Bioenvironmental Engineering Site Assessment I

Unit 6: Noise Health Threats

Unit Description: For this unit, you will be stationed on Chuuk Island, where Mount Bolanos Air Base is being established. During your assignment, you'll be determining whether a noise source area is hazardous and interpreting noise survey results. You will also work through the process of performing an octave band noise survey, and you will develop noise health threat control options.

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Lesson 1: Hazardous Noise

Lesson Description

Extensive construction efforts are underway to ensure that Chuuk Island becomes a strategic asset in the Pacific. You expertise is needed to determine whether the noise generated by the equipment poses a health threat to the construction workers. Upon completion of this lesson, you will be able to determine when a noise source or area is hazardous.

Lesson Overview (Page 1 of 8)

An important aspect of your role in helping to ensure the safety of personnel is identifying hazardous noise sources or areas.

As you evaluate noise data for the construction equipment, you will:

- Recall the principles of direct and reflective noise.
- Recall principles related to hazardous noise sources and areas.
- Determine if a noise source or area is hazardous in a given scenario.

Audio Script

Narrator: CE Red Horse is beginning the construction of a hangar to support the Global Hawk aircraft. This hangar will be designed to withstand winds of up to 170 mph and to be resistant to earthquakes.

New construction equipment will be used to assemble the bearings and counterweights for the hangar's earthquake resistant construction. This equipment uses a girding process to custom-fit the bearings for the hangar. Using the noise data gathered on the new equipment, you'll need to determine if a hazardous noise source or area exists.

Mount Bolanos AB Scenario (Page 2 of 8)

Over the past few months, you've developed an effective working relationship with the Civil Engineering Red Horse vertical construction shop on base and the site supervisor, TSgt Thames. During your meetings, you've encouraged him to let the BE office know when a new process is undertaken at the construction site so the process can be evaluated to determine proper controls for personnel.

TSgt Thames called the BE office a week ago to inform you that the shop will begin construction with new equipment for the Global Hawk hangar project. After receiving the message, you set up an appointment to evaluate the noise levels at the construction site.

Audio Script

BE Tech: Good afternoon. TSgt Thames said you're the man I need to see about the new equipment you've got here for the hangar construction.

Shop Worker: Oh yeah, he told me you'd be coming by. You're checking out noise levels, right?

BE Tech: That's right. The surface grinder you just got—can you tell me how it's operated?

Shop Worker: We use it to shape the bearings when they need to be specially fit. They're all pre-fabricated when we get them. So when we need a custom one, we just place it in the device, and the grinding wheel shapes it to the specifications we need.

BE Tech: Is the machine operated manually, or is it remotely controlled?

Shop Worker: It's manual. It's in that room over there if you want to take a look.

BE Tech: Okay, thanks. If you could demonstrate how it works, I'll set up my equipment so I can get data on the noise levels when it's running.

Shop Worker: Sure! Let me just grab some earplugs for us while you're setting up. I don't know if the ones we have are good enough, but they've got to be better than nothing.

Scenario Challenge Point (Page 3 of 8)

Before collecting the data, you consider the various ways that noise from the machine may affect the operator. Match each description with the appropriate noise pathway by marking the appropriate block in the table.

Descriptions	Direct Noise Pathway	Indirect Noise Pathway	Reflective Noise Pathway
Sound waves are transmitted to the receiver after rebounding from other surfaces.			
Sound waves are transmitted to the receiver straight from the source.			
Sound waves are transmitted to the receiver through the air after vibrations from the source travel through a solid.			

Noise Pathways (Page 3a of 8)

As vital as sound is to daily life, too much of it can be harmful. In order for a high level of noise to pose a health threat, it must have a source, pathway, and receiver. If one of these components is eliminated, the threat does not exist.

Most noise producers will usually take two or more paths to the receiver. There are three primary noise pathways which are determined by how the sound waves are transmitted.

Direct Noise Pathway

Direct noise is transmitted directly from the source to the receiver. Examples in which the dominant pathway is direct noise include:

- Listening to music through headphones.
- Standing next to a running jet engine.
- Using a table saw in a shop.

The primary controls used for direct noise sources include:

- Shields and barriers.
- Partial enclosures.
- Total enclosures.

Reflective Noise Pathway

Reflective noise is transmitted by sound waves which rebound from other surfaces and then travel to the receiver. It is important to note that smooth walls tend to act as "sound mirrors" which reflect sound better than rough surfaces. An example of a reflective noise is an echo.

The primary control used for reflective noise is application of acoustically absorbent materials directly to the wall or ceiling surface. Noise-absorbent materials can also be applied by suspending hanging baffles from the ceiling and using gaskets with noise reduction capabilities to seal doorways.

Indirect Noise Pathway

Indirect noise is transmitted when vibrations from the source travel through a solid and are then transmitted through the air to the receiver. This type of noise is usually generated at lower frequencies. An example of indirect noise is the "hum" transmitted through ducts, steel girders, and floors from items such as a loud stereo system or large moving machinery.

The primary control used for indirect path noises is vibration isolation by relocating the source or using anti-vibration materials, such as springs, rubber, or foam.

Hazardous Noise Sources (Page 4 of 8)

To evaluate potentially hazardous noise sources, you will use survey equipment to identify if the source of the noise is capable of producing levels that exceed 85 dB(A) at a normal operator's position.

When conducting a noise survey, it is important to consider all sources that have the potential to exceed the noise threshold. For example, if you are surveying a shop, don't forget to include smaller tools that may not always be in open view and have the potential to be classified as a hazardous noise source.

Hazardous Noise Areas (Page 5 of 8)

In addition to personnel working directly with hazardous noise sources, it is important to consider exposure levels for other people in the area who may be affected due to their proximity to the source. The area that includes the noise threat may be considered a **hazardous noise area.**

There are two methods used to determine hazardous noise areas:

- **Direct.**
- **Indirect.**

Hazardous Noise Area

The levels used to determine a hazardous noise area are the same as those used to determine a hazardous noise source; however, the difference is that the classification refers to the entire area impacted. According to paragraph 3.6.3.1 of AFOSH Std 48-20, a hazardous noise area is any area where personnel could be exposed to any of the following criteria:

- An 8-hour continuous sound pressure level (SPL) greater than 85 dB(A),
- Continuous or intermittent noise above 115 dB, OR
- Peak SPLs above 140 dB.

Direct Method

The direct method is the preferred method for determining a hazardous noise area. This method measures the current, actual sound intensity and exposure durations present in the area.

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The direct method is the preferred method for determining a hazardous noise area. This method measures the current, actual sound intensity and exposure durations present in the area.

Indirect Method

You can also determine a hazardous noise area by using noise data gathered during previous noise surveys. Once you know the sound levels in the area and the duration of each exposure, you can obtain the representative equivalent sound level for a given time period using the LeqT or C/T calculations. If the LeqT calculation is over 85 dB(A) or the C/T calculation is greater than 1, the area should be considered a hazardous noise area.

LeqT Calculation:

$$L_{eqT} = 10Log\left[\frac{t\times\left(\frac{dbA_1}{10}\right)+t\times10\left(\frac{dbA_2}{10}\right)+\ldots t\times10\left(\frac{dbA_n}{10}\right)}{T}\right]$$

Where:

- L_{eqT} = Equivalent sound level for time period T
- T = Total time period in minutes
- t = Exposure times
- dbA = Sound level for each exposure time

C/T Calculation:

$$\frac{C_1}{T_1}+\frac{C_2}{T_2}+\frac{C_3}{T_3}+\ldots\frac{C_n}{T_n}$$

Where:

- *C = Times of exposure to a given level*
- *T = Allowable exposure levels*

Appraisal (Page 6 of 8)

According to AFOSH Std 48-20, which of the following is NOT a criterion for determining if a noise source or area should be considered hazardous?

Choices	**Answer**
Continuous sound level greater than 85 dB(A)	______________________
Multiple-source noise levels above 120 dB	
Continuous or intermittent noise above 115dB	
Peak sound pressure levels above 140 dB	

Scenario Challenge Point (Page 7 of 8)

You run the initial noise survey to collect data on the new equipment and record the noise levels detected.

You record the noise levels and determine whether the new equipment and the area it is in should be classified as hazardous.

Audio Script

BE Tech: Okay, I think that'll do it. Thanks for the demo.

Shop Worker: No problem. So how'd we do? Is our new grinder a health threat?

The surface grinder is designed to be operated only when bearings need to be adjusted. While the machine was in use, the sound pressure levels reached 125 dB(A) at the operator's position. Based on this information, should the machine and the room in which it is used be classified as hazardous?

A Yes

B No

Lesson Summary (Page 8 of 8)

As with any health threat, it is important to consider how hazardous noise impacts the workers exposed to the source of the threat, and how that threat affects other people in the area. In order to do this, you should be able to determine when a noise source or area is considered hazardous.

In this lesson you:

- Recalled the principles of direct and reflective noise.
- Recalled principles related to hazardous noise sources and areas.
- Determined if a noise source or area is hazardous in a given scenario.

Audio Script

Narrator: You have classified the new equipment and the area it's used in as hazardous. Because of the data you collected, you are able to recommend engineering controls and appropriate hearing protection for the machine operators.

Lesson 2: Octave Band Noise Surveys

Lesson Description

As construction of the new hangar for Mount Bolanos Air Base continues, you will be called upon to evaluate the noise levels to which the workers are exposed. Upon completion of this lesson, you will be able to interpret noise survey results. You will also learn about performing an octave band noise survey.

Lesson Overview (Page 1 of 13)

As you visit the site and evaluate the workers' exposure, you will:

- Recall the relationship of results to standards, mission accomplishment, and health effects.
- Compare noise survey results to standards for a given scenario.
- Recall the purpose of octave band noise surveys.
- Describe the process for performing octave band noise surveys.
- Identify variations in octave band noise survey processes, including audiometric booth surveys.
-

Audio Script

Narrator: Construction on the new aircraft hangar at Mount Bolanos Air Base is progressing and becoming enclosed by exterior walls. As the work has progressed, personnel have begun complaining of temporary hearing loss, potentially caused by the rivet guns used to attach panels needed for the steel work on the outside walls. Several of the workers have asked their supervisor for a different type of hearing protection. The supervisor has requested that you visit the site to identify if there is a noise health threat and perform an octave band survey, if needed.

Relationship of Results to Standards, Effects, and Mission (Page 2 of 13)

Any time you are performing noise surveys, it's important to remember how the analysis results relate to applicable **standards,** and how hazardous noise affects **personnel** and the **mission.** You'll evaluate noise level results and compare them to standards to determine whether a health threat exists and whether controls are needed.

For noise, as with other health threats, BE personnel conduct sampling or surveying in the HRA and OEHSA processes to address health threats and communicate appropriate recommendations to decision-makers.

Even when a noise health threat exists, the mission criticality could be high enough that the risk of incurring the health effects at the measured level of exposure is determined to be an acceptable risk.

Standards

When conducting a noise source survey, you must always compare the results with the appropriate standard or criterion level. The standard you should use for classifying a noise source as hazardous is the Air Force criterion level of 85 dB(A) in accordance with (IAW) AFOSH Std 48-20. This means that the allowable time for an 85 dB(A) exposure is 8 hours. For every increase of 3 dB, the allowable time that personnel can be exposed is cut in half.

Personnel

Personnel exposed to hazardous levels of noise may be at risk for temporary and permanent hearing loss as well as the potential for other health effects such as stress, muscle tension, ulcers, increased blood pressure, and hypertension.

Mission

Noise health threats can affect personnel's ability to perform their mission tasks effectively or safely. For example, if workers are exposed to continuous hazardous noise, their ability to respond to verbal warnings or direction from other personnel may place them and others in danger or can hinder the effectiveness of the mission.

Appraisal (Page 3 of 13)

In order to maintain the safety of personnel and accomplish mission objectives, which one of the following standards does the Air Force use as an indicator of acceptable noise levels?

A Not to exceed 77 dB(A) over 8 hours

B Not to exceed 83 dB(A) over 8 hours

C Not to exceed 85 dB(A) over 8 hours

D Not to exceed 94 dB(A) over 8 hours

Purpose of an Octave Band Survey (Page 4 of 13)

Octave band surveys allow you to identify and isolate the cause of a noise problem by segmenting the frequencies for analysis.

The octave band survey is used for any of the following purposes:

- Monitor background levels in rooms used for audiometric testing.
- Evaluate the **whole body effects** of sound.
- Calculate hearing protection device (HPD) noise attenuation when the 8-hour TWA exceeds 94 dB(A).

Whole Body Effects

No octave or 1/3 octave band level may exceed 145 dB for frequencies in the range of 1 Hz through 40 kHz, and the overall sound pressure level must be below 150 dB (unweighted).

Appraisal (Page 5 of 13)

Which two of the following are purposes of an octave band survey?

A Monitor noise levels at the operator's position that could reach above 100 dB(A).

B Monitor noise levels to ensure frequencies do not reach above 5000 Hz.

C Monitor noise levels to evaluate the whole body effects of sound.

D Monitor noise levels in rooms used for audiometric testing.

Scenario Challenge Point (Page 6 of 13)

After arriving at the construction site, you use the sound level meter (SLM) to take your initial measurements of the noise levels generated by the rivet guns being used.

You anticipate that you may need to perform an octave band survey to collect more data at the construction site. The readings from the initial source survey indicated that the sound pressure levels (SPLs) in the middle of the hangar are 95 dB(A). Based on this reading, should you conduct an octave band survey?

A Yes

B No

When to Conduct an Octave Band Survey (Page 6a of 13)

Once an initial noise source survey has been conducted and the levels are determined to be potentially hazardous, engineering controls should be considered. At that point, your follow-up actions may include performing an octave band survey, sometimes referred to as an engineering noise survey.

If you find that the 8-hour time weighted average (TWA) is above 94 dB(A), conducting an octave band survey is the preferred course of action.

There are no limits for unprotected noise exposures <80 dB(A). However, 80 to 85 dB(A) exposures have time-weighted limitations. Exposures of more than 12 hours should be followed by periods of equal length in quiet [less than 72 dB(A)]. Therefore, situations may occur where octave band surveys help contribute to an assessment for finding ways to reduce exposure (e.g., engineering controls).

Mount Bolanos Air Base Scenario (Page 7 of 13)

You return to the BE shop to prepare to conduct the octave band survey.

When you arrive at the BE shop, you discover that SrA Jeans is preparing to conduct an octave band survey at a different location on base.

Audio Script

BE Tech (SrA): I'm glad you're here. I'm working on putting this octave band survey together and I have a couple of questions.

BE Tech: I'm working on one too. What can I help you with?

BE Tech (SrA): We'll, I've completed the pre-survey process and determined that an octave band survey is needed, but I don't know where to go from there.

BE Tech: The first thing you'll want to do is to pre-calibrate and perform an operational check on the sound level meter in the octave band analyzer mode. The actual techniques required for the octave band survey are similar to the initial noise survey that you've already performed.

Scenario Challenge Point (Page 8 of 13)

Before you conclude your conversation with SrA Jeans, you point out that, while the goal of the initial survey is to identify noise health threats, the goal of the octave band survey is to identify the best control available. Build a list of the four tasks you advise SrA Jeans to complete as part of the octave band survey.

Word Bank	List
Recommend appropriated controls	______________________
Calculate hearing protector attenuation values	______________________
Post-calibrate the octave band survey equipment	______________________
Interview the personnel working at the site	______________________
Perform an operation check on the equipment	
Determine which octave bands will be surveyed	

Octave Band Survey Process (Page 8a of 13)

Once the pre-analysis has occurred and you've determined that an octave band survey is needed, use the following steps to ensure that octave band survey data is accurate.

1. Pre-calibrate the sound meter equipment.
2. **Perform an operational check of the equipment** (i.e., the meter responds to noise in the environment).

3. On-site, use the same technique as an initial noise survey when taking measurements. Instead of taking just the dB(A) measurements, you should take the dB(A) and dB flat measurements. Also, take measurements for each of the **8 octave bands between 63 Hz and 8000 Hz**. If your instrument has the capability to measure 31.5 Hz and 16K Hz, it can be beneficial to include these extreme frequencies as well.
4. **Post-calibrate the equipment** after returning to the BE Shop.
5. Once you have the readings, you should begin your analysis by **calculating hearing protector attenuation values** for worker's hearing protection.
6. After analyzing the data, you can **recommend specific controls.** -calibrate the sound meter equipment.

Perform an Operational Check of the Equipment

An operational check of the equipment should be conducted to ensure that it is in good working order. An operational check can be as simple as noticing that the meter responds to noises in the immediate environment, such as conversations. You should also make sure that you have all of the required equipment before leaving the BE shop.

Octave Bands Between 63 Hz and 8000 Hz

The nominal center frequency and frequency ranges for the eight octave bands required in an octave band survey are shown below**.**

Nominal Center Frequency	Frequency Range (Band Limits)
63 Hz	44.6 – 89.2
125 Hz	89.0 – 178.0
250 Hz	177.6 – 355.2
500 Hz	354.3 – 708.8
1000 Hz	707.1 – 1414.2
2000 Hz	1410.9 – 2821.7
4000 Hz	2815.0 – 5630.1
8000 Hz	5616.7 – 11233.5

Post-Calibrate the Equipment

It is important to post-calibrate your equipment because the octave band analyzer may have been damaged during use. You need to have confidence the calibration settings did not change during operation.

Calculate Hearing Protector Attenuation Values

You can calculate hearing protector attenuation values by subtracting two standard deviations from the manufacturer's mean attenuation values for the at-the-ear noise level calculation. The estimated at-the-ear sound levels at each octave band are then compared to the A-weighting scale and added logarithmically for the total A-weighted sound pressure level.

Recommend Specific Controls

Engineering controls are the first choice to reduce hazardous noise exposures. Due to cost and design limitations associated with some engineering control solutions, administrative controls and/or the use of personal protective equipment may be necessary.

Mount Bolanos Air Base Scenario (Page 9 of 13)

After conducting the octave band survey, you recommend the appropriate controls to the shop supervisor. The recommendations are accepted and workers are issued new hearing protection devices that specifically address the health threats caused by the rivet guns.

Variations of the Octave Band Survey Process (Page 10 of 13)

In general, the process for performing an octave band survey remains the same from situation to situation. However, for each survey you conduct in the future, you should consider the environment in which you will be surveying.

If you are conducting a noise survey outside in windy conditions or near a fan, you may need to use a wind screen on the equipment to ensure that moving air doesn't disrupt the diaphragm of the SLM.

Some instruments have the capability to measure 31.5 Hz and 16 kHz, which can be beneficial in situations where extreme frequencies are produced. For example, noise radiated into a building by aircraft engines running on the ground nearby can most effectively be controlled using active noise control (ANC) because of the low frequencies produced.

Audiometric Booth Surveys (Page 11 of 13)

Certifying the audiometric booth test environment is a BE responsibility in support of the Base Hearing Conservation Program (HCP) to determine what the background noise levels are inside the booth. The audiometric booth survey is an octave band survey which is performed using equipment conforming at least to **Type 1 and Order 3 requirements** of the latest approved ANSI Standard. Measurements of the background SPLs in the audiometric test room must be taken annually.

The primary difference between a typical octave band survey and an audiometric booth survey is that the audiometric booth survey only surveys five of the eight octave bands. Each octave band has a maximum level that is allowed before further action must be taken to attempt to bring the measured levels to acceptable levels.

Audiometric testing must be performed by licensed or certified personnel and conducted in a certified testing environment with background octave band SPLs not greater than the levels shown below, IAW AFOSH Std 48-20.

Type I and Order 3 Requirements

Type I requirements are taken from the latest approved ANSI Standards S1.4A to S1.4-1983. The Order 3 extended range requirements are based on the latest approved ANSI Standard S1.11-1993.

Audiometric Booth Survey Octaves and Maximum Levels					
Frequency (Hz)	500	1000	2000	4000	8000
Maximum Level (dB)	27	29	34	39	41

Appraisal (Page 12 of 13)

How often are audiometric booth surveys required?

A Quarterly

B Every 6 months

C Annually

D Every 3 years

Lesson Summary (Page 13 of 13)

Interpreting noise survey results and conducting octave band noise surveys are important skills used to recommend appropriate controls to protect exposed personnel.

In this lesson you:

- Recalled the relationship of results to standards, mission, and effects.
- Compared noise survey results to standards for a given scenario.
- Recalled the purpose of octave band noise surveys.
- Described the process for performing octave band noise surveys.
- Identified variations in octave band noise survey processes, including audiometric booth surveys.
-

Audio Script

Narrator: Now that you have worked through the process of performing an octave band noise survey for Mount Bolanos Air Base, you are better equipped to perform such surveys in the future.

Lesson 3: Noise Health Threat Control Options

Lesson Description

Work has begun to demolish an abandoned runway on Chuuk Island to prepare for new construction. Personnel have been using large pneumatic jackhammers to break up the concrete, and you need to evaluate the effectiveness of the hearing protection they are using. Upon completion of his lesson, you will be able to develop noise health threat control options for a given scenario.

Lesson Overview (Page 1 of 13)

While developing noise health threat control options for the construction workers, you will:

- Recall effectiveness of control methods at source, path, and receiver.
- Select appropriate HPD, given noise health threats and equipment limitations.
- Determine if HPD for noise health threats is used and maintained in accordance with established guidelines.

Audio Script

Narrator: Part of your routine includes visiting construction sites to ensure that workers are wearing the proper hearing protection for the jobs they are performing. When you arrive at the site where workers are breaking up an abandoned runway using pneumatic jackhammers, you notice they are wearing a potentially ineffective type of HPD.

Mount Bolanos AB Scenario (Page 2 of 13)

While you're at the site, you speak with the supervisor about your concerns regarding the type of noise protection being worn.

Audio Script

Supervisor: What brings you out today?

BE Tech: Well, I was just on a routine visit to the site to check the noise levels of the equipment. I think there may be a problem with the type of HPD the workers are wearing while they're using jackhammers.

Supervisor: What's the problem?

BE Tech: The workers are wearing ear plugs, but, with the level of noise I suspect they're being exposed to, I think they need double hearing protection. I'll need to get some more information and determine which earmuffs they should use with those plugs.

Supervisor: Okay, let me know what you find out.

Effectiveness of Control Methods (Page 3 of 13)

When recommending controls for noise health threats, keep in mind that there are three areas in which controls can be applied and that the effectiveness of controls is heavily dependent on frequency. As always, you should remember the hierarchy of controls, with engineering controls being the most desirable because it mitigates the threat at the source. Select each tab to learn about controlling noise health threats at the source, in the path, and at the receiver.

Tab: Source

Controlling a health threat at the source is the most desirable method because it decreases the possibility that personnel can be exposed to the threat due to incorrect HPD use or accidental exposure. Engineering controls used for noise health threats include:

- **Process substitution.**
- **Product substitution.**
- **Machine treatments.**

Process Substitution

Process substitution includes process elimination, substitution of materials, process changes, or design changes for processes that contribute to noise health threats.

Examples of noise-reduction methods using process substitution include:

- Use of quieter materials whenever possible (such as hot rather than cold metals).
- Welding instead of riveting.
- Compression riveting instead of pneumatic riveting.
- Use of electric tools instead of pneumatic tools.
- Grinding instead of chipping.
- Mechanical forging instead of drop forging.
- Use of conveyers instead of chutes.
- Use of belt or screw drives instead of gear drives.

Product Substitution

When new equipment is being considered or purchased, it must have the lowest noise levels that are technologically and economically feasible. Newer and quieter equipment, as reported by the manufacturer, does not replace the need for you to perform your own readings on the equipment; however, manufacturer information can assist you with making recommendations to decision-makers about what to purchase.

When it is deemed necessary to replace good but noisy equipment, there may also be advantages other than lower sound levels that help outweigh the expense. The newer equipment might be more productive, consume less energy, or provide better quality control.

Machine Treatments

In addition to regular and appropriate repair and maintenance, machine treatments should be considered to reduce vibration of the equipment. This is an important option which is often neglected until a noise problem becomes severe. Malfunctioning or poorly maintained equipment sometimes makes more noise than properly maintained equipment. There are three methods for treating machines to reduce the noise being produced.

- Reduce the driving force of the machine by adjusting the rotational forces, replacing worn parts, balancing, alignment, or lubrication.
- Isolate the responding surface when modification to the driving force is not practical. Use strategies such as installing metal machine guards, grilles, and equipment casings to increase the isolation of the machine.
- Reduce surface response by increasing the mass of the surface to cut down on vibration. Materials with greater thickness or density vibrate much less.

Tab: Path

If controlling the noise at the source is not a possibility, you should control the noise in the path. This is the most common method for controlling noise.

Common engineering methods used to control noise in the path include shields and barriers, enclosures, and room treatments. The primary administrative methods used for controlling noise though the pathway are equipment labeling and controlling the distance or direction from the source.

When controlling noise in the path, you should consider:

- **The distance between the source and the receiver.**
- **The sound absorption properties within a given space.**
- **Impact of proposed sound absorbent materials on a given space.**

The Distance Between the Source and the Receiver

When controlling noise in the path, it's important to identify the distance from the noise source where the noise levels become constant. This distance, known as the critical distance, helps determine which workers or workstation would benefit by more sound absorbent materials.

Although you will not be calculating the critical distance in this course, you may want to be aware of the formula used to determine it:

$$d_c = \sqrt{}RQ\ /16\ \pi$$

Where:
R = room constant
Q = directivity factor

The Sound Absorption Properties Within a Given Space

When evaluating noise controls in an area, you should consider the feasibility of controlling noise health threats based on room dimensions and the materials used for the interior walls, floor, and ceiling. The method used to measure the amount of sound absorption that exists within a given space is known as the room constant (R).

Although you will not be calculating the room constant (R) in this course, it may be helpful for you to be aware of how it is done. First, you should determine the average room absorption for the space you are evaluating. The average room absorption ($\bar{a}$) is calculated using the following formula:

$$\frac{A_1 a_1 + A_2 a_2 + \ldots A_n a_n}{A_1 + A_2 + \ldots A_n}$$

Where:
A = The surface area of a room for each material used. (expressed in square feet or square meters)

a = Sound absorption coefficients.

Once you have calculated the average room absorption (ɑ), you can calculate the room constant (R) using the following formula:

$$R = \frac{\bar{a} A_t}{1 - \bar{a}}$$

Where:
A_t = sum of all room surface areas
$\bar{a}$ = Average room absorption

Impact of Proposed Sound Absorbent Materials on a Given Space

Every material has certain sound-absorbing properties, which are expressed as absorption coefficients (ɑ).

The method used for predicting the impact of various absorbents on noise reduction using the absorption coefficients is the Noise Reduction calculation. The formula for performing this calculation is shown below; however, you will not be using the Noise Reduction calculation in this course.

$$NR = 10 \log \frac{R_{proposed}}{R_{existing}}$$

Where:
R = Room Constant

Receiver

Controlling noise health threats at the receiver is the least reliable and least permanent solution because it relies on worker behavior. One way to control noise health threats at the receiver is to move the source of operation so the receiver is farther away from the source. Other methods include administrative controls such as:

- Labeling of areas and equipment.
- Worker rotation.
- Training.

If all other options are not effective or plausible, the use of HPD should be considered. HPD used for noise health threats include ear muffs, ear plugs, and other sound-attenuating devices.

Relocating the Noise Source (Page 4 of 13)

As you evaluate noise health threats, you may determine that the most appropriate course of action for controlling the health threat is to relocate the noise source. Before relocating the source, you need to ensure that the new area will be conducive for keeping the noise levels at the receiver within permissible limits.

Keep in mind the inverse square properties of noise when you evaluate where to relocate a noise source. For example, as distance from a noise source increases, the noise levels decrease.

The following formula is used to describe this inverse relationship and estimate the distance required to reduce the noise to 85 dBA.

$$d_2 = d_1 \times 10^{(dB_1 - dB_2)/20}$$

Where:
d_2 = distance to the desired dBA level (typically 85 dBA)
dB_1 = measured level dBA
d_1 = distance where level dB_1 was measured
dB_2 = desired sound level at d_2 (typically 85 dBA)

Once you have decided to relocate a noise source, you should also consider how the properties of the new environment will impact noise levels. For example, if you decide to move a piece of equipment indoors, you may need to analyze the sound absorption of the new space to determine if moving the source will create a noise health threat to personnel in the new area.

Equipment Relocation Practice (Page 5 of 13)

While conducting a routine HRA at a shop on base, you determine that you may need to relocate an air compressor to another location due to noise levels that exceed permissible limits. You measure the noise levels at 94 dBA at 4 feet from the source. Estimate the distance required (to the nearest hundredth) to reduce noise levels from the air compressor to 85 dBA.

$$d_2 = d_1 \times 10^{(dB_1 - dB_2)/20}$$

Where:
d_2 = distance to the desired dBA level (typically 85 dBA)
dB_1 = measured level dBA
d_1 = distance where level dB_1 was measured
dB_2 = desired sound level at d_2 (typically 85 dBA)

$$\_\_\_.\_\_\_ \text{ ft} = \_\_\_ \text{ ft} \times 10^{(\_\_\_ \text{ dBa} - \_\_\_ \text{ dBa})/20}$$

Appraisal (Page 6 of 13)

Following are several questions to check your knowledge of controlling noise health threats. Select the correct answer for each question.

Which one of the following controls would be appropriate for controlling noise at the source?

A Shields and barriers

B Machine treatments

C Worker rotation

Which one of the following controls would be appropriate for controlling noise in the path?

A Shields and barriers

B Machine treatments

C Worker rotation

Which one of the following controls would be appropriate for controlling noise at the receiver?

A Shields and barriers

B Machine treatments

C Worker rotation

Which one of the following describes the distance from the noise source where the noise levels become constant?

A Directivity Factor

B Critical Distance

C Room Constant

Which one of the following describes the amount of sound absorption that exists within a given space?

A Room Constant

B Average Room Absorption

C Sound Absorpti0on Coefficients

Which of the following statements is true regarding the relationship between noise levels and distance?

A As the distance decreases, the noise levels decrease.

B As the distance increases, the noise levels increase.

C As the distance increases, the noise levels decrease.

Scenario Challenge Point (Page 7 of 13)

After speaking with the site supervisor, you make your way to where the workers are demolishing the runway, and you use your survey equipment to conduct an initial noise survey. Based on those results, you return the next day to record the employees' full-shift exposure levels. You find that the 8-hour TWA is 99 dB(A).

Using your findings, you need to determine the appropriate type of HPD for personnel using the jackhammers. Which method should you use?

A Noise Attenuation Method

B Octave Band Method

C C-A Calculation

D Noise Reduction Rating

Noise Health Threat HPD Selection (Page 7a of 13)

When selecting appropriate HPD for noise protection, you should consider the limitations of HPD and how to obtain data needed to select the appropriate equipment. When using HPD selection methods, remember to compare the attenuation ratings to the Air Force criterion of 85 dB(A). Select each tab to learn about the HPD selection methods.

Tab: Noise Protection Limitations

The most important limitation of HPDs is that the effectiveness of the control relies on the worker's strict adherence to the proper wear, maintenance, and care of the HPD. In order for HPDs to be effective, workers must know exactly when and where to use them; what protection devices are needed; and how to clean, maintain, and properly store them.

Limitations also include the frequencies for which a particular HPD is effective. When determining if a particular piece of equipment is designed to protect against the identified health threat, you can refer to the manufacturer's information, if available, in addition to Air Force references such as the Air Force Research Laboratory (AFRL) list.

It's also important to avoid overprotection. Excessive attenuation may cause the worker distress, resulting in non-compliance with wear of the HPDs. If HPDs are recommended, the ear level exposure is recommended to remain between 76 and 84 dB(A) per 8 hour exposure, IAW AFOSH Std 48-20 paragraph 5.7.

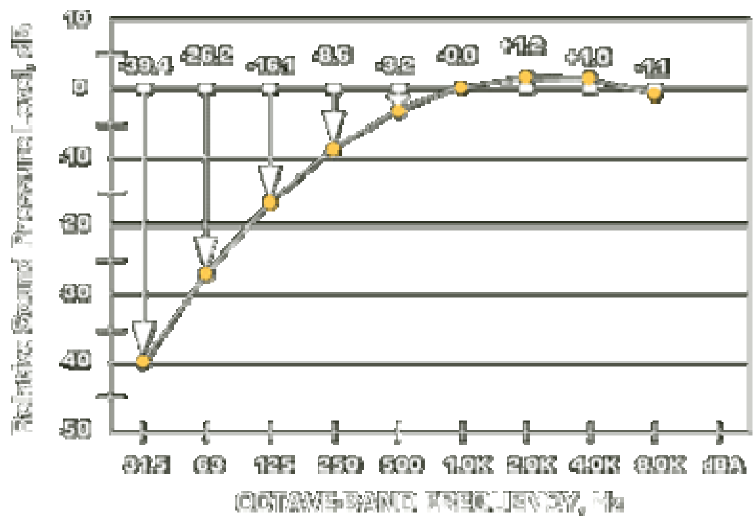
Tab: Octave Band HPD Selection Method

The Octave Band Method is the preferred method to calculate HPD noise attenuation when the 8-hour TWA exceeds 94 dB(A). This method involves calculating attenuated sound levels at each octave band, given a particular HPD, and will allow you to determine if that equipment will provide the required protection at a specified frequency. You will use the following steps to determine the overall attenuation using the octave band method:

1. List the results from your octave band analysis (OBA).
2. List the HPD mean attenuation from the manufacturer's literature (product container or website) or NIOSH website.
3. List the HPD standard deviation from the manufacturer's literature or NIOSH website.
4. Multiply the standard deviation by 2 (Step 3 x 2).
5. Adjust the mean attenuation (Step 2 – Step 4).
6. Adjust the readings (Step 1 – Step 5).
7. List the **A-Weighted Corrections**. These factors are used to convert to the A-weighted scale for each octave band and can be found in resources like the NIOSH Hearing Protector Device Compendium.
8. List the A-weighted attenuation noise (Step 6+Step 7).
9. Obtain the overall attenuation using the following formula:

$$SPL = 10\log\left[10^{\left(\frac{SPL_1}{10}\right)} + 10^{\left(\frac{SPL_2}{10}\right)} + \ldots 10^{\left(\frac{SPL_n}{10}\right)}\right]$$

A-Weighted Curve



Tab: Noise Reduction Rating (NRR) HPD Selection Method

The Noise Reduction Rating (NRR) is the preferred method for estimating HPD noise attenuation when the 8-hour TWA is less than 94 dB(A). The NRR is an attempt to describe hearing protection through a single number and simplify complex attenuation data for the general pubic by making it an EPA requirement for manufacturers of hearing protection.

The NRR assumes that there are equal noise levels in each octave band.

To use the NRR method, follow these steps:

- Locate the NRR for the hearing protection device which you are evaluating, usually found in the manufacturer's literature, from the AFRL, or on the NIOSH website.
- Insert the NRR and the SPL into the following calculation and solve the problem:
- [SPL] in dB(A)-(NRR-7 dB)=presumed exposure
- Compare your results to the standards included in AFOSH 48-20 which requires an attenuation value below 85 dB(A).

Octave Band HPD Selection Method (Page 8 of 13)

After conducting an OBA, you'll use the results to select appropriate HPD for the jackhammer operators using the Octave Band Method. Make sure you have a **scientific calculator** available.

Scientific Calculator

If you do not have a scientific calculator with you, you can use the Windows calculator provided in the Accessories folder. The default settings can be changed to show a scientific calculator by selecting *View>Scientific* from the menu bar.

Step 1

You believe the Bilsom 822 II NST Earmuffs may be appropriate for the jackhammer operators to use, but you need to work through the octave band HPD selection method to be sure. First, you list the results from your octave band analysis, as shown.

Step		*125*	*250*	*500*	*1K*	*2K*	*4K*	*8K*	*dB(X)*
1	Your OBA results	88	91	96	98	100	102	101	107 dB (F)

Step 2

Next, you consult manufacturer's literature for the Bilsom 822 II NST Earmuffs and list the HPD mean attenuation values from the manufacturer's literature, as shown.

Step		*125*	*250*	*500*	*1K*	*2K*	*4K*	*8K*	*dB(X)*
1	Your OBA results	88	91	96	98	100	102	101	107 dB (F)
2	Manufacturer's mean attenuation	18.2	25.1	29	29.7	29.4	30.6	31.9	

Step 3

You also consult the manufacturer's literature to list the HPD standard deviation, as shown.

Step		*125*	*250*	*500*	*1K*	*2K*	*4K*	*8K*	*dB(X)*
1	Your OBA results	88	91	96	98	100	102	101	107 dB (F)
2	Manufacturer's mean attenuation	18.2	25.1	29	29.7	29.4	30.6	31.9	
3	Manufacturer's HPD standard	2.7	3	2.6	2.1	2	2.2	2.2	

Step 4

Next, you double the standard deviation for each octave band. Complete each calculation for Step 4 by multiplying Step 3 by the number 2 and entering your responses in the table.

Step		*125*	*250*	*500*	*1K*	*2K*	*4K*	*8K*	*dB(X)*
1	Your OBA results	88	91	96	98	100	102	101	107 dB (F)
2	Manufacturer's mean attenuation	18.2	25.1	29	29.7	29.4	30.6	31.9	
3	Manufacturer's HPD standard	2.7	3	2.6	2.1	2	2.2	2.2	
4	Adjusted Standard Deviation	5.4	_._	_._	_._	_._	_._	_._	

Step 5

Then you adjust the mean attenuation for each octave band. Complete each calculation for Step 5 by subtracting Step 4 from Step 2. The first one has been done for you.

Step		*125*	*250*	*500*	*1K*	*2K*	*4K*	*8K*	*dB(X)*
1	Your OBA results	88	91	96	98	100	102	101	107 dB (F)
2	Manufacturer’s mean attenuation	18.2	25.1	29	29.7	29.4	30.6	31.9	
3	Manufacturer’s HPD standard	2.7	3	2.6	2.1	2	2.2	2.2	
4	Adjusted Standard Deviation	5.4	6	5.2	4.2	4	4.4	4.4	
5	Adjusted Mean Attenuation	12.8	_._	_._	_._	_._	_._	_._	

Step 6

Next, your readings must be adjusted by subtracting the adjusted mean attenuation from the OBA results for each octave band. Complete each calculation for Step 6 by subtracting Step 5 from Step 1. The first one has been done for you.

Step		*125*	*250*	*500*	*1K*	*2K*	*4K*	*8K*	*dB(X)*
1	Your OBA results	88	91	96	98	100	102	101	107 dB (F)
2	Manufacturer’s mean attenuation	18.2	25.1	29	29.7	29.4	30.6	31.9	
3	Manufacturer’s HPD standard	2.7	3	2.6	2.1	2	2.2	2.2	
4	Adjusted Standard Deviation	5.4	6	5.2	4.2	4	4.4	4.4	
5	Adjusted Mean Attenuation	12.8	19.1	23.8	25.5	25.4	26.2	27.5	
6	Adjusted Readings	75.2	__._	__._	__._	__._	__._	__._	

Step 7

Next, you list the A-weighted corrections, as shown.

Step		*125*	*250*	*500*	*1K*	*2K*	*4K*	*8K*	*dB(X)*
1	Your OBA results	88	91	96	98	100	102	101	107 dB (F)
2	Manufacturer’s mean attenuation	18.2	25.1	29	29.7	29.4	30.6	31.9	
3	Manufacturer’s HPD standard	2.7	3	2.6	2.1	2	2.2	2.2	
4	Adjusted Standard Deviation	5.4	6	5.2	4.2	4	4.4	4.4	
5	Adjusted Mean Attenuation	12.8	19.1	23.8	25.5	25.4	26.2	27.5	
6	Adjusted Readings	75.2	71.9	72.2	72.5	74.6	75.8	73.8	82.4dB (A)
7	A-Weighted Corrections	-6.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	

Step 8

You use the A-weighted corrections to find the A-weighted attenuation noise. Complete each calculation for Step 8 by adding Step 6 and Step 7. The first one has been done for you.

	Step	125	250	500	1K	2K	4K	8K	dB(X)
1	Your OBA results	88	91	96	98	100	102	101	107 dB (F)
2	Manufacturer's mean attenuation	18.2	25.1	29	29.7	29.4	30.6	31.9	
3	Manufacturer's HPD standard	2.7	3	2.6	2.1	2	2.2	2.2	
4	Adjusted Standard Deviation	5.4	6	5.2	4.2	4	4.4	4.4	
5	Adjusted Mean Attenuation	12.8	19.1	23.8	25.5	25.4	26.2	27.5	
6	Adjusted Readings	75.2	71.9	72.2	72.5	74.6	75.8	73.8	82.4dB (A)
7	A-Weighted Corrections	-6.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
8	A-Weighted Attenuated Noise	59.1	__._	__._	__._	__._	__._	__._	

Step 9

Finally, you obtain the overall attenuation. Complete the calculation for Step 9 and type your answer in the input field.

$$SPL = 10\log\left[10^{\left(\frac{SPL_1}{10}\right)} + 10^{\left(\frac{SPL_2}{10}\right)} + \ldots 10^{\left(\frac{SPL_n}{10}\right)}\right]$$

	Step	125	250	500	1K	2K	4K	8K	dB(X)
1	Your OBA results	88	91	96	98	100	102	101	107 dB (F)
2	Manufacturer's mean attenuation	18.2	25.1	29	29.7	29.4	30.6	31.9	
3	Manufacturer's HPD standard	2.7	3	2.6	2.1	2	2.2	2.2	
4	Adjusted Standard Deviation	5.4	6	5.2	4.2	4	4.4	4.4	
5	Adjusted Mean Attenuation	12.8	19.1	23.8	25.5	25.4	26.2	27.5	
6	Adjusted Readings	75.2	71.9	72.2	72.5	74.6	75.8	73.8	82.4dB (A)
7	A-Weighted Corrections	-6.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
8	A-Weighted Attenuated Noise	59.1	63.3	69	72.5	75.8	76.8	72.4	
9	Overall Sound Level with HPD								__._ dB(A)

Noise Reduction Rating (NRR) Selection Method Practice (Page 9 of 13)

Remember that when the 8-hour TWA is less than 94 dB(A), the NRR HPD Selection Method is preferred for estimating HPD noise attenuation. The exercise below will walk you through selecting appropriate HPDs using the NRR Method.

Step 1
Locate the NRR for the hearing protection device which you are evaluating. In this example, you will be evaluating the Peltor Tactical 6-S electronic headset, which has an NRR of 19 dB. The SPL for this example is 92 dB(A).

Step 2
Insert the NRR and the SPL into the following calculation and solve:

SPL in dB(A) - (NRR - 7 dB) = presumed Exposed Noise Level (ENL)

__._ dB(A) - (__._- 7 dB) = __._ dB(A)

Step 3
Compare your results to the criterion in AFOSH Std 48-20 which requires an attenuation value below 85 dB(A).

Step 4
Based on the calculations and your comparison to the standard, determine whether the selected HPD in this example is adequate.

A The HPD is adequate

B The HPD is NOT adequate

Appraisal (Page 10 of 13)

Using the appropriate HPD selection method, build a list of HPD that would be appropriate for a shop that had an SPL 8-hour TWA of 89 dB(A).

Word Bank	List
David Clark 310 with an NRR of 20	______________________
Bilsom 707 with an NRR of 23	______________________
Westone 42 with an NRR of 10	______________________
E.A.R Ultratech 12 with an NRR of 12	
Sonomax sonocustom with an NRR of 9	
E.A.R. Ulstra 9000 with an NRR of 16	

Mount Bolanos AB Scenario (Page 11 of 13)

By using the Octave Band Method, you determine that the Bilsom 822 II NST earmuffs are an appropriate type of HPD for personnel using the jackhammers at the Global Command Center construction site.

After recommending the earmuffs, you conduct training with the workers so they will be well-informed about the appropriate use and maintenance of the HPD. You instruct each worker on the proper way to wear the earmuffs in conjunction with the hardhats and safety glasses already being worn.

Some workers from a different site have also been invited to the training session. These workers primarily use earplugs when performing their tasks, so you take time to explain and demonstrate the proper way to insert earplugs.

Scenario Challenge Point (Page 12 of 13)

Which two of the following situations are examples of INCORRECT use or maintenance of HPD?

A Operation of a jackhammer without HPD

B Wearing a hardhat equipped with ear muffs

C Wearing ear muffs that completely cover the ears

D Wearing ear muffs that do not cover the ears

Use and Maintenance of Hearing Protection Devices (Page 12a of 13)

When visiting a worksite, you may encounter situations where the proper noise HPD has been issued, but personnel are not wearing it correctly because it is uncomfortable or doesn't fit properly.

HPDs can only protect personnel if they are used and maintained according to Public Health guidelines and manufacturer's specifications. Hearing protection should be stored in a clean and dry place. Fitted plugs and muffs can be cleaned with mild soap and water. Damaged or worn cushions should be replaced.

There are many things that should be **considered** when evaluating if HPD is used and maintained appropriately.

HPD Considerations

When addressing HPD, consider:

- Does it fit personnel correctly?
- Are earplugs inserted in the ear properly?
- Have ear muffs been adjusted to accommodate a hardhat while properly sealing over the ear?
- Has the HPD been left out in the sun or lying on a piece of equipment to get dirty or greasy?
- Has the HPD been cleaned and checked prior to use?

Lesson Summary (Page 13 of 13)

You've learned that developing noise health threat control options is based on specific noise health threats and limitations of controls. Remember to always use the hierarchy of controls when communicating your control recommendations to decision-makers.

In this lesson you:

- Recalled effectiveness of control methods at source, path, and receiver.
- Selected appropriate HPD, given noise health threats and equipment limitations.
- Determined if HPD for noise health threats is used and maintained in accordance with established guidelines.

Audio Script

Narrator: You and the supervisor meet with the workers and review the information you provided in their training. After the meeting, you observe the workers properly wearing the HPD, and you feel confident that the health threat is sufficiently controlled.

Resources

- Bioenvironmental Engineering Field Manual
- AFOSH Std 48-20 Occupational Noise and Hearing Conservation Program
- ANSI S1.4-1983 (R1977) SLM Weighting Curves
- *The Noise Manual*, 5th Edition, AIHA, 2003
- NIOSH Hearing Protector Device Compendium

Answer Key: Appraisals / Scenario Challenge Points

Lesson 1: Hazardous Noise

Page 3 of 8

Before collecting the data, you consider the various ways that noise from the machine may affect the operator. Match each description with the appropriate noise pathway by marking the appropriate block in the table.

Descriptions	Direct Noise Pathway	Indirect Noise Pathway	Reflective Noise Pathway
Sound waves are transmitted to the receiver after rebounding from other surfaces.			X
Sound waves are transmitted to the receiver straight from the source.	X		
Sound waves are transmitted to the receiver through the air after vibrations from the source travel through a solid.		X	

Rationale: Direct noise is transmitted directly from the source to the receiver. Indirect noise is transmitted when vibrations from the source travel through a solid and are then transmitted through the air to the receiver. Reflective noise is transmitted when sound waves rebound from other surfaces and then travel to the receiver.

Page 6 of 8

According to AFOSH Std 48-20, which of the following is NOT a criterion for determining if a noise source or area should be considered hazardous?

Multiple-source noise levels above 120 dB

Rationale: A hazardous noise area is any area where personnel could be exposed to an 8-hour continuous sound level greater than 85 dB(A), continuous or intermittent noise above 115 dB, or peak sound pressure levels above 140 dB.

Page 7 of 8

The surface grinder is designed to be operated only when bearings need to be adjusted. While the machine was in use, the sound pressure levels reached 125 dB(A) at the operator’s position. Based on this information, should the machine and the room in which it is used be classified as hazardous?

A Yes

Rationale: The sound pressure levels reached 125 dB(A) at the operator's position. Even though the machine will only be operated when needed, the source and area around the machine should be considered hazardous because the noise levels exceed the 115 dB threshold for continuous or intermittent noise.

Lesson 2: Octave Band Noise Surveys

Page 3 of 13

In order to maintain the safety of personnel and accomplish mission objectives, which one of the following standards does the Air Force use as an indicator of acceptable noise levels?

C Not to exceed 85 dB(A) over 8 hours

Rationale: The standard that the Air Force uses as an indicator of acceptable noise levels is 85 dB(A). In other words, the allowable time for an 85 dB(A) exposure is 8 hours.

Page 5 of 13

Which two of the following are purposes of an octave band survey?

C Monitor noise levels to evaluate the whole body effects of sound.

D Monitor noise levels in rooms used for audiometric testing.

Rationale: The octave band survey is used to monitor background levels in rooms used for audiometric testing and to evaluate the whole body effects of sound. It is not used to monitor noise levels only at operators' positions or to ensure that certain frequencies are not produced.

Page 6 of 13

The readings from the initial source survey indicated that the sound pressure levels (SPLs) in the middle of the hangar are 95 dB(A). Based on this reading, should you conduct an octave band survey?

A Yes

Rationale: If the initial surveying equipment records a reading of 94 dB(A) or higher, performing an octave band survey is the preferred course of action.

Page 8 of 13

Before you conclude your conversation with SrA Jeans, you point out that, while the goal of the initial survey is to identify noise health threats, the goal of the octave band survey is to identify the best control available. Build a list of the four tasks you advise SrA Jeans to complete as part of the octave band survey.

Answers
Recommend appropriate controls
Post-calibrate the octave band survey equipment
Calculate hearing protector attenuation values
Perform an operation check on the equipment

Rationale: You should perform an operation check on the equipment prior to leaving the shop to go to the site. When returning to the BE shop after working on an octave band survey, you should post-calibrate the equipment, calculate hearing protector attenuation values for worker's hearing protection, and recommend the appropriate controls. Interviewing personnel and determining which octave bands will be surveyed are not part of the octave band survey process.

Page 12 of 13

How often are audiometric booth surveys required?

C Annually

Rationale: The audiometric booth test is an octave band survey which is performed annually to determine what the background noise levels are inside the booth.

Lesson 3: Noise Health Threat Control Options

Page 5 of 13

While conducting a routine HRA at a shop on base, you determine that you may need to relocate an air compressor to another location due to noise levels that exceed permissible limits. You measure the noise levels at 94 dBA at 4 feet from the source. Estimate the distance required (to the nearest hundredth) to reduce noise levels from the air compressor to 85 dBA.

$$d_2 = d_1 \times 10^{(dB_1 - dB_2)/20}$$

Where:
d_2 = distance to the desired dBA level (typically 85 dBA)
dB_1 = measured level dBA
d_1 = distance where level dB_1 was measured
dB_2 = desired sound level at d_2 (typically 85 dBA)

$$\mathbf{11.27}\text{ ft} = \mathbf{4}\text{ ft} \times 10^{(\mathbf{94}\text{ dBa} - \mathbf{85}\text{ dBa})/20}$$

Rational: To arrive at this answer, you should follow the steps shown below:

94-85 = 9

9/20 = 0.45

4 x 10 x^y 0.45 = 11.27

The distance required to reduce the noise levels to 85 dBA is 11.27 feet.

Page 6 of 13

Which one of the following controls would be appropriate for controlling noise at the source?

B Machine treatments

Rationale: Machine treatments can reduce vibrations, thus controlling noise at the source.

Which one of the following controls would be appropriate for controlling noise in the path?

A Shields and barriers

Rationale: Shields and barriers control noise in the path.

Which one of the following controls would be appropriate for controlling noise at the receiver?

C Worker rotation

Rationale: Noise at the receiver can be controlled by worker rotation.

Which one of the following describes the distance from the noise source where the noise levels become constant?

B Critical Distance

Rationale: The critical distance describes the distance from the noise source where the noise levels become constant.

Which one of the following describes the amount of sound absorption that exists within a given space?

A Room Constant

Rationale: The room constant describes the amount of sound absorption that exists within a given space.

Which of the following statements is true regarding the relationship between noise levels and distance?

C As the distance increases, the noise levels decrease.

Rationale: As a general rule, as the distance from a noise source increases, the noise levels decrease.

Page 7 of 13

After speaking with the site supervisor, you make your way to where the workers are demolishing the runway, and you use your survey equipment to conduct an initial noise survey. Based on those results, you return the next day to record the employees' full-shift exposure levels. You find that the 8-hour TWA is 99 dB(A).

Using your findings, you need to determine the appropriate type of HPD for personnel using the jackhammers. Which method should you use?

B Octave Band Method

Rationale: The Octave Band Method is the preferred method to calculate HPD noise attenuation when the 8-hour TWA exceeds 94 dB(A). The Noise Reduction Rating (NRR) is the preferred method for estimating HPD noise attenuation when the 8-hour TWA is less than 94 dB(A). The C-A method is not recommended for use.

Page 8 of 13

Step 4

Next, you double the standard deviation for each octave band. Complete each calculation for Step 4 by multiplying Step 3 by the number 2 and typing your responses in the table.

	Step	*125*	*250*	*500*	*1K*	*2K*	*4K*	*8K*	*dB(X)*
1	Your OBA results	88	91	96	98	100	102	101	107 dB (F)
2	Manufacturer’s mean attenuation	18.2	25.1	29	29.7	29.4	30.6	31.9	
3	Manufacturer’s HPD standard	2.7	3	2.6	2.1	2	2.2	2.2	
4	Adjusted Standard Deviation	5.4	**6**	**5.2**	**4.2**	**4**	**4.4**	**4.4**	

Step 5

Then you adjust the mean attenuation for each octave band. Complete each calculation for Step 5 by subtracting Step 4 from Step 2 and typing your responses in the table. The first one has been done for you.

	Step	*125*	*250*	*500*	*1K*	*2K*	*4K*	*8K*	*dB(X)*
1	Your OBA results	88	91	96	98	100	102	101	107 dB (F)
2	Manufacture’s mean attenuation	18.2	25.1	29	29.7	29.4	30.6	31.9	
3	Manufacturer’s HPD standard	2.7	3	2.6	2.1	2	2.2	2.2	
4	Adjusted Standard Deviation	5.4	6	5.2	4.2	4	4.4	4.4	
5	Adjusted Mean Attenuation	12.8	**19.1**	**23.8**	**25.5**	**25.4**	**26.2**	**27.5**	

Step 6

Next, your readings must be adjusted by subtracting the adjusted mean attenuation from the OBA results for each octave band. Complete each calculation for Step 6 by subtracting Step 5 from Step 1 and typing your responses in the table. The first one has been done for you.

	Step	*125*	*250*	*500*	*1K*	*2K*	*4K*	*8K*	*dB(X)*
1	Your OBA results	88	91	96	98	100	102	101	107 dB (F)
2	Manufacturer’s mean attenuation	18.2	25.1	29	29.7	29.4	30.6	31.9	
3	Manufacturer’s HPD standard	2.7	3	2.6	2.1	2	2.2	2.2	
4	Adjusted Standard Deviation	5.4	6	5.2	4.2	4	4.4	4.4	
5	Adjusted Mean Attenuation	12.8	19.1	23.8	25.5	25.4	26.2	27.5	
6	Adjusted Readings	75.2	**71.9**	**72.2**	**72.5**	**74.6**	**75.8**	**73.8**	

Step 8

You use the A-weighted corrections to find the A-weighted attenuation noise. Complete each calculation for Step 8 by adding Step 6 and Step 7 and typing your responses in the table. The first one has been done for you.

	Step	*125*	*250*	*500*	*1K*	*2K*	*4K*	*8K*	*dB(X)*
1	Your OBA results	88	91	96	98	100	102	101	107 dB (F)
2	Manufacturer's mean attenuation	18.2	25.1	29	29.7	29.4	30.6	31.9	
3	Manufacturer's HPD standard	2.7	3	2.6	2.1	2	2.2	2.2	
4	Adjusted Standard Deviation	5.4	6	5.2	4.2	4	4.4	4.4	
5	Adjusted Mean Attenuation	12.8	19.1	23.8	25.5	25.4	26.2	27.5	
6	Adjusted Readings	75.2	71.9	72.2	72.5	74.6	75.8	73.8	82.4dB (A)
7	A-Weighted Corrections	-6.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
8	A-Weighted Attenuated Noise	59.1	**63.3**	**69**	**72.5**	**75.8**	**76.8**	**72.8**	

Step 9

Finally, you obtain the overall attenuation. Complete the calculation for Step 9 and type your answer in the input field.

	Step	*125*	*250*	*500*	*1K*	*2K*	*4K*	*8K*	*dB(X)*
1	Your OBA results	88	91	96	98	100	102	101	107 dB (F)
2	Manufacturer's mean attenuation	18.2	25.1	29	29.7	29.4	30.6	31.9	
3	Manufacturer's HPD standard	2.7	3	2.6	2.1	2	2.2	2.2	
4	Adjusted Standard Deviation	5.4	6	5.2	4.2	4	4.4	4.4	
5	Adjusted Mean Attenuation	12.8	19.1	23.8	25.5	25.4	26.2	27.5	
6	Adjusted Readings	75.2	71.9	72.2	72.5	74.6	75.8	73.8	82.4dB (A)
7	A-Weighted Corrections	-6.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
8	A-Weighted Attenuated Noise	59.1	63.3	69	72.5	75.8	76.8	72.4	
9	Overall Sound Level with HPD								**81.2 dB(A)**

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Step 2
Insert the NRR and the SPL into the following calculation and solve:

SPL in dB(A) - (NRR - 7 dB) = presumed Exposed Noise Level (ENL)

92 dB(A) - (**19**- 7 dB) = **80** dB(A)

Step 4
Based on the calculations and your comparison to the standard, determine whether the selected HPD in this example is adequate.

A **The HPD is adequate**

Rationale: The presumed ENL for the Peltor Tactical 6-S electronic headset is 80 dB(A). Therefore, this HPD is adequate for the SPL of 92 dB(A) used in this example.

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Using the appropriate HPD selection method, build a list of HPD that would be appropriate for a shop that had an SPL 8-hour TWA of 89 dB(A).

List
David Clark 310 with an NRR of 20
E.A.R Ultratech 12 with an NRR of 12
E.A.R. Ulstra 9000 with an NRR of 16

Rationale: You should use the NRR method to determine appropriate PPE in this situation. The NRR HPD selection method is the preferred method for estimating HPD noise attenuation when the 8 hour TWA is less than 94 dB(A). You should always compare your results to AFOSH Std 48-20, which requires attenuation below 85 dB(A). Also keep in mind that workers wearing HPDs which provide too much attenuation, such as the Bilsom 707 (NRR 23), may feel isolated from their surroundings. Ear level exposure is recommended to be between 76 and 84 dBA for an 8-hour exposure IAW AFOSH Std 48-20.

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Which two of the following situations are examples of INCORRECT use or maintenance of HPD?

A Operation of a jackhammer without HPD

D Wearing ear muffs that do not cover the ears

Rationale: HPD can only protect personnel if it is used and maintained according to the manufacturer's specifications. You should observe how the HPD is being worn as well as any potential situations that could cause the HPD to not work properly.

Course Glossary

Acronyms

AAR
After Action Report

ACADA
Automatic Chemical Agent Detection Alarm

AFI
Air Force Instruction

AFMIC
Armed Forces Medical Intelligence Center

AFMS
Air Force Medical Service

AFMSA
Air Force Medical Support Agency

AFOSH
Air Force Occupational and Environmental Safety, Fire Prevention and Health

AFRRAD
Air Force Radiation and Radioactive Recycling and Disposal

ALARA
As Low As Reasonably Achievable

AMC
Aerospace Medicine Council

amu
Atomic Mass Unit

AO
Area of Operations

AOC
Area of Concern

AOR
Area of Responsibility

BE
Bioenvironmental Engineering Flight

CBRN
Chemical, Biological, Radiological, Nuclear

CE
Civil Engineering

COA
Course of Action

COC
Contaminant of Concern or Constituent of Concern

CONUS
Continental United States

CSM
Conceptual Site Model

CV
Coefficient of Variability

DIA
Defense Intelligence Agency

DF
Duty Factor

DOD
Department of Defense

DOE
Department of Energy

DOS
Department of State

DOT
Department of Transportation

D_{pel}
Estimated Hazard Distance

DRI
Direct Reading Instruments

EHF
Extremely High Frequency (Occurs between 30 and 300 GHz)

EMR
Electromagnetic Radiation

EPA
Environmental Protection Agency

EPD
Electronic Personal Dosimeters

FPWG
Force Protection Working Group

G_{abs}
Absolute Gain

HF
High Frequency (Occurs between 3 and 30 MHz)

HRA
Health Risk Assessment

HRE
Health Risk Estimate

HRM
Health Risk Management

IATA
International Air Transport Association

IPE
Individual Protection Equipment

LCL
Lower Confidence Limits

LET
Linear Energy Transfer

LF
Low Frequency (Occurs between 30 and 300 kHz)

MAJCOM
Major Command

MEDIC CD
Medical Environmental Disease Intelligence and Countermeasure CD

MIO
Medical Intelligence Officer

MF
Medium Frequency (Occurs between 300 and 3,000 kHz (3MHz))

MOPP
Mission Oriented Protection Posture

MPE
Maximum Permissible Exposure

MSP
Mission Support Plan

NFB
Near-Field Boundary

NGIC
National Ground Intelligence Center

NHZ
Nominal Hazard Zone

NIOSH
National Institute for Occupational Safety and Health

NOHD
Nominal Ocular Hazard Distance

NRC
Nuclear Regulatory Commission

OCONUS
Outside the Continental United States

OEH
Occupational and Environmental Health

OEHSA
Occupational and Environmental Health Site Assessment

OEL
Occupational Exposure Limits

OEL-C
Occupational Exposure Limits-Ceiling

OEL-STEL
Occupational Exposure Limits-Short Term Exposure Limit

OEL-TWA
Occupational Exposure Limits-Time Weighted Average

OH
Occupational Health

ORM
Operational Risk Management

OSHA
Occupational Safety and Health Administration

OSI
Office of Special Investigation

P_{avg}
Average Power

PEL
Permissible Exposure Limit

PH
Public Health

P_p
Peak Power

PPBS
Planning, Programming and Budgeting System

PPE
Personal Protective Equipment

PPM
Parts per million

PRF
Pulse Repetition Frequency

PW
Pulse Width

RFR
Radio Frequency Radiation

RSO
Radiation Safety Officer

S
Main-Beam Power Density

SAR
Specific Absorption Rate

S_{avg}
Power Density Average

SEG
Similar Exposure Group

SHF
Super High Frequency (Occurs between 3 and 30 GHz)

SLM
Sound Level Meter

S_{max}
Maximum Power Density

SPL
Sound Pressure Level

TLD
Thermoluminescent Dosimeters

TWG
Threat Working Group

UHF
Ultra High Frequency (Occurs between 300 and 3,000 MHz)

USACHPPM
United States Army Center for Health Promotion and Preventive Medicine

UTC
Unit Type Code

VA
Vulnerability Assessments

VHF
Very High Frequency (Occurs between 30 and 300 MHz)

VLF
Very Low Frequency (Occurs between 3 and 30 kHz)

Definitions

Absolute Gain (G_{abs})
The ratio of the power that would be required at the input of an ideal isotropic radiator to the power actually supplied to the given antenna, to produce the same radiant intensity in the far-field region.

Action Level
An airborne exposure level that dictates active air monitoring, medical monitoring, and employee training. The Action Level is one-half the Occupational Exposure Limit for time-weighted average (OEL-TWA) exposures, except where 29 CFR 1910 Subpart Z designates a different concentration or where the statistical variability of sample results indicates that a lower fraction of the OEL should be used as the Action Level.

Activity
The number of disintegrations or transformations of radioactive material per unit of time (usually expressed in seconds).

Antenna
The point on an RFR emitter where RFR energy radiates into free space.

Asbestos
A natural material that is made of tiny threads or fibers. The fibers can enter the lungs as a person breathes. Asbestos can cause many diseases, including cancer. Asbestos was used to insulate houses from heat and cold. It has also been used in car brakes and for other purposes. Some old houses still have asbestos in their walls or ceilings.

Asbestosis
A lung disease caused by breathing asbestos fibers over a period of time. The fibers eventually scar the lungs and make breathing difficult. Symptoms are similar to asthma.

Atomic Mass Unit (amu)
Approximately equal to the mass of a proton or a neutron and is used to describe the mass of an atom.

Becquerel (Bq)
The international standard for the unit of measurement for activity.

Breathing Zone
The location where exposure is measured in air sampling. The breathing zone is located forward of the shoulders within 9 inches of the nose and mouth. Breathing zone measurements are taken beneath a welder’s helmet or face piece but outside of any respiratory protective devices.

Bremsstrahlung
An interaction that causes a form of x-ray production in which high-speed beta particles penetrate the electron cloud and interact with the nucleus.

Carcinogens
Hazardous materials that stimulate the formation of cancer.

Ceiling Limit (OEL-C)
The limit for an employee’s exposure which shall not be exceeded during any part of the work day. If instantaneous monitoring is not feasible, the OEL-C will be evaluated during the worst-case 15-minute exposure period.

Chrysotile
The most common asbestos type. Chrysotile asbestos fibrils may appear crinkled, like permed or damaged hair, under plane-polarized light.

Coefficient of Variation (CV)
For an air sampling method, the CV is the standard deviation of the sampling and analytical error divided by the mean of the sample results. The CV is used to calculate the confidence limits for sampling. OSHA uses the term sampling and analytical error (SAE) to account for the total variation or error in the method.

Compton Scatter
A gamma/x-ray interaction which takes place between a photon and an outer electron where the photon has more energy than the electron can accept, so it imparts only a portion of its energy to the electron.

Conceptual Site Model (CSM)
Articulates the health threats and exposure pathways and begins when data or information is gathered during Predeployment and Baseline Activities.

Confidence Limits
The upper confidence limit (UCL) and lower confidence limit (LCL) are the boundaries for a single sample or a series of samples that have a specified probability (usually 95 percent) of including the true value of the level of exposure.

Controlled Environments
An area where personnel are aware of the potential for RFR exposures associated with their employment or duties.

Counts per minute (cpm)
The amount of radiation detected by an instrument each minute.

Diffuse Reflection
Situations where a laser beam is bounced off a dull or uneven surface that breaks the beam apart.

Disintegration per minute (dpm)
The number of atoms that decay or transform in a given amount of material per minute.

Disintegration per second (dps)
The number of atoms that decay or transform in a given amount of material per second.

Dose
The quantity of radiation absorbed.

Dose Rate
The quantity of radiation absorbed per unit of time.

Duty Factor (DF)
A unit-less number which only applies to pulsed wave systems that describes the ratio of time an RFR emitter is on to the total operating time.

Electromagnetic Radiation (EMR)
Waves of energy that can travel through space and matter.

Electromagnetic Spectrum
The entire frequency range of electromagnetic waves, or wave radiation.

Energy
The ability to do work.

Estimated Hazard Distance (D_{pel})
The distance from the antenna to the point where the power density equals the permissible exposure limit (PEL).

Excitation
Occurs when there is an addition of energy to an atomic system, changing the atom from a "ground" state to an excited state.

Exposure
Exposure occurs when an employee is subjected to a hazardous material through any of these routes: inhalation, ingestion, skin contact, or skin absorption. Airborne exposures are specified as the duration and concentration of hazardous materials measured in the breathing zone of an individual worker without regard for personal protective equipment used by the worker.

Exposure Assessment
An exposure assessment is a process of estimating or calculating potential exposure of a health threat for an individual or population at risk. The assessment includes professional judgment, calculations based on estimates or models, actual measurements, collection and analysis of samples, and statistical evaluation.

Exposure Pathway
Includes a threat and the opportunity for the population to come into contact with the threat.

f
Algebraic express that means, "a function of."

Fission
The splitting of the nucleus of an atom into nuclei of lighter atoms, accompanied by the release of energy.

Frequency
A value of how often a wavelength cycle occurs in a second.

Gain
The antenna's ability to concentrate its energy in a certain direction.

Hazardous materials
Materials that pose a hazard and require a Material Safety Data Sheet as defined in FED-STD 313, Federal Standard, Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Governmental Activities.

Health Risk
The health risk equals threat "combined with" vulnerability (health risk = (threat) + (vulnerability)). A health risk is an identified health threat and the vulnerability of the population at risk of coming into contact (i.e., completion of an exposure pathway) with the health threat.

Health Risk Assessment (HRA)
Health risk assessment is the process of identifying and analyzing or evaluating (exposure and toxicity assessments) OEH threats in populations or at locations over time (HRA = f [(health risk) "+" (HRE) "+" (COA)]). The HRA "product" is the validated health threat, qualified by the HRE, and the COA which includes overall mission impact, recommended control options, associated uncertainties, risk mitigation estimate(s), and a cost-benefit analysis if applicable.

Health Risk Communication
Health risk communication is the process of effectively communicating potential health effects, outcomes, and control measures to all stakeholders (i.e., commanders, supervisors, AF personnel, military, families, and the public). It provides detailed information about the HRA and should occur throughout the HRA process.

Health Risk Estimate (HRE)
Health Risk Estimate is the probability and severity of loss from exposure to the health threat. The HRE is a function of probability and severity when either or both increase the Health Risk Estimate increases. The HRE is also referred to as a health risk level.

Health Risk Management (HRM)
Health risk management is a decision-making process to evaluate and select COAs, minimize OEH risks, and maximize benefits for operations and missions. HRM is the health component of the ORM process and health risk management recommendations and decisions are integrated into the commander's ORM decision-making.

Health Threat
A health threat is a potential or actual condition that can cause short or long-term injury, illness, or death to personnel. A health threat can be occupational or environmental in origin; internal or external to the installation; or continuous, intermittent, or transient; and includes enemy capability and intent.

Ionization
Occurs when beta particles interact with nearby atoms causing an electron to be removed, creating an ion pair.

Ionizing Radiation
Radiation which has enough energy to change the atomic structure of matter.

Isotope
Elements with the same number of protons, but a different number of neutrons.

Kinetic Energy
Energy of motion.

Laser
Light amplification by stimulated emission of radiation.

Linear Energy Transfer (LET)
Energy lost by particles along the path through which they are traveling.

Mass
Description of how much matter there is present in an object.

Maximum Permissible Exposure (MPE)
The level of laser radiation to which a person may be exposed without hazardous effects or adverse biological changes in the eyes or skin.

Mesothelioma
Cancer that generally occurs in the chest, abdominal region, and areas surrounding the heart. It is typically associated with exposure to asbestos.

n
Algebraic express that means, "Number of samples."

Nominal Hazard Zone (NHZ)
The area within a laser workplace in which the exposure from direct beam, specular reflection, and diffuse reflection could exceed the Maximum Permissible Exposure (MPE).

Nominal Ocular Hazard Distance (NOHD)
The distance along the laser beam beyond which the exposure is not expected to exceed the appropriate Maximum Permissible Exposure (MPE).

Non-aqueous Phase Liquids (NAPLs)
Non-aqueous phase liquids are liquids that are sparingly soluble in water. Because they do not mix with water, they form a separate phase. For example, oil is an NAPL because it does not mix with water, and oil and water in a glass will separate into two separate phases. NAPLs can be lighter than water (LNAPL) or denser than water (DNAPL). Hydrocarbons, such as oil and gasoline, and chlorinated solvents, such as trichloroethylene, are examples of NAPLs.

Non-ionizing Radiation
Radiation which does not have enough energy to change the atomic structure of matter.

Nuclear Stability
Describes the certain combinations of neutrons and protons within a nucleus of an atom which are required for that atom to be considered stable.

Occupational and Environmental Health Site Assessment (OEHSA)
The key operational health tool for producing data or information used for health risk assessments (HRA) and to satisfy Occupational and Environmental Health (OEH) surveillance requirements.

Occupational Exposure Limit (OEL)
The limit for the airborne concentrations of a specified substance for a specified time. Employees will not be exposed to concentrations greater than the OEL. The term OEL includes all OEL-TWAs, OEL-STELs, OEL-Cs, and acceptable ceiling concentrations, that apply to a specific substance. For each hazardous material, the OELs are the most stringent limits found in the latest edition of the TLV Booklet published annually by the American Conference of Government Industrial Hygienists, in 29 CFR 1910 Subpart Z, and in AFOSH Standards for specific substances. OELs apply to occupational exposures for each individual worker for a single 8-hour work shift except where 29 CFR 1910 Subpart Z allows 40-hour averages. Exposure during work shifts that exceed 8 hours must be adjusted before applying an OEL.

Operational Risk Management (ORM)
A systematic process of identifying hazards, assessing risk, analyzing risk control options and measures, making control decisions, implementing control decisions, accepting residual risks, and supervising/reviewing the activity for effectiveness.

Optical Cavity
The component that houses the laser.

Pair Production
Occurs when a photon disappears in the vicinity of a nucleus, and an electron and positron appear in its place.

Particulate Radiation
Fast-moving atomic or subatomic particles that may be charged positively or negatively or not at all.

Peak Power (P_p)
The maximum power density during the on time for a pulsed wave system.

Permissible Environment
Operational environment in which host country military and law enforcement agencies have control as well as the intent and capability to assist operations that a unit intends to conduct.

Permissible Exposure Limit (PEL)
The value to which an individual may be exposed without exhibiting damaging biological effects and is based on the emitter's frequency.

Photochemical Reaction
A chemical reaction which is induced by the absorption of energy in the form of visible, infrared, or ultraviolet radiation.

Photoelectric Effect
An "all or none" energy loss where gamma rays impart all of their energy into an electron.

Pleural Effusion:
When too much fluid collects between the lining of the lung and the lining of the inside wall of the chest.

Positron
Created when a proton changes into a neutron and a positron because there are too many protons in the n:p ratio.

Potential Energy
Energy of position.

Pulse Repetition Frequency (PRF)
The number of times the signal is on per unit of time.

Pulse Width (PW)
The length of time the signal is on for a pulsed wave system.

Quality Factor (Q)
A dimensionless quantity assigned to each type of radiation that allows doses to be normalized in relation to each other.

Radiation
Energy in the form of waves or moving subatomic particles emitted by an atom or other body as it changes from a higher energy state to a lower energy state.

Radiation Absorbed Dose (RAD)
The amount of radiation absorbed by the tissue.

Radioactive Decay
The spontaneous disintegration or transformation of an atom in an attempt by that atom to reach a stable state.

Radioactive Material (RAM)
Material which contains unstable (radioactive) atoms that give off radiation as they decay or transform.

Radioactivity
The spontaneous emission of matter or energy from the nucleus of an unstable atom.

Radioisotopes
Unstable isotopes that, in an attempt to become a stable atom, emit energy in the form of radiation.

Regulated Area
An area under the supervisor's control where entry and exit are restricted and controlled to prevent exposure to hazards. An area shall be established when a requirement in 29 CFR 1910 or 29 CFR 1926 exists, or when BE determines that employees entering the area might be exposed to a hazard unless access is controlled.

Short Term Exposure Limit (OEL- STEL)
A time-weighted exposure for a 15 minute (or shorter) period which shall not be exceeded during the work day. The definition of STEL is different in 29 CFR 1910.1000 (a) (5) (ii) and in the TLV Booklet. The definition must correspond to the reference being cited. As with other OELs, OEL-STELs are the most stringent limits found in the latest TLV Booklet, in 29 CFR 1910 Subpart Z, and in AFOSH Standards for specific substances.

Short-Term Public Emergency Exposure Guideline (SPEGL)
An acceptable peak concentration for unpredicted, single, short-term emergency exposures of the general public. These limits do not apply to occupational exposures.

Specific Absorption Rate (SAR)
An expression of how much RFR energy is imparted to each kilogram of biological body mass per second. SAR is expressed in units of watts per kilogram (W/kg).

Specular Reflection
Situations where a laser beam is reflected from shiny, mirror-like surfaces.

Spontaneous Fission
Spontaneous fission is a natural mode of decay in which nuclei disintegrate.

Stakeholders
Any individual who is affected by the content of the communication and/or will be making decisions based on the information provided.

Stratigraphy
The layering of rock or ice strata, from which information on succession, age relations, and origin can be deduced.

Threshold Limit Values—(TLVRs)
Exposure guidelines published annually by the American Conference of Governmental Industrial Hygienists (ACGIH) in Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. TLVRs are employed as OELs when they are more stringent than the OSHA PELs.

Time-Weighted Average (OEL-TWA)
Eight-hour average concentration for which the average is mathematically adjusted for the duration of exposure. The method for calculating OEL-TWAs is shown in 29 CFR 1910.1000 (d) and in the TLV Booklet.

Toxicology Assessment
Process of estimating the human toxicological impact of a specific material based on published and unpublished literature sources and taking into consideration: uptake, metabolism/biotransformation, transport and storage, and excretion including acute (short-term) and chronic (long-term) human health endpoints.

Transmission Line
Carries the RFR signal from the transmitter to the antenna.

Transmitter
The part of an RFR emitter that generates the RFR signal.

Uncontrolled Environments
An area where exposures may be incurred by people who have no knowledge or control of the hazard.

Wavelength
The distance from one peak of a wave to the next peak of a wave.