |
| | Bay door to spray booth, 1 ft opening | 77 |
| | Bay door, no tools in use | 60 |
| | Outside spray booth, compressor on | 73 |
| Building 1499 | HPWJ in open bay, 15 feet away | 102 |
| | HPWJ in open bay, along side wall | 79 |
| | HPWJ in open bay, rear edge | 108 |
| | HPWJ in open bay, 40 ft away | 95 |

| Location | Process | dBA |
|---|---|---|
| Assembly Bldg | Grinding and welding nearby | 85 |
| | Track grinder on, 8 ft away | 90 |
| | Track grinder on, 5 ft away | 95.5 |
| | Hand-held Angle grinder, 5 ft away | 97.5 |
| Truck Cab | Idle On, diesel engine, front of cab | 80.4 |
| Shop | Pre-Outfit 2, No tools on | 66.2 |
| Ultra Hall | Shop area, ambient | 75.2 |
| Ultra Hall | Shop area, South Bay | 81.3 |
| Panel Line Bldg | Outside, Ventilation On | 86.5 |
| Panel Line Bldg | Outside, Siren On | 88.6 |
| Panel Line Bldg | Ambient, MidBldg, Column 39 | 85.3 |
| | 2 grinders, 10 ft away | 85.2 |
| Aluminum shop | Ambient, Entry walk-through | 80.8 |
| | Mid-shop | 84.6 |
| | Siren on | 94 |
| Assembly Bldg | Welder Training/Hydro Blast Booth (off) | 65.3 |
| Weld School | Welding in booths | 78.4 |
| Forklift Cab | 18-Ton Hyster, In Cab | 72-80 |
| Forklift Cab | 4-ton Hyster, In Cab | 80.5 |
| Forklift Cab | 4-Ton Hyster, CB radio on high volume | 98.6 |
| Forklift Cab | 4-Ton Hyster, Rev Up Throttle RPMs | 95 |
| Forklift Cab | 4-Ton Hyster, at Idle | 80.5 |
| Forklift Cab | 4-ton Hyster, Rev Up Throttle | 88 |
| Forklift Cab | Radio On | 92.9 |
| Truck Cab | Radio On, Heater Fan on Hi, | 76 |
| Truck Cab | Radio and CB on | 92 |

| Location | Process | dBA |
|---|---|---|
| Drydock 3 | Ambient, Pre-Blasting | 70 |
| | Genie Lift in Motion | 83 |
| | Moving hoses and manlifts | 67 |
| | HPWJ, WOLMA Unit, Under Hull | 107 |
| | HPWJ, WOLMA Unit, Under Hull | 106 |
| | HPWJ, 30 ft away | 89.2 |
| | Helper pulling rope, moving equipment | 98 |
| | Edge of Compressor Trailer | 100.5 |
| | Rear of Compressor Trailer | 103 |
| | HPWJ Operator at WOLMA Unit | 104.4 |
| | HPWJ Wand, 10 ft away | 97.5 |
| | Side of Compressor Trailer, On | 108.5 |
| | Honda Generator, GX650 | 97.4 |
| | HPWJ Wand, 10 ft away | 95 |
| | Below HPWJ Wand operator on manlift | 98.8 |
| | Edge of Compressor trailer | 102.3 |
| | Break; compressors and nozzles off | 67 |
| | Under hull, 2 HPWJ wands in use | 95-100 |
| Shipboard | Shaker room, needle guns in use | 97 |
| | Shaker room, ambient | 72 |
| | EPOD Area, 2 needle guns 6 ft away | 96 |
| | EPOD Area, ambient, no tools | 66-73 |
| | EPOD Area, Pump motor on | 77 |
| | Shaker Room, Needle guns | 101.8 |
| Drydock 3 | Compressors on | 101-103 |
| | HPWJ at Wand Operator | 106-110 |
| Shipboard | Shaker Room, Grinding, SMAW | 94 |
| | EPOD Area, Moving and Rigging | 70-80 |
| | Shaker Room, Grinding & Banging | 107.5 |
| | Shaker Room, SMAW Welding Only | 70.1 |
| | EPOD Area, Needle Gun in use | 100.2 |
| | EPOD Area, Needle Gun in use | 102.3 |
| | EPOD Area, ambient; no tools if use | 66 |
| | EPOD Area, chain falls, no power tools | 78-80 |