Contents

1.0 <u>Purpose & Scope</u>

Purpose: The purpose of this procedure is to provide guidance from the NHC administrator to noise and hearing conservation service providers in key elements that are part of an effective Noise and Hearing Conservation (NHC) program.

This document describes program elements necessary for compliance with OSHA and DOE regulations.

2.0 <u>Responsibilities</u>

2.1 The BNL Noise and Hearing Conservation program is implemented through a matrixed organization of several BNL organization units. BNL organization units providing NHC services are responsible to follow this SOP if applicable in conducting their operations.

2.2 The *SHSD Noise and Hearing Conservation Program Administrator* maintains this SOP in accordance with current regulatory drivers.

3.0 Definitions

none

4.0 Prerequisites

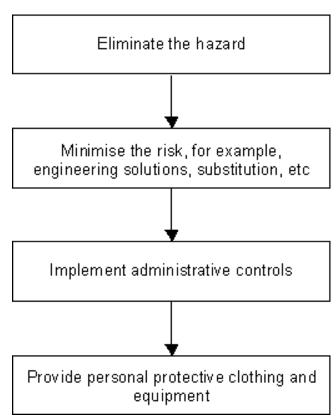
Only persons qualified by their organizations are to use the guidance in this SOP to determining control of noise sources.

5.0 Precautions

none

6.0 Procedure

The service providers follow existing SOPs and use the Attachments of this SOP for guidance on technical issues relating to performing testing and issuing personal protective equipment.



6.1 Control of noise should be based on the following hierarchy of controls:
- 6.1.1 Substitution of less hazards noise sources ,
- 6.1.2 Engineering controls such as isolation, barriers, and absorbers
- 6.1.3 Administrative controls, and finally
- 6.1.4 Personal protective equipment (while controls are being installed or when not effective or feasible).

6.2 Machines and processes should be regarded as collections of noise sources, each of which generates noise in a particular manner.
- 6.2.1 List all potential noise sources (within each machine or process).
- 6.2.2 Break the list into categories of the noise source-
  - <u>Aerodynamic noise</u> (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

6.2.3 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.

6.3 IH Group personnel, in conjunction with RCD Facility Support, should obtain diagnostic information on the source of the noise and the characteristics of the source, including:

6.3.1 Frequency of the noise- especially via an octave band analysis

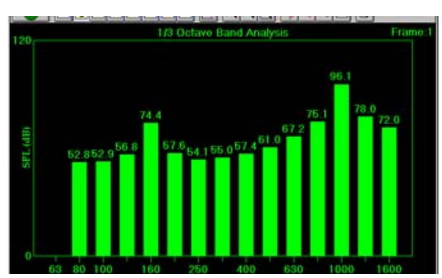
6.3.2 Properties of the source such as shape, size, and vibration

6.3.3 Location of noise source

6.3.4 Location of exposed personnel

6.3.5 Duration of Exposure and dose

6.3.6 Reduction level to be sought



6.4 IH Group personnel are to 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.

7.0 Implementation and Training

7.1 Only persons qualified by their organizations are to use the guidance in this SOP in determining control of noise sources.

7.2 IH Group personnel are qualified by the NHC Program Administrator using IH Group personnel as per *IH SOP 96120.*

8.0 References

8.1 BNL SBMS Subject Area: *Noise and Hearing Conservation*

8.2 29CFR1910.95 OSHA *Occupational Noise* standard

8.3 ACGIH Threshold Limit Values and BEIs

8.4 OSHA *Technical Manual* SECTION III: CHAPTER 5

8.5 *DOE Order 440.1A*

8.6 NIOSH 79-117: Industrial Noise Control Manual

8.7 IH SOP 96120 *BNL Noise and Hearing Conservation Program: SHSD IH Groups Role*

9.0 Attachments

9.1 **Guidance on Engineering, Administrative and Personal Protective Equipment Control of Noise Sources**

9.2 **Guidance on Estimating the Adequacy of Hearing Protector Attenuation**

10.0 Documentation

Document Review Tracking Sheet		
Prepared By: *(signature/date on file)* R. Selvey 3/22/01 Certified Industrial Hygienist	Reviewed By / Date: *(signature/date on file)* J. Peters 5/11/01 Certified Industrial Hygienist	Approved By / Date: *(signature/date on file)* R. Selvey 05/11/01 Industrial Hygienist Group Leader
Filing Code: **IH52QR.01**	QA Review / Date:	Effective Date: **05/11/01**

Periodic Review Record		
Date of Review	Reviewer Signature and Date	Comments Attached
5/29/01	*(signature/date on file)* R. Selvey	Minor typographical error correction, addition of ACGIH to reference list in Section 7, minor change in Attachment 8.2 to clarify OSHA protection factor.
04/06/04	*(signature/date on file)* R. Selvey	Revision to Format Section 7. Revision to posting: sign wording to match new SBMS Subject Area. Qualification link added. Additional information on engineering controls added to Attachment 9.1.

Attachment 9.1

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.

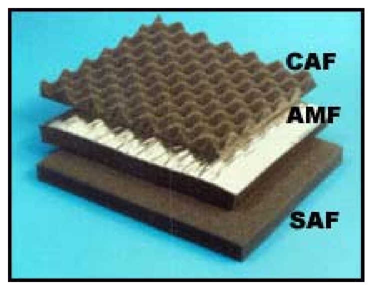
- High frequency audible noise is also easily absorbed by any of the so-called acoustical materials (e.g., glass fiber or foam).

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.

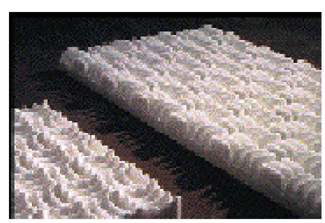
Convoluted Acoustic Foam (CAF)
CAF is open-celled polyester foam featuring peaks and valleys which redirect sound waves into the foam where the sound is converted to kinetic energy and absorbed. It provides 4 times more absorptive surface than flat foams. NRC rating: 1" - .80, 2" - .86, 3" - .91.



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.

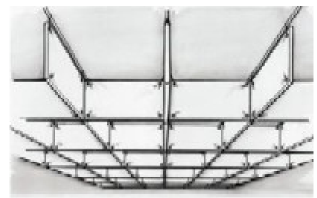
Sonex® Melamine Foam Acoustical Panels



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

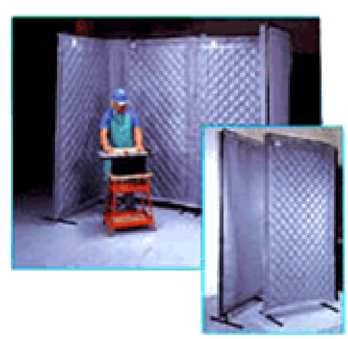
Ceiling baffles reduce reverberant noise in large rooms, noisy sections of plant floors, or over sound curtain enclosures. Each absorber measures 2' H x 4' W and includes nickel-plated grommets for hanging. Provides approximately 10 Sabins of absorption. When hung in the recommended density of one absorber 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.

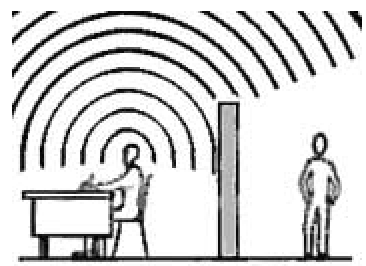


Modular Acoustic Screens: The frame is made from steel tubing. Joint and platform legs are often designed so the entire screen can be assembled or disassembled. Each screen forms a continuous sound seal with adjacent screens via a hook and loop fastener on each curtain edge to join adjacent screens together. 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

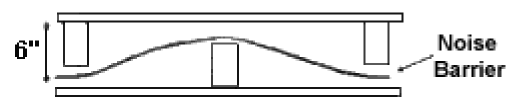
Barriers

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.



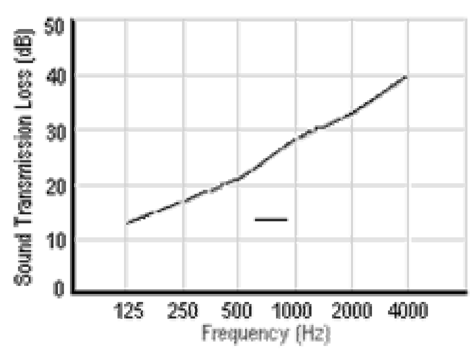
When greater transmission loss is needed, a noise barrier can be added to the interior of the stud wall.

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).

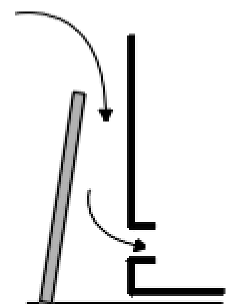
In most cases it is possible to halve the noise of pneumatic systems by using specially designed silencers and air nozzles.

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 IH96150 Attachment 9.2.

- 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.

Attachment 9.2

Guidance on
Estimating the Adequacy of Hearing Protector Attenuation

Noise Reduction Ratings (NRR) were developed by the Environmental Protection Agency (EPA) and must be shown on the hearing protector package. OSHA 29CFR1910.95 *Appendix B* describes methods of using the NRR to determine whether a particular hearing protector provides adequate protection and have been adopted by the BNL NHC Administrator. However, the OSHA Technical Manual recommends *Field Attenuation of Hearing Protection* to estimate the attenuation afforded to a noise-exposed employee in an actual work environment. This is because the field use of ear protectors does not afford the same degree of protection achieved in the laboratory using well-trained subjects under ideal test conditions. To adjust for workplace conditions, applying a safety factor of 50% is recommended by OSHA and adopted by the BNL SHSD Industrial Hygiene Group as their policy hearing protection recommendations.

Selection of method depends upon the noise measuring instrument. Use the following methods, or a more protective method, to determine the adequacy of hearing protectors. When using the NRR to assess hearing protector adequacy, adjust the NRR by the following:

Weighting	OSHA Attenuation Methodology
A	**Dosimeter** taking A-weighted measurements: (A) Convert the A-weighted dose to TWA. (B) **Subtract 7 dB** from the NRR. (C) Subtract the remainder from the A-weighted TWA to obtain the estimated A-weighted TWA under the ear protector. (D) To adjust for workplace conditions, apply a safety factor of 50% (i.e. divide by 2).
A	**Sound level meter** set to the A-weighing network for **area monitoring:** (A) **Subtract 7 dB** from the NRR for the area or the employee's A-weighted TWA. (B) Subtract the remainder from the A-weighted sound level for the area or from the A-weighted TWA. (C) To adjust for workplace conditions, apply a safety factor of 50% (i.e. divide by 2).
C	**Dosimeter** capable of C-weighted measurements: (A) Obtain the employee's C-weighted dose for the entire workshift, and convert to TWA. (B) **Subtract the NRR** from the C-weighted TWA to obtain the estimated A-weighted TWA under the ear protector. (C) To adjust for workplace conditions, apply a safety factor of 50% (i.e. divide by 2).

Weighting	OSHA Attenuation Methodology
C	**<u>Sound level meter</u>** set on the C-weighting network for **<u>area monitoring</u>**: (A) Obtain a representative sample of the C-weighted sound levels in the employee's environment. (B) **Subtract the NRR** from the C-weighted average sound level to obtain the estimated A-weighted TWA under the ear protector. (C) To adjust for workplace conditions, apply a safety factor of 50% (i.e. divide by 2).

Combining Ear Muff and Ear Plugs:

A weighting: Determine the laboratory-based noise attenuation (NRR) for the higher rated hearing protector, subtract 7dB, and apply a safety factor of 50%. Then add 5 dB to the field-adjusted NRR to account for the use of the second hearing protector.

C weighting: Determine the laboratory-based noise attenuation (NRR) for the higher rated hearing protector apply a safety factor of 50%. Then add 5 dB to the field-adjusted NRR to account for the use of the second hearing protector.

The following example shows how the safety factor is used:

TWA_8 = 100 dBA
Muff NRR = 19 dB

Laboratory Rated Attenuation is: (19-7) = 12 dB
Approximate Field Attenuation is: (19-7) × 50% = 6 dB

100 dBA TWA_8 - 12 dB = 88 dBA
100 dBA TWA_8 - 6 dB = 94 dBA

Conclusion:
The protected TWA using the safety factor is 94 dBA. Feasible engineering controls must be implemented. (The OSHA HCA does not require applying a 50% correction factor, so for regulatory compliance, the protected TWA is 88 dBA. Therefore, hearing protection with greater attenuation is not required by the OSHA standard. If an employee exhibits an STS, better hearing protection may be required.)