IH96300
Noise Measurement & Control

1.0 Purpose/Scope

This procedure provides standardized methods for:

- Conducting personal surveys with dosimeters. Unless not practical, perform employee exposure assessments with a noise dosimeter over the full shift. A dosimeter logs the exposure of the worker as they move through the work area.
- Conducting area surveys with direct reading noise meters. An area survey meter, know as a Sound Pressure Level meter (SPL) is used to determine baseline noise levels and area noise levels to determine the need for area warning posting, locate problem-noise sources, and measuring the effectiveness of engineering controls. It is used as a screening tool to determine the need for personal monitoring and to sketch isometric lines for control area delineation. An area survey meter can be used in limited situations for employee exposure assessments, such as for operations that are short in duration (15 to 30 minutes) and that involve limited employee movement so that the meter can measure the actual employee exposure. In these cases, the meter reading must be observed and recorded over the entire time of exposure.
- Investigating Standard Threshold Shift (STS) to determine the work conditions of the affected employee and extenuating circumstances from non-work issues.
- Recommending control measure for high noise sources.

2.0 Responsibilities

2.1 Personnel that perform exposure monitoring with this procedure are responsible to follow all steps in this procedure.

2.2 The data collected using this meter must have an appropriate evaluation of the hazard and risk by a skilled Industrial Hygiene professional.

3.0 Definitions

ACGIH: American Conference of Governmental Industrial Hygienists

Decibel (dB): A non-dimensional unit used to express sound pressure levels. It is the log of the ratio of the measured sound pressure level to a reference level.

dBA: A sound pressure level in decibels made on the A-scale of a sound level meter. This

unit of measure approximates the response of the human ear.

dBC: Sound pressure based on a nearly flat, non-weighted scale.

Dose: A percentage of the maximum allowable noise that a worker can be exposed to per day. This is a computation that is based on the following variables: Criterion Level, Lower Threshold, and the Exchange Rate. Allowable dose is 100%.

Fast/Slow Response: A meter setting which electronically compensates for varying field pressure levels with simulated slow or fast "needle" inertia. Slow response is used for personal exposure monitoring. Slow response eliminates rapid fluctuation in the meter response (analog needle or digital display) to allow for a more stable reading that is easier for the operator to interpret.

Frequency: The number of cycles completed by a periodic quantity in a unit time. Unit, hertz (Hz) measures cycles per second.

Impulse or Impact Noise Levels: Variations in noise levels that involve peak levels spaced at periods of greater than one per second. Where the intervals are less than one second, it should be considered a continuous noise source.

Occupational Exposure Limit (OEL): The maximum time weighted average (TWA) exposure permitted for employee exposure, based on the less of the OSHA Permissible Exposure Limits (PEL) or ACGIH Threshold Limit Value (TLV). OSHA exposure levels are calculated on a 5 dB doubling rate, whereas ACGIH utilizes a 3 dB doubling rate (for each drop of 3 dB in the average noise measurement double the allowable work time). BNL follows the most protective OEL.

Standard Threshold Shift (STS): OSHA has defined an STS as a change in hearing threshold relative to the baseline audiogram of an average of 10 dB or more at 2000, 3000, and 4000 Hz in either ear.

4.0 Prerequisites

4.1 **Prior to using this procedure:**

- Complete training for hazards other than noise may be needed for entry into restricted areas (check with ESH Coordinator or FS Representative for the facility).
- Complete Noise and Hearing Conservation Training
- Have a Baseline audiogram if the exposure to the person performing the survey will be in excess of the OSHA Permissible Exposure Limits (PEL) or ACGIH Threshold Limit Value (TLV), which ever is less (see Table A).

4.2 **Area Access**:

- Contact the appropriate Facility Support Representative or FS Technician to obtain approval to enter radiological areas.

- Verify with the appropriate Facility Support Representative or FS Technician if a *Work Permit* or *Radiological Work Permit* is needed or is in effect. If so, review and sign the permit.
- Use appropriate PPE for area. Use ear muff or plugs (or both) if the area is >85dBA.

Table A: OSHA PEL & ACGIH TLV

Duration/Day			OSHA PEL (dBA)	ACGIH TLV (dBA)
Hours	Minutes	Seconds		
24	1440			80
16	960			82
8	480		90	85
4	240		95	88
2	120		100	91
1	60		105	94
½	30		110	97
¼	15		115	100
1/8	7.5			103
	3.75			106
	1.88			109
	0.94			112
		28		115
		14		118
		7.03		121
		3.52		124
		1.76		127
		0.88		130
		0.44		133
		0.22		136
		0.11		139
*No exposure to continuous or intermittent noise levels in excess of 140 dBC peak should be allowed				

5.0 Precautions

5.1 Hazard Determination:

- The operation of an area survey meter does not cause exposure to any chemical, physical, or radiological hazards. The meters do not generate Hazardous Waste.

- By its very nature, a noise survey meter may be used in areas where excessive noise levels exist or are suspected to be present. Exposures to noise levels above the PEL and/or TLV may cause temporary or permanent hearing loss.

- The meters used in this procedure are light (less than 2 pounds (1Kg)) and do not pose an ergonomic hazard.

5.2 Personal Protective Equipment:

- In areas where noise levels exceed the *Occupational Exposure Limit (OEL)*, hearing protection must be worn. The hearing protection should be able to reduce the noise levels below the OEL. See SBMS Noise and Hearing Conservation for Guidance on Hearing Protection Devices and their protection factors (Noise Reduction Ratio, NRR).

- Additional PPE: Other appropriate PPE for hands, feet, skin, head, or eyes may be needed for the area being entered. Check with your FS Representative.

5.3 **Work Planning:** All requirements of work permits and work planning system reviews must be met in performing this procedure.

5.4 **Environmental Impact and Waste Disposal:** This sampling does not have adverse impact on the environment or create waste for disposal.

5.5 **Job Risk Assessment:** Consult the *Job Risk Assessment* SHSD-JRA-05 for the risk analysis of this operation based on the hazards and controls of this SOP.

6.0 Procedure

6.1 Prepare the worker to be monitored and the person conducting the monitoring: Unless all work areas the worker will be in are known to be less than 85dBA, have the worker wear ear plugs or muffs during the sampling period. If the person conducting the sampling will also spend any time in an area above 85dBA, wear ear muffs or plugs during sampling.

6.2 Plan and conduct hazard assessments and exposure monitoring using the procedure outlined in I*H 60500 Planning Sampling & Reporting Personnel Exposure Monitoring Results* for: Exposure Assessment Sampling Strategy.

6.3 For Area Surveys follow the procedure described in Attachments 9.1, 9.2 and 9.3.

6.4 For Personal noise monitoring (dosimetry) follow the procedure described in Attachments 9.1, 9.2 and 9.4.

6.5 For conducting a Standard Threshold Shift investigation, follow the procedure described in Attachment 9.5.

6.6 When making recommendations for control of noise sources causing noise levels above occupational exposure limits, consult Attachment 9.6.

6.7 Recording readings on the appropriate form:

- Use a *BNL Direct Reading Sampling Instrument Form* (or equivalent) to record readings from Area Survey Meters (see Attachment 9.7).
- Use the BNL Noise Dosimetry form (or equivalent) to record readings from dosimeters (see Attachment 9.8).
- Return the original sampling form(s) to the SHSD IH Laboratory.

6.8 Return meter to the SHSD IH Laboratory.

6.9 Post-calibrate (i.e. single point operational accuracy check) the meter as per the Instrument Operation SOP.

6.10 Download dosimeter data at the IH Lab and keep a copy of the printout with the field form.

6.11 A competent person should write a hazard evaluation report that evaluates the survey data and summarizes the potential for occupational exposure and compliance with OSHA and ACGIH Occupational Exposure Limits (see Table A). See IH 60500 for more requirements on the content and reporting deadlines.

6.12 Ensure that a copy of the hazard evaluation report is sent to the IH Laboratory and is included in the ESHQ Directorate Recordkeeping system.

6.13 Ensure that a summary of any over-exposure operation is sent to the Occupational Medicine Clinic with the worker(s) BNL Life Number(s) noted.

6.14 Use the hazard evaluation report and/or an *Employee Notification Form* (sample in Attachment 9.9) to inform all employees whose monitoring results indicate exposure above the OELs.

6.15 The IH Group will maintain a copy of sampling results for at least 75 years.

7.0 Implementation & Training

7.1 Personnel are to be qualified on this SOP via Attachment 9.12 *Job Performance Measure Completion Certificate*. Qualification on this JPM is required on a 3 year basis.

7.2 Noise and Hearing Conservation Training and a Baseline audiogram may be needed if the exposure to the person performing the survey will be in excess of the OSHA Action Level or ACGIH Threshold Limit Value (TLV), which ever is less.

8.0 References

8.1 BNL SBMS Subject Area *Noise and Hearing Conservation*
8.2 OSHA Noise/Hearing Conservation Standard 29CFR1910.95.
8.3 NIOSH Criteria for a Recommended Standard-Occupational Noise Exposure, 1998
8.4 ACGIH American Conference of Governmental Industrial Hygienists Threshold Limit

Values for Chemical Substances and Physical Agents and Biological Exposure Indices 2005.

8.5 ANSI S1.13: Methods for the Measurement of Sound Pressure Levels.
8.6 OSHA *Technical Manual* SECTION III: CHAPTER 5
8.7 NIOSH 79-117: Industrial Noise Control Manual

9.0 Attachments

9.1 *Theory of Noise Measurements*
9.2 *Guidance on Hazard Assessment and Exposure Monitoring*
9.3 Area Survey Procedure
9.4 Personal Dosimetry Procedure
9.5 STS Evaluation Procedure
9.6 Control of Noise Guidance
9.7 *Noise Area Survey form*
9.8 *Noise Dosimeter form*
9.9 *Employee Notification form*
9.10 STS: Employee Noise Exposure Questionnaire
9.11 STS: Employee Notification Form of SHSD Evaluation Of Workplace Exposure
9.12 *Job Performance Measure*

10.0 Procedure Documentation

ISM Review - Hazard Categorization ☐ High ☒ Moderate ☐ Low/Skill of the craft
Validation: ☐ Formal Walkthrough ☐ Desk Top Review ☒ SME Review

Rev	Revision Log
0	Merger of IH96150, 96175 96200 and 96250. SME Reviewer/Date: R. Selvey 09/28/09
1	Revised distribution list in the Attachment 9.5 STS Evaluation. Reviewer/Date: R. Selvey 11/06/09
2	Revised format of Section 10. Reviewer: R. Selvey 03/04/14

Attachment 9.1

Theory of Noise Measurements

Octave-band filters separate the noise into discrete frequency ranges typically centered from 31.5 Hz to 16 kHz in octave intervals. Separation of the noise into these frequency bands is useful in predicting the success of various forms of engineering controls and in predicting the potential harmful nature of noise to human speech frequencies.

Weighting on scales A, B, C and Flat is done to adjust the microphone characteristics to simulate the response of the human ear's response to sound (dBA) or to other response curves that are more characteristics of the true sound pressure level (dBB, dBC, and Flat). If the measured sound levels are much higher on the C-weighting than on the A- weighting, much of the noise is contributed by the low frequencies.

- *A Network*: Simulates the response of the human ear to noise. Generally used in noise surveys to locate noise hazards. The A Network discriminates against the low frequencies quite severely as does the human ear. Most regulations require that noise be measured on the A-weighting scale.
- *B Network*: Moderately discriminates against low frequencies
- *C Network*: Barely discriminates against low frequencies. Nearly a flat response.
- *Flat*: No filtering of the incoming pressure signal, i.e., a flat response.

Microphone signal decay can be set to FAST, SLOW, IMPACT and IMPULSE response.

- **Employee exposure is made on Slow response**.
- Impact is used for single bursts such as a weapon shot.

Attachment 9.2

Guidance on Hazard Assessment and Exposure Monitoring

1. **Occupational Exposure Periodic Surveys-** Periodic surveys are done to determine compliance with occupational exposure standards based on measurement of employee exposure to noise.

   Assess high noise areas with Sound Pressure Level (SPL) measuring devices including Survey Meters and/or Personal Noise Dosimeters. Selection of the appropriate type of equipment to conform to specifications established in SHSD IH Group IH96 series SOPs and to the requirements cited in OSHA and ANSI standards.
   - All equipment is to be calibrated.
   - Conduct initial assessment at the installation and start of operation or for any equipment in operation that has not been previously evaluated by measurement or analogy to existing representative equipment.
   - Re-do surveys when changes to processes occur. Optimally operations should be re-surveyed on a periodic basis, ideally within a three to five year interval.

2. **Source and Area Measurements-** Ambient and source noise measurement for determining high noise areas may be included in the periodic survey program. Measurements are made in suspect areas to determine the intensity, frequency, and pattern of noise to:
   - Determine if excessive noise is present and annual surveys are needed,
   - Determine parameters for engineering control measures.

   The devices used will typically be Survey Meters and Octave Band Analyzers.
   Ambient and source noise measurements typically need to be re-done only when equipment or operation changes are made that could affect the noise level.

3. **Use of Survey Meters (Broad Band) for employee exposure measurements-**
   A Survey meter can be used to determine the SPL TWA in the area for compliance monitoring, when noise levels in the area to be surveyed are:
   - Uniform throughout the area,
   - Constant throughout the work period, and
   - Exposed personnel are not highly mobile within the workarea and remain in the area throughout the exposure period and do not enter and leave the area while performing typical work assignments.

4. Make measurements that are representative of exposure throughout the work shift by means of:
   - multiple readings taken at intervals during the work day or
   - data logging.

   Average readings on a time-weighted basis for the period of measurement or for the full shift as is appropriate based on the noise source.

   Locate the meter at worker ear level in a placement that characterizes the worker exposure while performing typical work activities. Operate the meter in the A-weighted scale, on slow response.

Survey meters may also be used to take instantaneous measurements of noise pressure levels for identification of high noise areas, and for taking measurements aimed at locating noise sources. In these cases, simulation of full work shift exposure and worker exposure is not necessary.

5. **Octave Band Analyzers (OBA)-**

Use OBAs for analysis of noise sources to determine the range of frequency and pressure level in each octave range. This data is used for determining appropriate engineering control and determining the potential for damage in human speech frequencies. Operation of the OBA as a survey tool and correlation of the results to worker exposure and duration are not mandatory.

Attachment 9.3

Direct Reading Meter Area Survey Procedure

1. Perform a Battery Check prior to use and at least once every half hour of use.

2. Warm-up the meter as per the Instrument Operation SOP.

3. Pre-calibrate (i.e. single point operational accuracy check) the meter as per the Instrument Operation SOP. BNL requires daily calibration to a portable calibrator. Daily calibration serves as a Bump check of the meter operation pre and post testing.

4. Select the desired weighting to A, B, C or FLAT (see Attachment 9.1) and the appropriate broadband weighting or octave band.
   - Employee exposure screening measurements should be taken on dBA.
   - Engineering and source characterization should be taken on dBC.

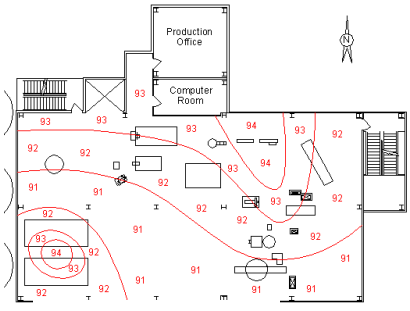
5. Select the desired detector response rate: FAST, IMP, PEAK, or SLOW. (Employee exposure measurements should be taken on SLOW.)

6. If appropriate, conduct an octave band analysis (OBA) for each frequency. OBAs are typically done for engineering measurements and are most useful if done on dBC weighting and SLOW response.

7. Operator Position: Preferably the operator should be further from the sound source than the microphone and positioned to reduce reflection of the sound to the meter. Hold the meter at arms length, not close to the body.
   - Do not stand between the sound source and microphone.
   - Do not place the hand within 12 cm (5 inches) of the microphone during measurements.

8. Take measurements at the employee's ear level (whether sitting, standing or bending) to estimate personal exposures and to locate isometric lines of noise intensity on a sketch for defining area levels (i.e., a plot of noise levels on the floor plan, a.k.a. isopleths).

9. Post-calibrate (i.e. single point operational accuracy check) the meter as per the Instrument Operation SOP.



Typical Isopleth Map

Attachment 9.4

Personal Dosimetry Procedure

1. Perform a Battery Check prior to use.

2. Warm-up the meter as per the Instrument Operation SOP.

3. Pre-calibrate (i.e. single point operational accuracy check) the meter as per the Instrument Operation SOP. BNL requires daily calibration to a portable calibrator. Daily calibration serves as a Bump check of the meter operation pre and post testing.

4. Dosimeter Setting: The dosimeters are pre-set in the IH lab to calculate both OSHA and ACGIH exposure data.

5. Microphone placement: The microphone must be attached to the worker near the ear (on the collar) and attached in the position prior to starting the meter logging of exposure. This will reduce false impact noise signals that occur when handling the microphone.

6. Record observations of the tasks done during the monitoring. Whenever possible, conduct full-shift monitoring.

7. Policy on monitoring during lunch breaks (30 –60 minutes) and short breaks (10-20 minutes):
   - During short breaks: The meter should be worn by the worker and left logging even if the worker leaves the noise area. If removed from the worker, the meter needs to be placed in the *pause mode* before handling the microphone.
   - During lunch breaks:
     - The meter should be placed in the *pause mode* and may be removed from the worker. The worker may wear the meter from the noise area but it must be put into *the pause mode*.
     - The meter should never be removed from the worker and left logging in the noise area.
     - Prior to return to work, the meter will be re-positioned on the worker before restarting the data logging.

8. Record the status of the placement and logging of the meter during breaks on the appropriate field documentation form.

Attachment 9.5

STS Evaluation Procedure

1. The IH Group Leader or designated representative receives and assigns the case to a specific IH Professional. The case is entered into the SHSD FATS system.

2. The assigned IH Professional reviews the notice of Illness/Injury Report provided by the Occupational Medicine Clinic and/or the Request for IH Field Services Follow-up from the Safety Engineering Group and seeks additional information if needed.

3. The IH Professional contacts the worker's supervisor to set an appointment for the initial discovery meeting. The supervisor and employee may be interviewed separately or together, however, a single joint meeting is recommended.

4. During the interview(s), the IH Professional completes the *STS: Employee Noise Exposure Questionnaire* (Attachment 9.10) to gather information on the current occupational exposure to noise, current non-work related exposure to noise (hobbies, second employment, etc), and past occupational and off-site exposure to noise (including military history).

5. If further information is needed, the IH Professional contacts any necessary individuals and interviews them to collect the required data.

6. The IH Professional searches IH database and formal reports to collect, review and verify previous monitoring meets current standards.

7. The IH Professional identifies the hearing conservation group to which the employee belongs, if applicable.

8. Once the initial information is gathered and reviewed by the IH Professional, s/he determines if monitoring may be necessary.

    - Examples: (1) the employee has worked for the last two years in a quiet environment there may be no need to conduct monitoring; (2) if employee has worked in one location and there are one or more sources of potential exposure a sound survey and/or dosimetry may be required; and (3) if employee has worked in multiple locations with various exposure levels, extensive dosimetry may be required to fully characterize the workers exposure.

9. Evaluation and Report
    - Upon completion of the interviews, document review, and monitoring, the IH professional assesses the worker's typical exposure and prepares a written evaluation of the work area(s)

and recommended response action(s), i.e. STS Investigation Report.

- At a minimum when exposures are found to be above the OEL, recommendations will include the follow-up procedures as stated in OSHA 29 CFR 1910.95 as follows:

Condition	Response
Employee not using PPE	Trained in hearing protector use and care b. Fitted with appropriate hearing protectors
Employee already using hearing protection	Refitted with appropriate hearing protectors Re-trained in hearing protector use and care c. Provided hearing protection with greater attenuation if necessary.
Employee needs additional testing or if medical pathology of ear may be caused/aggravate by wearing hearing protectors	Refer for a clinical audiological evaluation or otological examination as appropriate

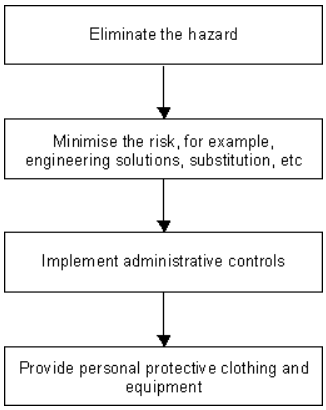
10. A copy of the STS investigation report is sent to the Occupational Medicine Clinic, Workers Compensation Administrator, Return-to-work Coordinator, Noise SME, SHSD IHG Manager, Safety & Health Representative, ESH Coordinator, the affected worker, and his/her supervisor.

11. The IHP will provide re-training in hearing protection use and document this re-training in the FATS closeout.

Attachment 9.6

Control of Noise Guidance

Follow this guidance on technical issues relating to performing testing and issuing personal protective equipment.



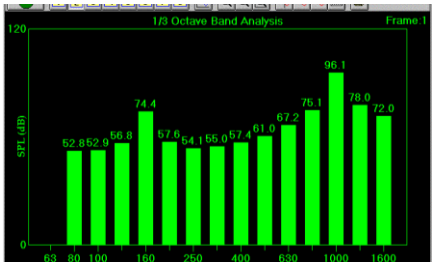
1. Base control of noise on the following hierarchy of controls:
   - Substitution of less hazards noise sources ,
   - Engineering controls such as isolation, barriers, and absorbers
   - Administrative controls, and finally
   - Personal protective equipment (while controls are being installed or when not effective or feasible).

2. Regard machines and processes as collections of noise sources, each of which generates noise in a particular manner.

3. List all potential noise sources (within each machine or process).

4. Break the list into categories of the noise source-
   - Aerodynamic noise (direct disturbance of the air): fans; compressed air- air jets, pneumatic exhausts, air motor exhausts; combustion
   - Mechanical noise (mechanical vibration which is transmitted through the machine structure to the external surfaces which vibrate and radiate noise): impacts- presses, mechanical handling; rotating machines- gears, pumps, bearings, electrical machines; friction forces and others- cutting tools, brakes

5. Rank the sources- Ranking the sources involves establishing the relative contributions from each source to the total noise produce by the machine or process. To achieve effective noise control the dominant sources must be controlled first. If the dominant sources are not treated first, the effect of any noise control measures will likely be limited to a maximum reduction of less than 3 dB. The main ranking techniques are:
   - *Listen:* associate the characteristics of the noise with an understanding of the machine operation.
   - *Alter operating characteristics*: change speeds, feeds, load etc and note effect on noise.
   - *Timing:* associate noise with parts of machine cycle.
   - *Isolate:* run each source separately or temporarily cover all sources (barrier mat) and uncover each in turn. Make sure you can do this safely.
   - *Frequency:* features of the frequency spectrum can be a powerful diagnostic tool.



6. Obtain diagnostic information on the source of the noise and the characteristics of the source, including:
   - Frequency of the noise- especially via an octave band analysis

- Properties of the source such as shape, size, and vibration
- Location of noise source
- Location of exposed personnel
- Duration of Exposure and dose
- Reduction level to be sought

7. Consult with the noise source owner, Plant Engineering, and equipment manufacturers to determine a workable solution to eliminate or lessen noise sources. At this stage noise control engineering expertise may be required in order to cost the options for each of the ranked sources and to predict the likely noise reduction for each option. Refer to Attachment 9.1 for guidance on the selection of engineering controls. Consider the cost and available control options.
   - Noise control at the source: engineering modifications that alter the process of noise generation.
   - Silencing: for aerodynamic sources with a conventional and unconventional "silencers" available.
   - Vibration isolation: introduce a vibration "break" to prevent the transmission of mechanical energy.
   - Vibration damping: extract and dissipate the energy in vibrating surfaces.
   - Enclosure: prevent the transmission of sound by introducing a barrier.
   - Barriers: place a partial barrier between source and receiver.

Guidance on Engineering Controls, Administrative Controls and Personal Protective Equipment - Abatement of Noise sources

Engineering Controls

The IH group will recommend engineering control for correction or reduction of existing noise sources which result in employee exposure to excessive noise. Selection of appropriate control measures shall be based on available technology, vendor literature, and previous experience. Sources of information utilized shall include ANSI, ASA, NIOSH, ACGIH publications.

- Noise control should minimize sources of noise; prevent the propagation, amplification, and reverberation of noise; and protect workers from excessive noise. Engineering controls include anti-vibration machine mountings, acoustical enclosures, and component replacement.

- High frequency noise is very directional and is relatively easily reflected or blocked by any type of barrier. The wavelength of a 16-kHz tone, for example, is about ¾ inch, so a barrier of 1 to 2 inches higher than the source is generally sufficient to reflect noise of approximately the same frequency away from a nearby worker.

- High frequency audible noise is also easily absorbed by any of the so-called acoustical materials (e.g., glass fiber or foam).

Absorbers

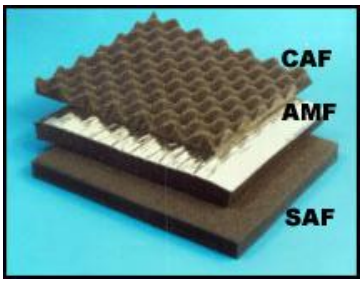
While many materials block sound - no single material blocks noise. The problem is the frequency range. Noise nearly always consists of many different frequencies in the frequencies ranging from 22Hz to over 11kHz. No single material can effectively block all these frequencies. The only way to block this kind of noise is to select a combination of materials which work together to effectively control sound across a broad

spectrum. In practice this is harder than it may seem since different materials grouped together change resonance characteristics and can respond in unexpected ways. When it comes to effective noise attenuation, it is the quality of the materials selected and the way in which they are combined that determines the performance of the finished product.

Acoustic Foams are excellent absorber particularly in the mid-to-high frequency noise ranges. They provide good structural integrity and require little mechanical support. They are easy to cut and fasten to almost any surface with a water-based adhesive.

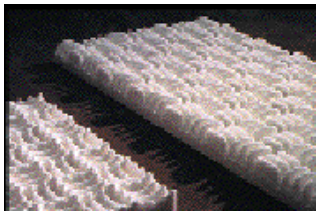
Convoluted Acoustic Foam (CAF)

CAF is open-celled polyester foam featuring peaks and valleys which redirect sound waves into the foam where the sound is converted to kinetic energy and absorbed. It provides 4 times more absorptive surface than flat foams. NRC rating: 1" - .80, 2" - .86, 3" - .91.



Aluminized Mylar Foam (AMF)

AMF is an open-celled polyester foam with an added one mil. aluminized mylar facing, laminated to one side. The facing reflects light and heat and keeps dirt, dust and grease from blocking the absorptive surface of the foam. Especially effective in dirty, greasy industrial environments. 1" thick NRC rating .70.



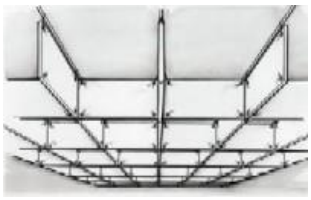
Standard Acoustic Foam (SAF)

SAF is an open-celled polyester foam particularly effective at absorption of mid-to-high frequency noise. Available in rolls 1" thick x 54" wide x 10', 25' or 50' long. NRC rating .85.

Sonex® Melamine Foam Acoustical Panels

Melamine Acoustical Foam with modified Anechoic design to provide increased absorption surface area.

Absorption Coefficients - ASTM C423-90a							
TYPE MTG	**125Hz**	**250Hz**	**500Hz**	**1KHz**	**2KHz**	**4KHz**	**NRC**
2" Natural A		0.31	0.81	1.01	0.99	0.95	0.80
2" Painted B	0.17	0.33	0.85	1.03	1.08	1.06	0.80



Ceiling Baffles

Hanging Fiberglass Noise Absorber

Ceiling baffles reduce reverberant noise in large rooms, noisy sections of

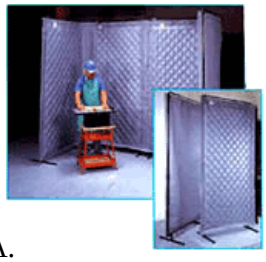
plant floors, or over sound curtain enclosures. Each absorber measures 2' H x 4' W and includes nickel-plated grommets for hanging. Provides approximately 10 Sabins of absorption. When hung in the recommended density of one absorber per 8-10 square feet of floor area, typical ambient noise reduction of 4-7 dBA can be achieved. Can be hung in parallel rows two feet apart, or in an eggcrate configuration. Typical Sound Transmission Coefficient is 8-10dBA

Poly-Covered Fiberglass

A low cost way to add sound absorption to large rooms or enclosures. 1.5" thick, high density fiberglass core, sealed in 2 mil off-white polyethylene cover; nickel-plated grommets provided for hanging. Typical Sound Transmission Coefficient is 4-7dBA

Quilted Fiberglass Material (QFM) Rolls

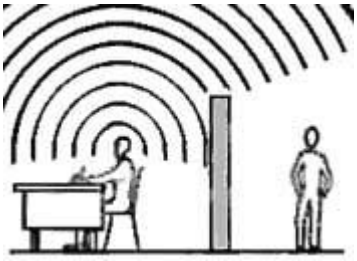
For special projects to fabricate enclosures or cover large areas. An excellent noise absorber made of high quality vinyl-coated facing cloth quilted to a supporting 2 lb./cubic foot density fiberglass. Outer shell is typically made to be resistant to oil, grease and mildew and can be wiped clean. Noise Reduction Coefficient 1" = 12 dBA; 2" = 17 dBA.



Modular Acoustic Screens: The frame is made from steel tubing. Joint and platform legs are often designed so the entire screen can be assembled or disassembled. Each screen forms a continuous sound seal with adjacent screens via a hook and loop fastener on each curtain edge to join adjacent screens together. Screens are a combination of mass-loaded vinyl barrier material, which redirects noise from its path, and Quilted Fiberglass Material (QFM), which absorbs reverberant noise in the enclosed area. Typical dBA reduction is 12-18 dBA.

Source of information: SINGER SAFETY COMPANY; 2300 N. Kilbourn Ave. Chicago, IL 60639 Phone: (800) 621-0089 Fax: (773) 235-0363

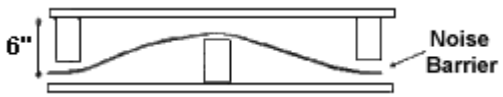
Barriers



Noise Barriers isolate a noisy piece of equipment or reinforce a sub-standard wall or ceiling, and can provide at least 25 decibels of noise reduction in most situations.

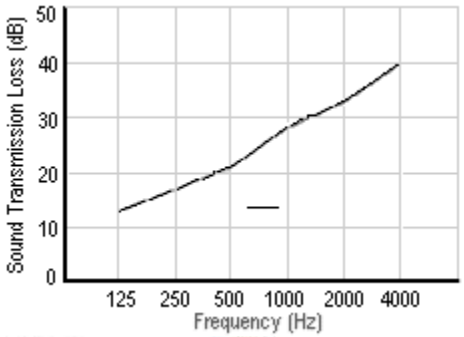
When greater transmission loss is needed, a noise barrier can be added to the interior of the stud wall.

Staggered Stud Wall with Noise Barrier



At the chart below shows, higher frequencies are most easily controlled with barriers.

Sound Transmission Class (STC)



Silencers

Air Nozzle Technology

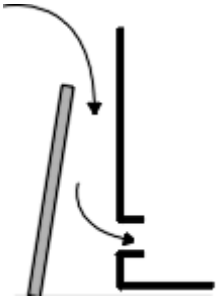
By replacing an open pipe with a engineered nozzle you can lower the sound level by at least 10 dB(A).
In most cases it is possible to halve the noise of pneumatic systems by using specially designed silencers and air nozzles.

Dampening

Low Frequency Machinery mounts obtain vibration control and precision leveling to isolate vibration and keep shock from traveling to or from a product.

Baffles

A baffle is an absorptive barrier. The baffle incorporates the acoustic plenum method for noise control. The design typically allows for the free air flow entry into the baffle. The sound absorbing material used is often a fiberglass panel with a polypropylene dust cover. A 16 dBA attenuation is possible.



Administrative Controls

When engineering controls are not reasonably achievable or are not sufficiently effective in controlling the noise exposure, the IH group may recommend administrative controls in the form of restricted time- access to high noise areas or rotation of employees during the workshift to achieve compliance with employee exposure standards. The use of administrative controls will be at discretion of the IH group if conditions of exposure are deemed to be acceptable and if provisions are demonstrated for enforcement of the control procedures by line

management.

- Administrative practices may require shift rotation or exposure limitation.
- Post areas with signage to alert workers to the high noise status of the area and the need for PPE.
    - Post areas when the noise level exceeds 85dBA.
    - Include information on the need for hearing protective equipment on the sign.
    - Wording for the signs is found in the Subject Area: *Noise and Hearing Conservation.*

Personal Protective Equipment

When Engineering and Administrative Controls have failed to achieve desired noise reduction, the IH group will assist in specifying and training in the use of personal hearing protective devices, including ear plugs and ear muffs.

- Selection of the devices should be made based on the level of attenuation needed, conditions under which the device will be used, characteristics of the user of the device, applicable statutes, and information from ANSI, ASA, NIOSH, ACGIH, other publications and vendor literature.

- Base the attenuation calculation on SBMS Noise & Hearing Conservation Exhibit *Noise Personal Protective Equipment & Hearing Protection Controls - Requirements & Recommendations*

- Refer to the *Personal Protective Equipment* Subject Area and the *Noise and Hearing Conservation* Subject Area for more detail on PPE use.

The types of hearing protection devices are used to protect workers' hearing from noise in the workplace:

Ear plugs

Soft, smooth foam is molded for maximum comfort, Tapered design with rounded tip aids insertion, typically NRR to about 29dB (field use NRR = 11 dB).

Fit into and seal the ear canal; generally treated as "disposable" after each use.

Banded plugs

High visibility headband for easy compliance checks, typically to NRR 22dB (field use NRR = 8 dB).

Ear muffs

Soft ear cushions improve comfort, typically Dielectric design for use around electrical hazards, Noise Reduction Rating typically range for NRR 20 to 30 (field use NRR = 7 to 12 dB), tested in accordance with ANSI S3.19. Use when frequent removal and replacement of hearing protection is necessary.

Noise Cancellation Muffs

Headphones that use a small microphone mounted in each earpiece to monitor the outside noise getting to the ear. A special electronic circuit then creates a signal perfectly opposite to the outside noise so as to cancel it out before it reaches the ear.

Typically they are only able to reduce noise by about 10dB over a limited frequency range. They cancel low frequencies best and typically do not cancel high frequencies effectively.

BROOKHAVEN NATIONAL LABORATORY
Environmental Safety & Health Directorate

SOUND PRESSURE LEVEL SURVEY
NOISE MEASUREMENT FORM

DATE:	SURVEYOR(S):

I. AREA INFORMATION

DEPT:	BLDG:	ROOM:
SOURCE:		
ENGINEERING CONTROLS:		

II. EMPLOYEE INFORMATION

FIRST NAME:	LAST NAME:	BNL #:
DEPT:	BLDG:	JOB TITLE:
EXPOSURE DURATION (HRS):	EXPOSURE (TIMES PER DAY):	EXPOSURE (DAYS PER YR):
JOB PERFORMED:		
PPE USED:		

III. SURVEY INSTRUMENT INFORMATION

INSTRUMENT:	MODEL:						SERIAL#:					
FACTORY CALIBRATION DATE:	PRE-CAL: BY:						POST CAL: BY:					
BATTERY CHECK (Y/N):		125	250	500	1000	2000		125	250	500	1000	2000
CALIBRATOR SERIAL #:	dBA						dBA					
	dBC						dBC					

IV. SAMPLING INFORMATION & RESULTS

Response: ___FAST ___SLOW WIND SCREEN: Y N

TIME	LOCATION OF SAMPLE READING	SPL READING dBA	SPL READING dBC	COMMENTS, SPECIAL CONDITIONS, and/or STATUS OF SOURCE

_____Additional Data on back of form

V. CONCLUSIONS & RECOMMENDATIONS

Return completed form to: SHSD IH Lab

FILE CODE: IH96SR. FORM IH96300 9.7 (09/28/09)

IV. SAMPLING INFORMATION & RESULTS (continued)

Response: ___FAST ___SLOW WIND SCREEN: Y N

TIME	LOCATION OF SAMPLE READING	SPL READING dBA	SPL READING dBC	COMMENTS, SPECIAL CONDITIONS, and/or STATUS OF SOURCE

Additional Data on back of form

SKETCH OF SAMPLING AREA (OPTIONAL)

BROOKHAVEN NATIONAL LABORATORY Environmental, Safety, Health Directorate	**EMPLOYEE NOISE DOSIMETER** NOISE MEASUREMENT FORM
DATE:	SURVEYOR(S):
SAMPLE NUMBER:	IH INDEX NUMBER:

I. AREA INFORMATION		
DEPT:	BLDG:	ROOM:
NOISE SOURCE:		
ENGINEERING CONTROLS:		

II. EMPLOYEE INFORMATION		
FIRST NAME:	LAST NAME:	BNL #:
DEPT:	BLDG:	JOB TITLE:
EXPOSURE DURATION (HRS):	EXPOSURE (TIMES PER DAY):	EXPOSURE (DAYS PER YR):
JOB PERFORMED:		
PPE USED:		

III. SURVEY INSTRUMENT PREPARATION INFORMATION		
INSTRUMENT: **QUEST DOSIMETER**	MODEL: ☐ **Q-300** ☐ **DLX**	SERIAL#:
CALIBRATOR SERIAL #:	PRE-CAL: BY:	POST CAL: BY:
BATTERY CHECK (Y/N):		

IV. SAMPLING INFORMATION & RESULTS ____Record Below or _____See Printed Data Log Report

TOTAL TIME (hh.mm)	DOSIMETER I			DOSIMETER II			DOSIMETER III		
OVER-EXPOSURE Y / N	% Dose	LAVG	LMAX	% Dose	LAVG	LMAX	% Dose	LAVG	LMAX

V. WORKER ACTIVITY INFORMATION		
TIME		COMMENTS- DETAILS ON THE ACTIVITY
ON	OFF	

Optional sketch of the Area

VI. ADDITIONAL COMMENTS ON THE JOB, TASK, HAZARD, ETC.

VII. CONCLUSIONS & RECOMMENDATIONS

BROOKHAVEN NATIONAL LABORATORY

IH96300 Attachment 9.9
NOISE Exposure Monitoring - Employee Notification Record

Date Results Received:	Date Notification Due:	**Date Notification Completed:**
Date of Sampling:	Work Location:	
Work Being Conducted:		

This Section to be completed by the **Industrial Hygiene Professional**

Exposure in Compliance with ACGIH & OSHA	**PPE or Time Prevented Exceeding the Exposure Standard**	**Exposure Exceeds Standards (ACGIH or OSHA)**
Monitoring data indicates exposure levels were **in compliance** with regulatory limits. The employees represented by this exposure monitoring were informed of the results by: Print Name: Notifier's Signature:	Monitoring data indicates the exposure would have been above regulatory levels, but personal protective equipment or the limited time in the area controlled exposure to acceptable levels. Employees represented by this exposure were informed of the results and corrective actions by: Print Name: Notifier's Signature:	Monitoring data indicates exposure levels were **ABOVE** a regulatory limit. The employees represented by this exposure monitoring were informed of the results and corrective actions by: Print Name: Notifier's Signature:

Hazard: **NOISE**

	Measured & PPE Adjusted Exposure **TWA_8 = 8-hour time-weighted average**	**Occupational Exposure Limits Exceeded** **PEL** = Permissible Exposure Limit **TLV** = Threshold Limit Value
Employee Name: BNL ID: ☐ PPE Ear Plugs NRR = ☐ PPE Ear Muffs NRR = Field NRR= (Calculated Noise Reduction Rating with safety factor)	ACGIH TWA_8 **Without** PPE (dBA)	---
	ACGIH TWA_8 **With** PPE (dBA)	☐ ACGIH TLV > 85 dBA TWA_8
	OSHA TWA_8 **Without** PPE (dBA)	☐ OSHA Action Level > 85 dBA TWA_8 [audiometric testing & training required]
	OSHA TWA_8 **With** PPE (dBA)	☐ OSHA PEL > 90 dBA TWA_8

ACGIH=American Conference of Governmental Industrial Hygienists **OSHA = Occupational Safety & Health Administration**

Corrective Actions
Required when Personal Exposure is Above Occupational Exposure Limit(s)

Corrective Action Needed (Substitution, Engineering Controls, Administrative Controls, PPE):	**Implementation Due Date:**

Who received a copy of this form: *Write in the name (* required)*

***Worker:**	***OMC:**	**Other:**
***Supervisor:**	***ESH Coordinator:**	**Other:**

Return this form to the **Industrial Hygiene Group (Building 120)** as soon as employee notification is made.

BROOKHAVEN NATIONAL LABORATORY

SAFETY & HEALTH SERVICES DIVISION
INDUSTRIAL HYGIENE GROUP

IH96300
Attachment 9.10
Rev Date: 09/28/09

Investigation/Evaluation of Standard Threshold Shifts

EMPLOYEE NOISE EXPOSURE QUESTIONNAIRE

EMPLOYEE NAME		DIVISION	DATE STS	INTERVIEW DATE	BNL LIFE#
_____ LAST INITIALS			STS _____dB		
CURRENT AMBIENT SPL RANGE _____dB(A)	SLM BNL#	HC PROGRAM PARTICIPANT? ☐ YES ☐ NO	SUPERVISOR _____ LAST, FIRST INITIALS BADGE #		PHONE

REQUESTOR		SHSD INVESTIGATOR		
_____ LAST, FIRST	_____ BADGE #	_____ LAST, FIRST	_____ INITIALS	_____ BADGE #

Job Title: _____ How Long? _____
Job Description: _____

Does the employee work in areas or use equipment that employee considers loud or that is labeled as a hazardous noise area? ☐ Yes ☐ No If yes, please describe.

Location/Equipment	Duration	Frequency	Ave. SPL	Continuous/Impact

Comments/Controls: _____

Was the employee exposed to loud noises on previous jobs? ☐ Yes ☐ No If yes, please describe.

Date	Type of Job	Equipment	Duration	Frequency	Ave. SPL	Cont/Impact

Comments: _____

Has the employee been exposed to traumatic noise (e.g. gunfire, explosion) in past six months that the employee considers loud: ☐ Yes ☐ No If yes, please describe: _____
_____

Has the employee had current or past military service noise exposures: ☐ Yes ☐ No If yes, please describe:
_____
Is the employee right or left-handed? ☐ right ☐ left

Does the employee use hearing protective devices: ☐ Yes ☐ No. If yes, what type? ☐ Muffs ☐ Plugs ☐ Both. Specify the listed NRR _____dB, and the adjusted NRR _____dB.
Is the attenuation afforded appropriate for the noise level and frequencies, i.e., reduces the ambient noise below 85 dB? ☐ Yes ☐ No
If no, what is recommended?

What is the condition of the PPE?
Is it worn correctly ?

BROOKHAVEN NATIONAL LABORATORY

SAFETY & HEALTH SERVICES DIVISION
INDUSTRIAL HYGIENE GROUP

IH96300
Attachment 9.10
Rev Date: 09/28/09

Investigation/Evaluation of Standard Threshold Shifts

EMPLOYEE NOISE EXPOSURE QUESTIONNAIRE (page 2)

Occupational Exposures	Yes	Exposure Duration	Non-occupational Exposures	Yes	Exposure Duration
Grinding			Hunting/shooting		
Power Tool Operation			Power tool operation		
Chain saws			Chain saws		
Grass Cutting			Grass cutting		
Generators/pumps			Model airplane flying		
Compressors			Powered watercraft operation		
Metal working machines			Metal working machines		
Woodworking			Woodworking		
Impact equipment/air driven			Air driven tools		
Earth moving equipment			Farm machinery		
Hammering activities			Hammering activities		
Shop vacuum			Shop vacuum		
Explosions/firearms			Scuba diving		
High pressure discharges			Loud music/concerts		
Ventilation systems			Flying, non-commercial		
Compacting equipment			Contact sports		
Communications equipment			Motor vehicle racing		
Other			Other		

Additional Comments:_____
_____

Based on field review, SHSD □ **Recommends,** □ **Does not recommend** a comprehensive noise evaluation. Evaluation scheduled for: Date_____

Historical exposure monitoring data:
Area sound level at work position _____dBA, Personal exposure _____dBA as 8 hr. TWA, Date:_____
Area sound level at work position _____dBA, Personal exposure _____dBA as 8 hr. TWA, Date:_____
Area sound level at work position _____dBA, Personal exposure _____dBA as 8 hr. TWA, Date:_____
Comments:_____
_____

Current Exposure Evaluation Results:

Area sound level at work position _____dBA, Personal exposure _____dBA as 8 hr. TWA, Date:_____ ACGIH 8 Hour Dose _____
Area sound level at work position _____dBA, Personal exposure _____dBA as 8 hr. TWA, Date:_____ ACGIH 8 Hour Dose _____
Area sound level at work position _____dBA, Personal exposure _____dBA as 8 hr. TWA, Date:_____ ACGIH 8 Hour Dose _____

Comments (include information regarding impact and peak exposures)
_____
□ Include employee in the similar exposure group (SEG) specified as_____
□ No SEG exists for this job activity.

Determination:
SHSD determined that the subject employee □ **does,** □ **does not** have the potential to be exposed at or above the 8 hr. TWA □ **standard of 85BA,** □ **peak exposures >140 dB** on one or more days per week. The employee □ **is,** □ **is not** required to be in the hearing conservation program on the basis of job related noise exposure. Periodic noise monitoring □ **is,** □ **is not** required.

Interviewer: _____ Date: _____

IMPORTANT: Send copy to Occupational Medicine Clinic & SHSD Safety Engineering Group when investigation is in response to an STS.

Investigation/Evaluation of Standard Threshold Shifts

EMPLOYEE NOTIFICATION FORM OF SHSD EVALUATION OF WORKPLACE EXPOSURE

Employee Name:	BNL Number:
Industrial Hygiene Evaluator:	Evaluator Signature:
Date:	IH Service File Number:

The Occupational Medicine Clinic notified the Industrial Hygiene Group of BNL's Safety and Health Services Division that you received a hearing test and the results indicate a significant threshold shift (STS) in your hearing acuity as defined by the current Occupational Safety and Health Administration (OSHA) criteria.

The IH Group conducted an evaluation of your current and past work place conditions (job responsibilities and exposures) as well as use of personal protective equipment through interviews with you and your supervisor. Ambient and personal noise monitoring was conducted as necessary to determine the extent to which the workplace may currently contribute to any loss and a determination report has been provided to the clinic.

☐ It has been determined that the loss does not appear to be work related and no additional measures are recommended (i.e. workplace exposures did not exceed occupational exposure limits).

☐ It has been determined that the loss may have been work related, however, exposures above the BNL occupational exposure limits are not anticipated in the future.

☐ It has been determined that the loss may be work related and you may still be exposed above the BNL occupational exposure limits. The following recommendations regarding the proper use and care of personal protective equipment are provided to assist in lowering future exposures.

Condition	Response
Employee not using PPE	a) Train in hearing protector use and care (see reverse side) b) Fit with appropriate hearing protectors
Employee already using hearing protection	a) Re-fit (see reverse side)) b) Re-train in hearing protector use and care (see reverse side) c) Provide hearing protection with greater attenuation

Please fell free to contact the SHSD Industrial Hygiene Group with questions, comments, or concerns at:

Name:	Building:	Phone:

(over)

Investigation/Evaluation of Standard Threshold Shifts

The following information is presented to assist you in using earplug and earmuff hearing protection properly. For additional information or instruction in using other types of PPE visit the BNL Industrial Hygiene web site or contact the IH Group.

EARPLUGS: The Roll Down: Preparing A Foam Earplug For Insertion

Hands and plugs should be clean prior to use. Begin by rolling the plug into a very thin crease-free cylinder. The cylinder should be as small in diameter as possible, that is, *as tightly compressed as you can make it*. Do not worry about hurting
the plug — it is designed to be compressed in this way. Crease-free rolling is accomplished by squeezing lightly as you begin rolling, then applying progressively greater pressure as the plug becomes more tightly compressed. Make sure you roll (not twist), the plug into a cylinder rather than any other shape such as a cone or a ball. The plug is best rolled between the fingertips. One method is illustrated in Figures 1 and 2, with an alternative in Figure 3. Another option, for those with less finger strength, is to use the thumbs and forefingers of both hands as shown in Figure 4.


Figure 1


Figure 2


Figure 3

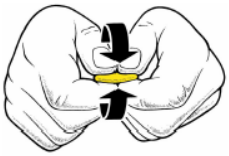


Figure 4

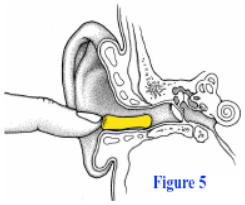


Figure 5


Figure 6

Once the plug has been properly rolled and compressed, immediately insert it well into the earcanal. The importance of compressing the plug tightly is that insertion into the ear canal can only be achieved when the plug's diameter is
less than the canal's. The plug then slides easily into place (Figure 5). As with all earplugs, fitting is easier if the ear canal is straightened and enlarged by pulling the outer ear (pinna) outward and upward during insertion (see Figure 6). Pull the
pinna firmly, usually in the direction the ear extends from the head. Don't just press it flat against the skull.

Plugs should be inserted into the right ear using the right hand and into the left ear with the left hand. The pinna should be pulled with the opposite hand by reaching behind or over the head. This allows the hand inserting the plug to have the best line of approach for proper fitting.

After insertion, hold the plug in place with a fingertip for a few moments until it begins to expand and block the noise. Once a plug has begun to expand, neither pushing nor twisting it will improve its fit. If the initial fit is inadequate, remove the plug, re-roll it, and try again. Occasionally when a foam plug is first inserted, it may be slightly uncomfortable if fitted deeply. Wait 30 seconds or so for it to expand to see if the discomfort subsides; if not, withdraw the plug slightly.

EAR MUFFS: Proper placement and use limitations.

Headband should be on top of head for best results. Ear cup cushions must fit well around temples of eyeglasses. Best results are obtained when the temple bar of glasses are not covered. Remove excess hair from under the ear cup cushions. Do not bend, alter or modify any part of the headband, cups, inserts or ear cup cushions. Ear cup cushions that are hardened or damaged should be replaced. Follow manufacturer's instructions for cleaning, care and maintenance. When earmuffs are correctly worn, your voice should sound muffled to you as if you are talking inside a barrel.

Noise and Hearing Conservation Program

Noise Measurement & Control

Job Performance Measure (JPM) Completion Certificate

Candidate's Name	Life Number:

Criteria	Qualifying Performance Standard	Unsat.	Recov.	Satisf.
1. **Hazard Analysis**	Understands the need to perform a hazard analysis of the area to determine the potential exposure to the self as sampler and workers in the area.			
2. Personal Protective Equipment	Understands the need to be aware of the potential surface contamination, airborne levels of contaminants, radiological hazards, and noise hazard. Knows how to determine the need for PPE.			
3. Pre-Testing Inspection	Understands the need to verify that the system to be monitored is operational and represents typical operation. Makes notation in sampling record if the operating conditions are atypical.			
4. Conducts appropriate interviews	Demonstrates knowledge in setting up and conducting monitoring with input from supervision and workers to determine exposure characteristics. Demonstrates knowledge of a work history during sampling.			
5. Investigation techniques	Knows the various measurement techniques- area survey, octave band analysis, and dosimetry and describes the appropriate time to use each and their advantages and limitations.			
	Demonstrates knowledge in the various weighting factors for noise. Can name the 3 weighting factors and their characteristics.			
	Demonstrates knowledge in mapping the area and indicating source and operator locations.			
	Demonstrates how and where to attach the dosimeter to the worker and when to turn on the meter.			
	Describe the approach in meter logging to be used for breaks, lunch, and early, unplanned ending of work or the noise source operation.			
6. Control of noise techniques	Can name the 3 different engineering control techniques and the instances when they will be effective and non-effective			
	Can name the 2 administrative control techniques and the instances when they will be effective and non-effective			
	Can name the 2 PPE control techniques and the instances when they will be effective and non-effective			
7. Documentation	Understands how to correctly fill out IH forms, transfers to IH databases, prepare an evaluation assessment report (including an evaluation of the relationship of the exposure to occupational exposure limits), and notify workers and management of the results.			

I accept the responsibility for performing the tasks as demonstrated within this JPM and the corresponding SOP.

Candidate Signature:	Date:

I certify the candidate has satisfactorily performed each of the above listed steps and is capable of performing the task unsupervised.

Evaluator Signature:	Date: