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BIOENVIRONMENTAL ENGINEERING

Noise

QUALIFICATION TRAINING PACKAGE

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Line Item 4.10.5: Perform noise calculations

TRAINER GUIDANCE

Proficiency Code:	2b
PC Definition:	Can do most parts of the task. Needs help only on hardest parts. Can determine step-by-step procedures for doing the task.
Prerequisites:	None
Training References:	AFOSH STD 48-20, *Occupational Noise and Hearing Conservation Program*, 10 May 13. May differ as publication is updated periodically.
Additional Supporting References:	None
CDC Reference:	4B051
Training Support Material:	• Noise data from multiple hazardous noise sources • Calculator
Specific Techniques:	Conduct hands-on training and evaluation.
Criterion Objective:	Given a calculator and noise survey data, calculate the combined noise level of like sources and the combined noise level of different sources successfully completing all checklist items with minimal trainer assistance.
Notes: These calculations are not all inclusive for noise calculations. Other calculations (dosimetry, octave band, etc. are located in the corresponding QTP's)	

TASK STEPS

Combined noise level of like sources

1. Identify the correct formula to determine the combined decibel level.[1]
2. Identify/Obtain decibel level of one source.
3. Identify number of sources with the same decibel level.
4. Substitute known quantities into the formula.[1]
5. Solve the formula to determine the decibel level of the combined sources.
6. Utilize OEMHIS (DOEHRS or equivalent), as applicable to document results.

Combined noise level of different sources

1. Identify the correct formula to determine the aggregate decibel level.[2]
2. Identify/Obtain decibel levels of each source.
3. Substitute known quantities into the formula.
4. Solve the formula to determine the decibel level of the different sources.
5. Utilize OEMHIS (DOEHRS or equivalent), as applicable to document results.

Calculating equivalent continuous sound level

1. Identify the correct formula.[3]
2. Identify the exposure time and dB(A) levels for each source above 80 dB(A).
3. Convert exposure time into minutes or hours. Ensure time units in the numerator and denominator match.
4. Replace the T with the exposure time. Place the dB(A) level in the numerator of the fractional exponent.
5. Simplify the fractional exponent.
6. Add the 3 quantities located in the numerator and divide by the denominator.
7. Find the log of the new product.
8. Multiply by 10 to achieve the L_{eqT}.
9. Utilize OEMHIS (DOEHRS or equivalent), as applicable to document results

LOCAL REQUIREMENTS: Use locally generated data from multiple hazardous noise sources.

NOTES: Information about decibel levels of identified noise hazards may be obtained from Bioenvironmental Engineering (BE) Hazard Risk Assessments (HRAs) surveys.

1. Combined noise level of like sources

Two identical sources (each with the same number of decibels) produce 3 dB more than a single such source.

The decibel level of more than two identical sources is determined by the following formula which provides an exact method of adding decibels when all sources are identical:

$$dB_{total} = 10\log n + dB_1$$

Where:
n = known quantities/number of identical sources.
dB_1 = dB level of a single source.

Example: There are **four** sources of noise in the shop each of which is **95** dB.

Step 1 – Identify the correct formula

$$dB_{total} = 10\log n + dB_1$$

Step 2 – Replace the variables in the formula
dB_{total} = 10 log **4** + **95**

Step 3 – Log the "n"
dB_{total} = 10 x **0.602** + **95**

Step 4 – Multiply the logged "n" by 10
dB_{total} = **6.02** + **95**

Step 5 – Solve the equation
dB_{total} = **101.02** dB

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2. Combined noise level of different sources

Make sure the decibels being added all have the same weighting..

The following formula is used to calculate the combined noise levels of different sources:

$$dB_{total} = 10\log\left(10^{\frac{dB_1}{10}} + 10^{\frac{dB_2}{10}} + \ldots 10^{\frac{dB_n}{10}}\right)$$

Where: dB_1, dB_2, dB_n = dB reading of each different source

Example: The shop has four sources of noise, all from different types of equipment, the measured decibel levels are **96** dB, **97** dB, **88** dB, and **93** dB.

Step 1 – Identify the correct formula

$$dB_{total} = 10\log\left(10^{\frac{dB_1}{10}} + 10^{\frac{dB_2}{10}} + \ldots 10^{\frac{dB_n}{10}}\right)$$

Step 2 – Replace the dB_1 …dB_n in the numerator of the fractional exponent.

$$dB_{total} = 10\log\left(10^{\frac{\mathbf{96}}{10}} + 10^{\frac{\mathbf{97}}{10}} + 10^{\frac{\mathbf{88}}{10}} + 10^{\frac{\mathbf{93}}{10}}\right)$$

Step 3 – Simplify the fractional exponent
dB_{total} = 10 log ($10^{\mathbf{9.6}}$ + $10^{\mathbf{9.7}}$ + $10^{\mathbf{8.8}}$ + $10^{\mathbf{9.3}}$)

Step 4 – Add the quantities for the dB level calculated
dB_{total} = 10 log (**3,981,071,706** + **5,011,872,336** + **630,957,344.5** + **1,995,262,315**)

Step 5 – Find the log of the new product
dB_{total} = 10 log (**11,619,163,701.5**)
Step 6 – Multiply by 10 to arrive at the calculated dB
dB_{total} = 10 x **9.06517487**
dB_{total} = **90.65** dB

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3. Calculating equivalent continuous sound level

If you have exposures to two or more levels in one day, you can use the following formula to calculate the L_{et}.

$$L_{eqT} = 10Log\left[\frac{t_1 \times 10^{\left(\frac{L_1}{10}\right)} + t_2 \times 10^{\left(\frac{L_2}{10}\right)} + ...t_n \times 10^{\left(\frac{L_n}{10}\right)}}{T}\right]$$

Where:
L_{et} = Equivalent sound level for time period T
L_i = sound level of each noise source above 80 dB (A)
T = total time period in minutes, usually 480 for 8-hour equivalent
t = exposure times (in minutes) for each noise source
The L_{et} calculation yields a TWA in decibels that is compared to the criterion level of 85 dB (A).

Example:

During a routine surveillance survey of the Phase Dock, BE identified a new inspection activity. As part of the evaluation process a special survey has been scheduled. The special survey requires you to evaluate the noise sources associated with the phase activity and make appropriate recommendations. You have been provided with a list of noise sources with approximate daily operational times. You surveyed those sources with a SLM and obtained the following data.

Equipment	Survey Location	Maximum Daily Exposure	dB(A)
A2 Boom Generator	Source	20 min	90
A2 Boom Generator	Operator Location	5 h	86
High-speed Air Drill	Operator Location	30 min	94

Use the noise source information and follow the steps below:

Step 1 - $L_{(eqT)}$ formula

$$L_{eqT} = 10Log\left[\frac{t_1 \times 10^{\left(\frac{L_1}{10}\right)} + t_2 \times 10^{\left(\frac{L_2}{10}\right)} + ...t_n \times 10^{\left(\frac{L_n}{10}\right)}}{T}\right]$$

Step 2 - (20 min @ 90 dB(A)), (5 h @ 86 dB(A), (30 min @ 94 dB(A)) are the exposure times and levels

Step 3 - Convert units to minutes (20 min @ 90 dB(A)), (300 min @ 86 dB(A)), (30 min @ 94 dB(A))

$$L_{eqT} = 10Log\left[\frac{20 \times 10^{\left(\frac{90}{10}\right)} + 300 \times 10^{\left(\frac{86}{10}\right)} + 30 \times 10^{\left(\frac{94}{10}\right)}}{480}\right]$$

Step 4 -

$$L_{eqT} = 10Log\left[\frac{2 \times 10^{10} + 1.19 \times 10^{11} + 7.53 \times 10^{10}}{480}\right]$$

Step 5 -

$$L_{eqT} = 10Log\left[\frac{2.143 \times 10^{11}}{480}\right]$$

Step 6 -

Step 7 – $L_{eqT} = 10Log[446458333.3]$

Step 8 - $L_{eqT} = 10 \times 8.649$

$L_{eqT} = 86.49$

TRAINEE REVIEW QUESTIONS

Line Item 4.10.5: Perform noise calculations

1. The vehicle maintenance shop at Rackety AFB is undergoing an assessment of its noise level in order to upgrade PPE. The BEE who took the measurements determined that the three individual power tools being used were operating at 97.08 dB, 98.45 db, and 97.35 db. What is the noise level during operation of all three tools?

2. The flight line at Clangor AFB has two identical tools that are used by its personnel. The BEE on base has already determined that the noise level when one is in use is 112 dB. What is the decibel level when both are in use?

3. The lab at Clank AFB is using equipment for a research project that required that the BE officer do a noise assessment. Her findings were that each of the three large centrifuges that the lab is using has a noise level of 97.87 dB. What is the noise level when all three centrifuges are in use?

PERFORMANCE CHECKLIST

Line Item 4.10.5: Perform noise calculations

Proficiency Code:	2b
PC Definition:	Can do most parts of the task. Needs help only on hardest parts. Can determine step-by-step procedures for doing the task.

DID THE TRAINEE…	YES	NO
COMBINED NOISE LEVEL OF LIKE SOURCES		
1. Identify the correct formula to determine the aggregate decibel level?		
2. Identify/Obtain decibel level of one source?		
3. Identify number of sources with the same decibel level?		
4. Substitute known quantities into the formula?		
5. Solve the formula to determine the decibel level of the combined sources?		
6. Utilize OEHIS (DOEHRS or equivalent), as applicable to document results?		
COMBINED NOISE LEVEL OF DIFFERENT SOURCES		
1. Identify the correct formula to determine the aggregate decibel level?		
2. Identify/Obtain decibel levels of each source?		
3. Substitute known quantities into the formula?		
4. Solve the formula to determine the decibel level of the different sources?		
5. Utilize OEHIS (DOEHRS or equivalent), as applicable to document results?		
CALCULATING EQUIVALENT CONTINUOUS SOUND LEVEL		
1. Identify the correct formula[3].		
2. Identify the exposure time and dB(A) levels for each source above 80 dB(A).		
3. Convert exposure time into minutes or hours. Ensure time units in the numerator and denominator match.		

4. Replace the T with the exposure time. Place the dB(A) level in the numerator of the fractional exponent.		
5. Simplify the fractional exponent.		
6. Add the 3 quantities located in the numerator and divide by the denominator.		
7. Find the log of the new product.		
8. Multiply by 10 to achieve the L_{eqT}.		
9. Utilize OEMHIS (DOEHRS or equivalent), as applicable to document results		
Did the trainee successfully complete the task?		

TRAINEE NAME (PRINT)

TRAINER NAME (PRINT)

ANSWERS

1. The vehicle maintenance shop at Rackety AFB is undergoing an assessment of its noise level in order to upgrade PPE. The BEE who took the measurements determined that the three individual power tools being used were operating at 97.08 dB, 98.45 db, and 97.35 db. What is the noise level during operation of all three tools?

A:

$$dB_{total} = 10 \log\left(10^{\frac{\mathrm{dB}_1}{10}} + 10^{\frac{\mathrm{dB}_2}{10}} + \ldots 10^{\frac{\mathrm{dB}_n}{10}}\right)$$

$$dB_{total} = 10 \log\left(10^{\frac{97.08}{10}} + 10^{\frac{98.45}{10}} + 10^{\frac{97.35}{10}}\right)$$

dB_{total} = 10 log ($10^{9.708}$ + $10^{9.845}$ + $10^{9.735}$)

dB_{total} = 10 log (5,105,050,000 + 6,998,419,960 + 5,432,503,315)

dB_{total} = 10 log (17,535,973,275.0)

dB_{total} = 10 x 9.239398924

dB_{total} = 92.39 dB

The noise level is 92.39 dB.

(Source: 4B051 CDC)

2. The flight line at Clangor AFB has two identical tools that are used by its personnel. The BEE on base has already determined that the noise level when one is in use is 112 dB. What is the decibel level when both are in use?

A: 115 db

(Source: 4B051 CDC)

3. The lab at Clank AFB is using equipment for a research project that required that the BE officer do a noise assessment. Her findings were that each of the three large centrifuges that the lab is using has a noise level of 97.87 dB. What is the noise level when all three centrifuges are in use?

A:

$$dB_{total} = 10 \log n + dB_1$$

dB total = 10 log 3 + 97.87

dB total = 10 x 0.477121255 + 97.87

dB total = 4.771212547 + 97.87

dB total = 102.64 dB

The noise level in the lab is 102.64 dB.

(Source: 4B051 CDC,

STS Line Item 4.10.7: Perform noise source surveys (dBA, impact, impulse, speech interference)

TRAINER GUIDANCE

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.
Prerequisites:	None
Training References:	• AFOSH STD 48-20, *Occupational Noise and Hearing Conservation Program,* 10 May 13. May differ as publication is updated periodically. • Fundamentals of Industrial Hygiene, 5th Edition, Chapter 9
Additional Supporting References:	• DoDI 6055.12, *Hearing Conservation Program*, Enclosure 3 & 4. • ANSI S1.4-1983 (R2006), *American National Standard Specification for Sound Level Meters*
CDC Reference:	4B051
Training Support Material:	• Sound level meter • Noise sources • DD Form 2214 *or equivalent (e.g. DOEHRS)* • SLM operator's manual
Specific Techniques:	Trainer may use an in-house noise source such as an emergency response generator and/or Radeco as a noise source for the purpose of completing this training.
Criterion Objective:	Given a noise source, necessary equipment, perform a noise source survey successfully completing all checklist items with NO trainer assistance.
Notes: Trainer may use an in-house noise source such as an emergency response generator and/or RADeCO as a noise source for the purpose of completing this training.	

TASK STEPS

Perform Noise Source Surveys – dBA

1. Properly pre-calibrate the SLM per the manufacturer's instructions.
2. Place windscreen on the SLM, if necessary.[1]
3. Select Proper weighting (A).
4. Set meter to slow response.
5. Measure background noise (turn noise source off and measure the noise level).
6. Hold the SLM at the operator's position with correct microphone orientation (orientation is dictated by type of microphone).[2]
7. Record A-weighted measurement.
8. Post-calibrate the SLM after the survey.
9. Document survey data (DOEHRS or equivalent).

Perform Noise Source Surveys – Impact/Impulse

1. Properly pre-calibrate the SLM per the manufacturer's instructions.
2. Place windscreen on the SLM, if necessary.[1]
3. Select Proper weighting (A/C).
4. Set meter to fast response.
5. Measure background noise (turn noise source off and measure the noise level).
6. Hold the SLM at the operator's position with correct microphone orientation (orientation is dictated by type of microphone).[2]
7. Record A-weighted measurement.
8. Post-calibrate the SLM after the survey.
9. Document survey data (DOEHRS or equivalent).

Perform Noise Source Surveys – Speech Interference

1. Properly pre-calibrate the SLM per the manufacturer's instructions.
2. Place windscreen on the SLM, if necessary.[1]
3. Select Proper weighting (A).
4. Set meter to slow response.
5. Measure background noise (turn noise source off and measure the noise level).
6. Hold the SLM at the operator's position with correct microphone orientation (orientation is dictated by type of microphone).[2]
7. Record A-weighted measurement.
8. Post-calibrate the SLM after the survey, compare recorded measurements to tables 5,6,7,8 in AFOSHSTD 48-20.
9. Document survey data (DOEHRS or equivalent).

LOCAL REQUIREMENTS:

NOTES:

1. Wind or strong air currents from fans can give you false high readings, so a wind screen should be used under such circumstances.

2. Hold the SLM out in front of you in the sound path so that it is in a free field. A free field microphone will be held at 0 degrees or straight at the source. A random incidence microphone will be held at a 70 degree angle to the source.

TRAINEE REVIEW QUESTIONS

STS Line Item 4.10.7: Perform noise source surveys (dBA, impact, impulse, speech interference)

1. When multiple noise sources are present, must you test the worker at each station? What must you keep in mind when you evaluate multiple sources?
2. Explain the reasoning and proper hand orientation of a random incidence microphone to the source.
3. In a situation when the actual sound level is unknown, how should you operate your meter? How do you determine an average reading?

PERFORMANCE CHECKLIST

STS Line Item 4.10.7: Perform noise source surveys (dBA, impact, impulse, speech interference)

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.

DID THE TRAINEE…	YES	NO
PERFORM NOISE SOURCE SURVEYS (DBA)		
1. Properly pre-calibrate the SLM per the manufacturer's instructions?		
2. Place windscreen on the SLM, if necessary?		
3. Select proper weighting (A)?		
4. Set meter to slow response?		
5. Measure background noise (turn noise source off and measure the noise level)?		
6. Hold SLM at operator's position with correction orientation (orientation dictated by type of microphone)?		
7. Properly record A weighted measurement?		
8. Post-calibrate the SLM after the survey?		
9. Document survey data (DOEHRS or equivalent)?		
Did the trainee successfully complete the task?		
PERFORM NOISE SOURCE SURVEYS (IMPACT/IMPULSE*)*		
1. Properly pre-calibrate the SLM per the manufacturer's instructions?		
2. Place windscreen on the SLM, if necessary?		
3. Select proper weighting (A & C)?		
4. Set meter to fast response?		

5. Measure background noise (turn noise source off and measure the noise level)?		
6. Hold SLM at operator's position with correction orientation (orientation dictated by type of microphone)?		
7. Properly record A and C weighted measurements?		
8. Post-calibrate the SLM after the survey?		
9. Document survey data (DOEHRS or equivalent)?		
Did the trainee successfully complete the task?		
PERFORM NOISE SOURCE SURVEYS (SPEECH INTERFERENCE)		
1. Properly pre-calibrate the SLM per the manufacturer's instructions?		
2. Place windscreen on the SLM, if necessary?		
3. Select proper weighting (A)?		
4. Set meter to slow response?		
5. Measure background noise (turn noise source off and measure the noise level)?		
6. Hold SLM at operator's position with correction orientation (orientation dictated by type of microphone)?		
7. Properly record A weighted measurement?		
8. Post-calibrate the SLM after the survey? Compare measured results to table 5,6,7,8 in AFOSHSTD 48-20?		
9. Document survey data (DOEHRS or equivalent)?		
Did the trainee successfully complete the task?		

TRAINEE NAME (PRINT) TRAINER NAME (PRINT)

ANSWERS

1. When multiple noise sources are present, must you test the worker at each station? What must you keep in mind when you evaluate multiple sources?

   A: Yes; mixed sounds could give you an inaccurate reading. You must evaluate all sources and find the ones that are significant to the noise exposure.

(Source: 4B051 CDC)

2. Explain the reasoning and proper hand orientation of a random incidence microphone to the source.

   A: Random incidence microphones are designed for "grazing" angles; it must be hold at 70 degrees or nearly perpendicular to the source.

(Source: 4B051 CDC)

3. In a situation when the actual sound level is unknown, how should you operate your meter? How do you determine an average reading?

   A: You should start the SLM at the highest range (130-140 db(A)); take readings roughly every 15 seconds for three to five minutes and calculate an average using the following formula

$$dB_{avg} = 10\log\left[\frac{10^{dB_1/10} + 10^{dB_2/10} + \ldots 10^{dB_n/10}}{n}\right]$$

(Source: 4B051 CDC)

STS Line Item 4.10.8: Perform worker exposure surveys (Dosimetry)

TRAINER GUIDANCE

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.
Prerequisites:	None
Training References:	• AFOSH STD 48-20, *Occupational Noise and Hearing Conservation Program*, 10 May 13. May differ as publication is updated periodically. • Fundamentals of Industrial Hygiene, 5th Edition, Chapter 9
Additional Supporting References:	• DoDI 6055.12, *Hearing Conservation Program*, Enclosure 3
CDC Reference:	4B051
Training Support Material:	• Noise dosimeters • Operator's manual • Computer
Specific Techniques:	Conduct hands-on training and evaluation.
Criterion Objective:	Given an industrial work center and necessary equipment, perform a noise dosimetry survey successfully while completing all checklist items with NO trainer assistance.
Notes: See Notes Section for formula. Only use equipment that has a current calibration certification.	

TASK STEPS

1. Check dosimeters to verify proper operation and sufficient battery life, replace if necessary.
2. Validate annual calibration.
3. Clear any previous data from the dosimeter.
4. Pre-calibrate dosimeter according to the manufacturer's instructions.
5. Verify proper dosimeter settings (criterion level, threshold level, exchange rate, etc.).[1]
6. Choose survey participants.
7. Brief employees.[2]
8. Attach dosimeter to employee with the microphone positioned properly.[3]
9. Initiate data logging, if not programmed.[4]
10. Stop data logging and collect the dosimeter at the end of the survey period.
11. Interview worker and gather exposure history for the surveyed period.
12. Post-calibrate the dosimeter.
13. Retrieve survey data from the dosimeter according to the manufacturer's instructions.
14. Calculate an equivalent continuous level (ECL).[5]
15. Utilize OEHMIS (DOEHRS or equivalent), as applicable.

LOCAL REQUIREMENTS:

NOTES:

1. Exchange rate of 3 dB, criterion level of 85 dB(A), threshold of 80 dB(A), upper detection limit of at least 130 dB(A).

2. Suggested topics to brief:
   - Provide proper wear instructions/responsibilities
   - Perform duties in a normal fashion
   - Do not yell or sing into microphone
   - Do not interfere or tamper with the dosimeter
   - Take care not to avoid banging the microphone against foreign objects
   - Do not remove the dosimeter
   - Document times for all break periods and significant noise exposures
   - Do not attempt to deliberately increase and/or decrease the exposure

3. The microphone is usually located on the collar and remains in that position for the entire workday. Orient and place the microphone as close as possible to the employee's ear.

4. Dosimeters should be checked periodically to ensure proper operation and microphone position.

5. **Formula:**

$$10\log\left(\frac{anti\log\left(\frac{ECL_1}{10}\right)+anti\log\left(\frac{ECL_2}{10}\right)+....anti\log\left(\frac{ECL_n}{10}\right)}{n}\right)$$

Where:
ECL = average daily equivalent continuous sound level
n = number of workdays monitored

TRAINEE REVIEW QUESTIONS

STS Line Item 4.10.8: Perform worker exposure surveys (Dosimetry)

1. What characteristics should a noise dosimeter have for measurements to be compared to Air Force standards?
2. Before initiating data logging, what steps must you perform?
3. What step must you perform after stopping data logging and collecting the dosimeter?
4. What information should you discuss with the worker before you start dosimetry?

PERFORMANCE CHECKLIST

STS Line Item 4.10.8: Perform worker exposure surveys (Dosimetry)

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.

DID THE TRAINEE…	YES	NO
1. Check dosimeters to verify proper operation and sufficient battery life?		
2. Validate annual calibration?		
3. Clear any previous data from the dosimeter?		
4. Pre-calibrate dosimeters according to the manufacturer's instructions?		
5. Verify proper dosimeter settings? (criterion level, threshold level, exchange rate, etc.)?		
6. Choose survey participants?		
7. Brief employees?		
8. Attach dosimeter to employee with the microphone positioned properly?		
9. Initiate data logging, if not programmed?		
10. Stop data logging and collect the dosimeter at the end of the survey period?		
11. Interview worker and gather exposure history for the surveyed period?		
12. Post-calibrate the dosimeters?		
13. Retrieve survey data from the dosimeter according to the manufacturer's instructions?		
14. Calculate an equivalent continuous level (ECL)?		
15. Document survey data (DOEHRS or equivalent)?		
Did the trainee successfully complete the task?		

TRAINEE NAME (PRINT) TRAINER NAME (PRINT)

ANSWERS

1. What characteristics should a noise dosimeter have for measurements to be compared to Air Force standards?

A:

- Exchange rate of 3 dB
- Criterion level of 85 dB(A)
- Threshold of 80 dB(A)
- Upper Detection Limit of at least 130 dB(A)

(Source: 4B051 CDC)

2. Before initiating data logging, what steps must you perform?

A:

1. Check dosimeters to verify proper operation and sufficient battery life, replace if necessary
2. Clear any previous data from the dosimeter
3. Pre-calibrate dosimeter according to the manufacturer's instructions
4. Verify proper dosimeter settings (criterion level, threshold level, exchange rate, etc.)
5. Choose survey participants
6. Brief employees
7. Attach dosimeter to employee with the microphone positioned properly

(Source: 4B051 CDC
)

3. What step must you perform after stopping data logging and collecting the dosimeter?

A: Interview worker and gather exposure history for the surveyed period

(Source: 4B051 CDC)

4. What information should you discuss with the worker before you start dosimetry?

A:

- Explain the purpose and importance of the data being collected to employee
- Provide proper wear instructions/responsibilities
- Perform duties in a normal fashion
- Do not yell or sing into microphone
- Do not interfere or tamper with the dosimeter
- Take care not to avoid banging the microphone against foreign objects
- Do not remove the dosimeter
- Document times for all break periods and significant noise exposures
- Do not attempt to deliberately increase and/or decrease the exposure

(Source: 4B051 CDC)

STS Line Item 4.10.9: Perform octave band noise surveys

TRAINER GUIDANCE

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.
Prerequisites:	None
Training References:	• ANSI S3.1-1999 (R2008), *Maximum Permissible Ambient Noise Levels for Audiometric Test Rooms* • DoDI 6055.12, *Hearing Conservation Program*, paragraph 6.8.2.2 • AFOSH Std 48-20,10 May 2013, *Occupational Noise and Hearing Conservation Program*
Additional Supporting References:	• ANSI S1.4-1983 (R2006), *American National Standard Specification for Sound Level Meters* • 29 CFR 1910.95, *Audiometric test rooms*, Appendix D
CDC Reference:	4B051
Training Support Material:	• Sound Level Meter w/Octave Band Analyzer
Specific Techniques:	Conduct hands-on training and evaluation.
Criterion Objective:	Given a noise source, determine the need for and perform an octave band noise survey successfully completing all checklist items with NO trainer assistance.
Notes: None	

TASK STEPS

Octave Band Analysis -

1. Select a type I sound level meter (SLM) with octave band analyzer and perform pre-calibration according to the manufacturer's instructions.
2. Set the octave band meter at "Z" weighting, "Fast," and "SPL."[1]
3. Measure sound levels at equipment operator's ear level.[2]
4. Measure/Test every position operator is normally in during the commission of his work.[2]
5. Point the microphone according to manufacturer's instructions.[3]
6. If the reading fluctuates considerably due to the variability of the sound level, take readings approximately every 3 to 5 minutes and calculate an average value.[4]
7. If there is no significant fluctuation (≤ 6 dB), observe the data screen for a number of seconds and record the level that is between the minimum and maximum readings and the central tendency.
8. Select the desired octave band (i.e. 500 hz, 1000 hz, 2000 hz, 4000 hz, and 8000 hz)
9. Repeat Steps 3 through 7 for each octave band.
10. Recalibrate the meter according to manufacturer's instructions.
11. Record the results of the OBA in OEHMIS (DOEHRS or equivalent), as applicable.

LOCAL REQUIREMENTS: None

NOTES:

1. This is called a dB all pass (flat or linear reading). dB flat means that equal weighting is given to all frequencies. Procedures for conducting an octave band analysis are similar to those for the noise source survey using the SLM. The main difference is the frequencies at which measurements are taken. For SLMs with the octave band filters attached, measurements are taken for dB(A), dB flat, and one for each of the octave bands. With a digital octave band analyzer, readings are automatically taken for the required frequencies.

2. Preferably, the operator will be at least three feet away.

3. A microphone is typically designed for use in a particular environment across a specific range of SPLs and frequencies. In addition, microphones differ in their directionality. Refer to manufactures guidelines microphone directionality.

4. $$dB_{avg} = 10\log\left[\frac{10^{dB_1/10} + 10^{dB_2/10} + 10^{dB_n/10}}{n}\right]$$

   Where:
   dB_n = each noise reading
   n = number of readings.

TRAINEE REVIEW QUESTIONS

STS Line Item 4.10.9: Perform octave band noise surveys

1. What is the value of the information obtained through octave band analysis?
2. What are octave band results used for?

PERFORMANCE CHECKLIST

STS Line Item 4.10.9: Perform octave band noise surveys

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.

DID THE TRAINEE…	YES	NO
Octave Band Analysis		
1. Select a type I sound level meter (SLM) with octave band analyzer and perform pre-calibration according to the manufacturer's instructions?		
2. Set the octave band meter at "Z" weighting, "Fast," and "SPL"?		
3. Measure sound levels at equipment operator's ear level?		
4. Measure/Test every position operator is normally in during the commission of his work?		
5. Point the microphone according to manufacturer's instructions?		
6. If the reading fluctuated considerably due to the variability of the sound level, take readings approximately every 3 to 5 minutes and calculate an average value?		
7. If there was no significant fluctuation (≤ 6 dB), observe the data screen for a number of seconds and record the level that is between the minimum and maximum readings and the central tendency?		
8. Select the desired octave band (i.e 500 hz, 1000 hz, 2000 hz, 4000 hz, and 8000 hz)?		
9. Repeat Steps 3 through 7 for each octave band?		
10. Recalibrate the meter according to manufacturer's instructions?		
11. Record the results of the OBA in OEHMIS (DOEHRS or equivalent), as applicable?		
Did the trainee successfully complete the task?		

TRAINEE NAME (PRINT) TRAINER NAME (PRINT)

ANSWERS

1. What is the value of the information obtained through octave band analysis?

   The results indicate the octave bands that contain the majority of the total sound power being radiated. This method will help you pinpoint the problem noise where you can concentrate your control efforts.

   (Source: 4B051 CDC)

2. What are octave band results used for?

   The results are used to determine engineering controls, select hearing protection devices, measure the SPL's in the audiometric booths, and evaluate the whole body effects of sound.

   (Source: 4B051 CDC)

STS Line Item 4.10.10: Perform audiometric booth surveys

TRAINER GUIDANCE

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.
Prerequisites:	None
Training References:	• AFOSH STD 48-20, *Occupational Noise and Hearing Conservation Program,* 10 May 13. May differ as publication is updated periodically.
Additional Supporting References:	• ANSI S1.4-1983 (R2006), *American National Standard Specification for Sound Level Meters* • ANSI S1.11-2004 (R2009), *Specifications for Octave-Band and Fractional Octave-Band Analog and Digital Filters*. • 29 CFR 1910.95, *Audiometric test rooms*, Appendix D • ANSI S3.1-1999 (R2008), *Maximum Permissible Ambient Noise Levels for Audiometric Test Rooms* • DoDI 6055.12, *Hearing Conservation Program*, para 6.8.2.2
CDC Reference:	4B051
Training Support Material:	• Sound Level Meter w/Octave Band Analyzer • Audiometric booth
Specific Techniques:	Conduct hands-on training and evaluation.
Criterion Objective:	Given a set of octave band readings, determine if an audiometric booth is in compliance with ANSI Standards successfully completely all checklist items with NO trainer assistance.
Notes: While one of the purposes for performing an octave band analysis is to determine adequacy of personnel protective equipment, the steps in conducting an OBA are relatively the same for a sound levels in an audiometric booth.	

TASK STEPS

Octave Band Analysis of Audiometric Booth

1. Select a type I sound level meter (SLM) with octave band analyzer and perform pre-calibration according to the manufacturer's instructions.
2. Ensure booth testing conditions in relation to external noise/activity, door closed, etc., are representative of typical audiometric testing conditions.
3. Set the octave band meter at "Z" weighting, "Fast", and "SPL."
4. Select the desired octave band (500, 1000, 2000, 4000, and 8000).
5. Measure sound pressure at the location relative to a patient's head inside booth.
6. Record results for each required octave band (listed below).[1]
7. Perform post-calibration of SLM according to the manufacturer's instructions.
8. Compare results to acceptable sound pressure levels listed in AFOSH Std 48-20, paragraph 2.11.10 provided in notes below.[1]
9. Utilize OEHMIS (DOEHRS or equivalent), as applicable

LOCAL REQUIREMENTS: N/A

NOTES:

1. For 500 Hertz (Hz), < 27 dB.
   For 1,000 Hz, < 29 dB.
   For 2,000 Hz, < 34 dB.
   For 4,000 Hz, < 39 dB.
   For 8,000 Hz, < 41 dB.

TRAINEE REVIEW QUESTIONS

STS Line Item 4.10.10: Perform audiometric booth surveys

2. What type of SLM is used to perform audiometric booth testing?
3. When performing audiometric booth testing, sound pressure levels are recorded at which frequencies?

PERFORMANCE CHECKLIST

STS Line Item 4.10.10: Perform audiometric booth surveys

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.

DID THE TRAINEE…	YES	NO
OCTAVE BAND ANALYSIS OF AUDIOMETRIC BOOTH		
1. Select the proper type of SLM and perform pre-calibration of SLM according to the manufacturer's instructions?		
2. Ensure booth testing conditions in relation to external noise/activity, door closed, etc., are representative of typical audiometric testing conditions?		
3. Set the octave band meter at "Z" weighting, "Fast", and "SPL"?		
4. Select the desired octave band (500, 1000, 2000, 4000, and 8000)?		
5. Measure sound pressure at the location relative to a patient's head?		
6. Record results for each required octave band?		
7. Perform post-calibration of SLM according to the manufacturer's instructions?		
8. Compare results to acceptable sound pressure levels listed in AFOSH Std 48-20, paragraph 2.11.10?		
9. Utilize OEHMIS (DOEHRS or equivalent), if applicable?		
Did the trainee successfully complete the task?		

TRAINEE NAME (PRINT) TRAINER NAME (PRINT)

ANSWERS

1. What type of SLM is used to perform audiometric booth testing?

A: Type I SLM with octave band analyzer

(Source: 4B051 CDC and AFOSH Std 48-20, *Occupational Noise and Hearing Conservation*, para 2.11.10)

2. When performing audiometric booth testing, sound pressure levels are recorded at which frequencies?

A: 500, 1000, 2000, 4000, and 8000

(Source: 4B051 CDC and AFOSH Std 48-20, *Occupational Noise and Hearing Conservation*,para 2.11.10.1-10.5)

STS Line Item 4.10.12 - Verify adequacy of hearing protection devices (calculate attenuation factor)

TRAINER GUIDANCE

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.
Prerequisites:	None
Training References:	• AFOSH Std 48-20, *Occupational Noise and Hearing Conservation Program,* 10 May 2013, Chapter 5.
Additional Supporting References:	29 CFR 1910.95, Apd B, *Methods for Estimating the Adequacy of Hearing Protector Attenuation; NIOSH HPD Compendium*
CDC Reference:	4B051
Training Support Material:	• Noise data • Calculator • AFOSH Std 48-20, *Occupational Noise and Hearing Conservation Program* • Manufacturer's noise reduction information
Specific Techniques:	Conduct hands-on training and evaluation.
Criterion Objective:	Given a calculator, octave band analysis (OBA) and/or noise reduction (NRR) data, calculate personal protective equipment (PPE) attenuation factors successfully completing all parts of the task on the performance checklist with NO trainer assistance.

Notes:

See Notes Section for formula. Hearing Protection Product Information can be found at the following web sites:

- www2a.cdc.gov/hp-devices/hp_srchpg01.asp
- www.cdc.gov/niosh
- Manufacturer's website

TASK STEPS

Octave Band Method *(Must use table in the notes section while following the steps below[1])*

1. Identify/gather noise source and octave band analysis (OBA) survey results for each noise source.
2. Identify total time of exposure for each noise source.
3. List results from the OBA survey (row 1 of table).
4. List the HPD mean attenuation (row 2 of table).
5. List the HPD standard deviation (row 3 of table).
6. Multiply the standard deviation by 2 (row 4 of table).
7. Adjust the mean attenuation (row 5 of table).
8. Adjust the readings (row 6 of table).
9. List the A-weighting correction values (see Notes).[2] (row 7 of table).
10. List the A-weighted attenuated noise (row 8 of table).
11. Obtain the overall attenuation (add dbA levels together using the formula – See Notes).[3]
12. Determine if HPD attenuates adequately.
13. Utilize OEHMIS (DOERHS or equivalent), as applicable to document results.

NRR Method

1. Locate the Noise Reduction Rating (NRR) for the HPD you are evaluating.[4]
2. Subtract 7 dB from the NRR.
3. Determine if HPD attenuates adequately.
4. If dual HPDS are used, add 3 dB to the highest noise reduction rated plug/muff.[5]
5. Utilize OEHMIS (DOEHRS or equivalent), as applicable to document results.

LOCAL REQUIREMENTS:

NOTES:

1. **Octave band analysis method instructions and table:**

Step 1 – List the results from the OBA.
Step 2 – List the HPD mean attenuation from the manufacturer's literature (product container or website) or NIOSH website, NIOSH Hearing Protector Device Compendium http://www2a.cdc.gov/hp-devices/hp_srchpg01.asp.
Step 3 – List the HPD standard deviation from the manufacturer's literature (product container or website) or NIOSH website.
Step 4 – Multiply the standard deviation by 2 (step 3 x 2).
Step 5 – Adjust the mean attenuation (step 2 – step 4).
Step 6 – Adjust the readings (step 1 – step 5).
Step 7 – List the A-weighting Corrections (*Fundamentals of Industrial Hygiene*, pg 216).
Step 8 – List the A-weighted attenuated noise (step 6 + step 7).

Frequency Hz	125	250	500	1000	2000	4000	8000
1. Results							
2. Mean (Avg) Attenuation							
3. Std Deviation							
4. Adjusted Std Deviation (Row 3 X 2)							
5. Adj Mean Attenuation (Row 2 – Row 4)							
6. Adjusted Readings (Row 1 – Row 5)							
7. A-Weighting Corrections (from list)							
8. A-Weighted Attenuation Noise (Row 6 + Row 7)							

2. The A-weighted correction factors table below, can be found in ANSI Std S1.4-1983 (R2006), in AIHA, The Occupational Environment: *It's Evaluation, Control, and Management*, 2nd Ed, Table 21.2 and in *Fundamentals of Industrial Hygiene*, 5th Ed, pg 216 Table 9-C.

HZ	125	250	500	1K	2K	4K	8K
CF	-16.1	-8.6	-3.2	0	+1.2	+1	-1.1

3. **Octave Band Analysis Formula:**

$$SPL = 10\log\left[10^{\left(\frac{SPL1}{10}\right)} + 10^{\left(\frac{SPL2}{10}\right)} + ... + 10^{\left(\frac{SPLn}{10}\right)}\right]$$

SPL_n = SPL for each source or SPL of each octave band

4. **Noise Reduction Rating Method Formula:**

To determine the at-the-ear A-weighted SPL using the NRR method, subtract 7 dB from the NRR and subtract the adjusted NRR from the A-weighted SPL for the noise source. This is reflected in the following formula:

SPL in dB(A) – (NRR – 7 dB) = presumed at the ear exposure

5. Double Hearing Protection - Add 3 dB to the highest noise reduction rating (NRR) of the plug or muff to estimate the combined protective rating if actual attenuation data for the combination is not available.

TRAINEE REVIEW QUESTIONS

STS Line Item 4.10.12 - Verify adequacy of hearing protection devices (calculate attenuation factor)

1. Problem #1: Calculate attenuation factor for Howard Leight Thunder 29 earmuff using the following OBA method. The noise source is a drill used for 2 hours each day. Use the noise source sound levels (dB) results from Step 1, which have been provided for you in the table below. Use this table to enter your answers for each step (2-8).

Step 1 – List the results from the OBA.
Step 2 – List the HPD mean attenuation from the manufacturer's literature (product container or website) or NIOSH website, NIOSH Hearing Protector Device Compendium http://www2a.cdc.gov/hp-devices/hp_srchpg01.asp.
Step 3 – List the HPD standard deviation from the manufacturer's literature (product container or website) or NIOSH website.
Step 4 – Multiply the standard deviation by 2 (step 3 x 2).
Step 5 – Adjust the mean attenuation (step 2 – step 4).
Step 6 – Adjust the readings (step 1 – step 5).
Step 7 – List the A-weighting Corrections (*Fundamentals of Industrial Hygiene*, pg 216).
Step 8 – List the A-weighted attenuated noise (step 6 + step 7).

Frequency Hz	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
1. Results	**84**	**86**	**85**	**89**	**93**	**95**	**93**
2. Mean (Avg) Attenuation							
3. Std Deviation							
4. Adjusted Std Deviation (Row 3 X 2)							
5. Adj Mean Attenuation (Row 2 – Row 4)							
6. Adjusted Readings (Row 1 – Row 5)							
7. A-Weighting Corrections (from list)							
8. A-Weighted Attenuation Noise (Row 6 + Row 7)							

Complete and calculate Step 9 on the next page.

STEP 9

Finally calculate the overall dB(A) level. Add the dB(A) level together using the following formula:

$$SPL = 10\log\left[10^{\left(\frac{SPL1}{10}\right)} + 10^{\left(\frac{SPL2}{10}\right)} + ... + 10^{\left(\frac{SPLn}{10}\right)}\right]$$

2. Interpret results for problem #1.

3. Calculate the at-the-ear A-weighted sound pressure level for EAR EZ Fit earplugs using the noise reduction rating (NRR) method. There is a single noise source: a pneumatic wrench that produces 98 dB(A) and 108 dB(C) and is used 3 hours a day).

4. What could happen if too much noise is attenuated by hearing protectors?

PERFORMANCE CHECKLIST

STS Line Item 4.10.12 - Verify adequacy of hearing protection devices (calculate attenuation factor)

Proficiency Code:	3c
PC Definition:	Can do all parts of the task. Needs only a spot check of completed work. Can identify why and when the task must be done and why each step is needed.

DID THE TRAINEE…	YES	NO
Octave Band Method		
1. Identify/gather noise source and octave band analysis (OBA) survey results for each noise source?		
2. Identify total time of exposure for each noise source?		
3. List results from the OBA survey?		
4. List the HPD mean attenuation?		
5. List the HPD standard deviation?		
6. Multiply the standard deviation by 2?		
7. Adjust the mean attenuation?		
8. Adjust the readings?		
9. List the A-weighting correction values?		
10. List the A-weighted attenuated noise?		
11. Obtain the overall attenuation (add dbA levels together using the formula)?		
12. Determine if HPD attenuates adequately?		
13. Utilize OEHMIS (DOEHRS or equivalent), as applicable to document results?		
NRR Method		
1. Locate the Noise Reduction Rating (NRR) for the HPD you are evaluating?		
2. Subtract 7 dB from the NRR?		
3. Determine if HPD attenuates correctly?		

4. If dual HPDS are used, add 3 dB to the highest noise reduction rated plug/muff?		
5. Utilize OEHMIS (DOEHRS or equivalent), as applicable to document results?		
Did the trainee successfully complete the task?		

TRAINEE NAME (PRINT)

TRAINER NAME (PRINT)

ANSWERS

1. Problem #1: Calculate attenuation factor for Howard Leight Thunder 29 earmuff using the following OBA method. The noise source is a drill used for 2 hours each day. Use the noise source sound levels (dB) results from Step 1, which have been provided for you in the table below. Use this table to enter your answers for each step (2-8).

Step 1 – List the results from the OBA.
Step 2 – List the HPD mean attenuation from the manufacturer's literature (product container or website) or NIOSH website, NIOSH Hearing Protector Device Compendium http://www2a.cdc.gov/hp-devices/hp_srchpg01.asp.
Step 3 – List the HPD standard deviation from the manufacturer's literature (product container or website) or NIOSH website.
Step 4 – Multiply the standard deviation by 2 (step 3 x 2).
Step 5 – Adjust the mean attenuation (step 2 – step 4).
Step 6 – Adjust the readings (step 1 – step 5).
Step 7 – List the A-weighting Corrections (*Fundamentals of Industrial Hygiene*, pg 216).
Step 8 – List the A-weighted attenuated noise (step 6 + step 7).

Frequency Hz	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
1. Results	**84**	**86**	**85**	**89**	**93**	**95**	**93**
2. Mean (Avg) Attenuation	19.6	24.8	32.6	38.6	38.9	38.8	40.7
3. Std Deviation	2	2.4	2.2	1.7	1.7	1.7	2.3
4. Adjusted Std Deviation (Row 3 X 2)	4	4.8	4.4	3.4	3.4	3.4	4.6
5. Adj Mean Attenuation (Row 2 – Row 4)	15.6	20	28.2	35.2	35.5	35.4	36.1
6. Adjusted Readings (Row 1 – Row 5)	68.4	66	56.8	53.8	57.5	59.6	56.9
7. A-Weighting Corrections (from list)	-16.1	-8.6	-3.2	0	1.2	1.0	-1.1
8. A-Weighted Attenuation Noise (Row 6 + Row 7)	52.3	57.4	53.6	53.8	58.7	60.6	55.8

STEP 9

Finally calculate the overall dB(A) level. Add the dB(A) level together using the following formula:

$$SPL = 10\log\left[10^{\left(\frac{SPL1}{10}\right)} + 10^{\left(\frac{SPL2}{10}\right)} + ... + 10^{\left(\frac{SPLn}{10}\right)}\right]$$

$$SPL = 10\log\left[10^{\left(\frac{52.3}{10}\right)} + 10^{\left(\frac{57.4}{10}\right)} + 10^{\left(\frac{53.6}{10}\right)} + 10^{\left(\frac{53.8}{10}\right)} + 10^{\left(\frac{58.7}{10}\right)} + 10^{\left(\frac{60.6}{10}\right)} + 10^{\left(\frac{55.8}{10}\right)}\right]$$

$$SPL = 10\log\left[10^{5.23} + 10^{5.74} + 10^{5.36} + 10^{5.38} + 10^{5.87} + 10^{6.06} + 10^{5.58}\right]$$

$$SPL = 10\log\left[169824 + 549541 + 229087 + 239883 + 741310 + 1148153 + 380189\right]$$

$$SPL = 10\log\left[3457987\right]$$
$$SPL = 65.4\,\text{dBA}$$

Where SPL_n= sound pressure level for each octave band.

For our example, the final SPL is 65.4 dB(A), so the HPD will attenuate the noise levels to below the standard.

(Source: 4B051 CDC, Bioenvironmental Engineering Journeyman: Volume 3, Unit 5, p. 5-38-39, top.)

*Note: Leave Step 1 with data in the table. Could also leave all other steps and remove all data from the tables, students must fill in the information following the steps provided and the blank tables.

2. Interpret results for problem #1.

A: Does it provide adequate protection to the worker? Yes, because it is below the criterion level of 85 dBA, but it may attenuate too much noise because it is below the recommended range of 76-84 dBA.

(Source: 4B051 CDC)

3. Calculate the at-the-ear A-weighted sound pressure level for EAR EZ Fit earplugs using the noise reduction rating (NRR) method. There is a single noise source: a pneumatic wrench that produces 98 dB(A) and 108 dB(C) and is used 3 hours a day).

A: NRR is listed at 28 on the manufacturer's website
dBA – (NRR -7)
98 – (28-7)
98-21 = 77

(Source: 4B051 CDC)

4. What could happen if too much noise is attenuated by hearing protectors?

A: If too much noise is attenuated, the worker may not be able to hear their coworker talking to them, giving instructions or calling out warnings. Care must be taken to avoid over protection.

(Source: 4B051 CDC)