DEPARTMENT OF THE AIR FORCE
Headquarters US Air Force
Washington, DC 20330-1030

QTP 4B051-10
23 March 2015

AIR FORCE SPECIALTY CODE 4B051
BIOENVIRONMENTAL ENGINEERING

Biological Health Hazards

QUALIFICATION TRAINING PACKAGE

Accessibility: ***Publications and forms are available on the e-publishing website at http://www.e-publishing.af.mil for downloading or ordering.***

Realeasability: ***There are no releasability restrictions on this publication.***

Table of Contents

STS Line Item 4.7.2: Identify/Evaluate biological health hazards

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:	• Fundamentals of Industrial Hygiene, Current Edition, Chapter 15 & 16. • AFMAN 48-155, *Occupational and Environmental Health Program*, 22 July 14, Chapters 3-5.
Additional Supporting References:	• BE Field Manual , 2009 • OSHA 29 CFR 1910.139, TB Standard. • Centers for Disease Control and Prevention website (http://www.bt.cdc.gov/agent/agentlist-category.asp)
CDC Reference:	4B051
Training Support Material:	• NIOSH Pocket Guide. • Computer Access. • Occupational and Environmental Health Readiness System (DOEHRS). • Medical Management of Biological Casualties Handbook (Bluebook). • Applicable Intelligence Sources **(see Task Step Note 9).** • Toxic Industrial Chemical/Toxic Industrial Material (TIC/TIM) Vulnerability Assessments. • Observations and interviews.
Specific Techniques:	Using given example(s) and scenario(s), conduct hands-on training and evaluation.
Criterion Objective:	Accurately identify and evaluate biological hazards via health risk assessments (HRA) principles, perform sampling/testing procedures (optional), and document data and results while successfully completing all checklist items with limited trainer assistance.

Notes:
This TRAINING MODULE provides an instrument to assess the trainee's knowledge and understanding of the definitions and processes required to perform accurate and comprehensive analysis, evaluation, and reporting of biological hazards. Its task-step format directs the trainee to demonstrate acumen regarding categorization of biological hazards and organisms, determination of routes of entry, and the risk and impact of warfare agents.

It continues by assessing the trainee's knowledge of informational sources and situational data and his/her ability to use this data in reviewing the factors impacting the biological health of the specific location. Knowledge of available sampling equipment is checked, while the sampling process has been stated as an optional task step. The conclusive step checks the trainee's ability to accurately compile a findings report and enter this data into the DOEHRS.

NOTE: This training does not include operation and procedures for use of biological detection equipment. Refer to respective manufacturer's instructional manuals for proper use of sampling devices, or appropriate TRAINING MODULE for device sampling procedures.

TASK STEPS

1. Categorize (potential) biological hazards[1].
2. Determine routes of entry and means of transmission[2].
3. Determine category of microbiological organisms[3].
4. Determine Category A[4], B[5], or C[6] for biological hazard.
5. Identify unique characteristics of hazard[7].
6. Determine methods of delivery/dissemination[8].
7. Review reports/data collected in Task Steps 1 and 2.
8. Review site-specific data in Defense Occupational and Environmental Health Readiness System (DOEHRS) or other intelligence sources[9].
9. Review threat factors[10].
10. Review factors impacting biological health[11].
11. Conduct sampling[12].
12. Document data and results obtained.

LOCAL REQUIREMENTS: None

NOTES:

1. Potential biological hazards include:
    a. Biological agent
    b. Biological warfare
    c. Pathogen
    d. Bloodborne pathogen
    e. Other infectious materials
    f. Infection
    g. Disease
    h. Chain of infection (see below)

    The six **conditions** (or links) necessary for infection and illness to occur are:
    1. The agent must be pathogenic.
    2. There must be a reservoir of a sufficient number for the organism to live and reproduce.
    3. The agent must be able to escape from the reservoir.
    4. The organism must be transferable or able to move or be moved through the environment by various means.
    5. There must be a portal of entry to the new host.
    6. The new host must be a susceptible agent

2. Routes of entry include:
    a. Inhalation
    b. Absorption via dermal contact
    c. Ingestion
    d. Injection

Means of transmission include:
1. Contact transmission
2. Vector-borne transmission
3. Airborne transmission

3. Categories of microbiological organisms included:
   a. Bacteria
   b. Viruses
   c. Other organisms (fungi, parasites and prions)

4. Category A viruses are those that:
   a. Can be easily spread or transmitted from person to person,
   b. Result in high death rates and have the potential of major public health impact,
   c. Might cause public panic and social disruption,
   d. Require special attention for public health preparedness.

   Category A viruses include:
   1. Variola major (smallpox)
   2. *Bacillus anthracis* (anthrax)
   3. *Yersinia pestis* (plague)
   4. *Clostridium botulinum* toxin (botulism)
   5. *Francisella tularensis* (tularaemia)
   6. Filoviruses
   7. Ebola hemorrhagic fever
   8. Marburg hemorrhagic fever
   9. Arenaviruses
   10. Lassa (Lassa fever)
   11. Junin (Argentine hemorrhagic fever) and related viruses

5. Category B viruses are those that:
   a. Are moderately easy to spread,
   b. Result in moderate illness rates and low death rates, and
   c. Require specific enhancements of CDC's laboratory capacity and enhanced disease monitoring.

   Category B viruses include:
   1. *Coxiella brunette* (Q fever)
   2. *Brucella species* (brucellosis)
   3. *Burkholderia mallei* (glanders)
   4. Alphaviruses
   5. Venezuelan encephalomyelitis
   6. Eastern and Western equine encephalomyelitis
   7. Ricin toxin from Ricinus communis (castor beans)
   8. Epsilon toxin of *Clostridium perfringens*
   9. Staphylococcus enterotoxin B
   10. Food- or waterborne pathogens

6. Category Cs viruses are those that:
   a. Are easily available,
   b. Are easily produced and spread, and
   c. Have potential for high morbidity and mortality rates and major health impact.

   Category C viruses include:
   1. Nipah virus
   2. Hantaviruses
   3. Tickborne hemorrhagic fever viruses
   4. Tickborne encephalitis viruses
   5. Yellow fever
   6. Multidrug-resistant tuberculosis

Additional information on A, B and C category disease agents can be found at the Center for Disease Control and Prevention website, currently located at: http://www.bt.cdc.gov and searching for "agent category list."

7. Hazard characteristics may include:
    a. Low Agent Requirement
    b. Large Area Coverage
    c. Affected by the Weather (Sunlight, Relative Humidity, Wind)
    d. Delayed Effects
    e. Pervasive
    f. Nondestructive to Nonliving Things
    g. Difficult to detect
    h. Easy to produce
    i. Broad Range of Effects

8. Methods of delivery/dissemination include:
    a. Aerosol
    b. Contamination of Food and Water
    c. Injection
    d. Vector-Borne

9. Intelligence sources include (but are not limited to):
    a. Historical and current property use of the site
    b. Known hazardous waste sites
    c. Known contamination and pollution in air, water and soil.
    d. Typical climate conditions, including normal and extreme temperatures, seasonal precipitation, and seasonal prevalent wind directions and velocities.
    e. Known property use including type of infrastructure, transportation networks, water treatment and distribution systems and wastewater collection and treatment systems.
    f. Maps and topographic and geological information relevant to the deployment area.
    g. Water and Food Vulnerability Assessments for the installation (site).
    h. After Action Reports (AARs)
    i. Prior reports from inspection agencies (OSHA, Joint Commission, Health Services Inspection (HSI).
    j. The Medical treatment facility Infection Control Plan, Tuberculosis (TB) Infection Control Plan and Bloodborne Pathogen (BBP) Exposure Control Plan.

10. Threat Factors include:
    a. Type of mission.
    b. Length of operation/deployment.
    c. Living conditions.
    d. Working conditions.
    e. Geographical location and conditions.
    f. Exposure parameters.
    g. Personal protective equipment (PPE) or individual protective equipment.
    h. Medical treatment resources.

11. Factors impacting biological health include:
    a. Determine effects on personnel.
    b. Consider affect on mission and operational requirements.
    c. Consider psychological effects on unit.
    d. Consider applicable occupational or exposure standards.
    e. Consider the potential for exposure variability.
    f. Identify plausible outcomes or potential consequences.
    g. Document determinations.

12. Sampling of biological agents may involve sampling a number of media. Specific equipment sampling training is not dealt with in this training module. Equipment that can be used to collect, detect, and/or identify biological agents includes:

a. Biological Sampling Kit including the Hand held Assay (HHA)
    i. Limited detection for surface testing for eight agents
b. XMX/2-MIL Bio-Aerosol Sampler
    i. Stationary piece of equipment that draws air samples to collect aerosols from the air.
c. Ruggedized Advanced Pathogen Identification Device (RAPID)
    i. Portable specialty instrument for military field hospitals and first responders that detects five biological agents.
d. Joint Biological Agent Identification and Diagnostic System (JBAIDS)
    i. Laboratory instrument system that rapidly identifies 14 biological threat agents from a variety of clinical specimen and environmental samples.
e. Portal Shield
    i. Automated networked biological detection system specifically designed for fixed sites; identifies 10 warfare agents simultaneously.
f. Joint Biological Standoff Detection System (JBSDS)
    i. Provides near-real-time detection of biological conditions and early warning of biological attacks when mounted on platforms.
g. HAZMAT ID
    i. Does not identify specific pathogens; indicates presence of biological material.
h. Dry Filter Unit
    i. Portable aerosol sample collector used inside building or limited area; collects particles.
i. Chem/Bio Sampling Kit (QuickSilver)(for sample collection)
    i. Highly efficient field sampling collection kits, capable of taking up to six solid, liquid and or wipe samples.

TRAINEE REVIEW QUESTIONS

STS Line Item 4.7.2: Identify/Evaluate biological health hazards

1. List the seven categories of bio-hazardous agents.
    1.
    2.
    3.
    4.
    5.
    6.
    7.
2. List the four general characteristics of biological threats.
    1.
    2.
    3.
    4.
3. List the conditions (or links) necessary for infection to occur.
4. Why do "High-Priority" biological warfare agents (Category A) pose the highest risk to the public and national security?

5. Which category of agents is easily available and spread, yet has the potential of high morbidity and mortality rates?
6. Define a vector-borne biological agent.
7. Which method is most effective in delivering a biological warfare agent?
8. List one source of existing documentation for obtaining biological hazard site information.

9. Match the equipment device to its capabilities:

A. Biological Sampling kit	_____ Does not identify specific pathogens; indicates presence of biological material.
B. XMX/2L-MIL Bio-Aerosol Sampler	_____ Laboratory instrument system that rapidly identifies 14 biological threat agents from a variety of clinical specimen and environmental samples.
C. RAPID	_____ Stationary piece of equipment that draws air samples to collect aerosols from the air.
D. Joint Biological Agent ID and Diagnostic System	_____ Automated networked biological detection system specifically designed for fixed sites; identifies 10 warfare agents simultaneously.
E. Portal Shield	_____ Highly efficient field sampling collection kits, capable of taking up to six solid, liquid and or wipe samples.
F. Joint Biological Standoff Detection	_____ Portable aerosol sample collector used inside building or limited area; collects particles.
G. HAZMAT ID	_____ Provides near-real-time detection of biological conditions and early warning of biological attacks when mounted on platforms.
H. Dry Filter Unit	_____ Limited detection for surface testing for eight agents.
I. Chemical/Biological Sampling Kit	_____ Portable specialty instrument for military field hospitals and first responders that detects five biological agents.

PERFORMANCE CHECKLIST

STS Line Item 4.7.2: Identify/Evaluate biological health hazards

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
1. Categorize (potential) biological hazards?		
2. Determine routes of entry and means of transmission?		
3. Determine category of microbiological organisms?		
4. Determine Category A, B, or C for biological hazard?		
5. Identify unique characteristics of hazard?		
6. Determine methods of delivery/dissemination?		
7. Review reports/data collected in Task Steps 1 and 2?		
8. Review site-specific data in Defense Occupational and Environmental Health Readiness System (DOEHRS) or other intelligence sources?		
9. Review threat factors?		
10. Review factors impacting biological health?		
11. Conduct sampling?		
12. Document data and results obtained?		
Did the trainee successfully complete the task?		

TRAINEE NAME (PRINT) TRAINER NAME (PRINT)

ANSWERS

1. List the seven categories of bio-hazardous agents.

   A:
   1. Bacteria
   2. Fungi
   3. Parasites
   4. Prions
   5. Rickettsiae
   6. Viruses other than arboviruses
   7. Arboviruses

   (Source: Centers for Disease Control and Prevention website (http://www.bt.cdc.gov/agent/agentlist-category.asp)

2. List the four general characteristics of biological threats.

   A:
   1. They are contagious.
   2. There is an incubation period.
   3. There is a communicability period.
   4. There is a resistance level

   (Source: Centers for Disease Control and Prevention website (http://www.bt.cdc.gov/agent/agentlist-category.asp)

3. List the conditions (or links) necessary for infection to occur.

   A:
   The agent must be pathogenic.
   There must be a reservoir of a sufficient number for the organism to live and reproduce.
   The agent must be transferable (able to move/be moved through the environment.
   There must be a portal of entry into the new host (individual).
   The new host must be susceptible to the biological agent.

   (Source: Centers for Disease Control and Prevention website (http://www.bt.cdc.gov/agent/agentlist-category.asp)

4. Why do "High-Priority" biological warfare agents (Category A) pose the highest risk to the public and national security?

   A:
   They can be easily spread or transmitted from person to person.
   They result in high death rates and have the potential of major public health impact.
   They might cause public panic and social disruption.
   They require special attention for public health preparedness.

   (Source: Centers for Disease Control and Prevention website (http://www.bt.cdc.gov/agent/agentlist-category.asp)

5. Which category of agents is easily available and spread, yet has the potential of high morbidity and mortality rates?

   A: Category C

   (Source: Centers for Disease Control and Prevention website (http://www.bt.cdc.gov/agent/agentlist-category.asp)

6. Define a vector-borne biological agent.

   A: A vector-borne agent is a biological agent that can be delivered using vectors such as mosquitoes, flies, fleas, lice and ticks.

   (Source: Centers for Disease Control and Prevention website (http://www.bt.cdc.gov/agent/agentlist-category.asp)

7. Which method is most effective in delivering a biological warfare agent?

   A: Aerosol

   (Source: Centers for Disease Control and Prevention website (http://www.bt.cdc.gov/agent/agentlist-category.asp)

8. List one source of existing documentation for obtaining biological hazard site information.

   A: (any of the following)
   DOEHRS
   Water (and Food) Vulnerability Assessments for the installation (site).
   After Action Reports (AARs).
   Prior reports from inspection agencies (OSHA, Joint Commission, Health Services Inspection (HIS)).
   The medical treatment facility Infection Control Plan.

   (Source: Centers for Disease Control and Prevention website (http://www.bt.cdc.gov/agent/agentlist-category.asp)

9. Match the equipment device to its capabilities:

J. Biological Sampling kit	G-- Does not identify specific pathogens; indicates presence of biological material.
K. XMX/2L-MIL Bio-Aerosol Sampler	D-- Laboratory instrument system that rapidly identifies 14 biological threat agents from a variety of clinical specimen and environmental samples.
L. RAPID	B-- Stationary piece of equipment that draws air samples to collect aerosols from the air.
M. Joint Biological Agent ID and Diagnostic System	E-- Automated networked biological detection system specifically designed for fixed sites; identifies 10 warfare agents simultaneously.
N. Portal Shield	I-- Highly efficient field sampling collection kits, capable of taking up to six solid, liquid and or wipe samples.
O. Joint Biological Standoff Detection	H-- Portable aerosol sample collector used inside building or limited area; collects particles.
P. HAZMAT ID	F-- Provides near-real-time detection of biological conditions and early warning of biological attacks when mounted on platforms.
Q. Dry Filter Unit	A-- Limited detection for surface testing for eight agents.
R. Chemical/Biological Sampling Kit	C-- Portable specialty instrument for military field hospitals and first responders that detects five biological agents.

(Source: Career Development Course 4B051)

STS Line Item 4.7.2.1: Hand-Held Assays (e.g., HHA Kits)

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:	• DoD Biological Sampling Kit Response Manual • AIM Biological Sampling Kit Training • Critical Reagents Program Hand Held Assay Panel (ESOH Service Center Website) https://hpws.afrl.af.mil/dhp/OE/ESOHSC/...(search ESOH Website) • Hand Held Assay Information Paper (ESOH Service Center Website) https://hpws.afrl.af.mil/dhp/OE/ESOHSC/...(search ESOH Website)
Additional Supporting References:	None
CDC Reference:	4B051
Training Support Material:	Positive or negative trainer HHA kits
Specific Techniques:	Conducts hands-on training and evaluation
Criterion Objective:	Given an HHA, perform sampling successfully completing all checklist items with limited trainer assistance on only the hardest parts.

Notes:

*****Hand Held Assay (HHA) is a form of biological assay called immunochromatography and is designed to provide a quick and accurate presumptive identification of selected biological warfare agents. The HHA is easy to use but, for it to be effective, it must be used correctly and under the right conditions. The HHA is not designed to be used in all circumstances. HHAs should not be used under the following conditions:

- Sampling porous surfaces. Porous surfaces contain grooves that can trap an agent thereby lowering the concentration available for testing. In addition, the grooves may contain dirt or other substances that could hinder the effectiveness of the assay.
- Sampling in areas where a lot of dust/dirt has collected. As previously mentioned, dirt and dust may contain inhibitors that effect the reliability of the assay.
- Sampling where there is an excessive concentration of the suspected agent. This may cause clogging (hook effect) and can lead to an inconclusive result. Where excessive amounts of sample exist, diluting the sample in HHA buffer 1:10 or 1:100 should be sufficient to obtain a reliable result.
- Soil sampling. Soil may contain microorganisms that have similar antigentic properties to a biological warfare agent and could cause a false positive. Soil also contains numerous inhibitors that could adversely affect the HHA result.
- When the HHA has been removed from its protective packaging prior to initiating a test the membrane can absorb humidity (when removed from the protective package) which can lead to an inconclusive test result.

An HHA is a one-time use capability designed to presumptively identify agents. The current capability allows for presumptive identification of up to10 different biological warfare threat and 4 stimulant agents. The results can be utilized to advise and assist in facilitating the resolution of a biological incident. HHAs are NOT designed to be the sole method of identification and are not for diagnostic use.

All results whether positive, negative or inconclusive should be documented. It is important to keep in mind that no matter what the outcome of an HHA, these tests provide only presumptive identification and that the samples will need further evaluation at a confirmatory lab.

Ensure when using an HHA the area where the HHAs are being used is flat and clean.

TASK STEPS

1. Ensure HHA is at room temperature prior to use.
2. Keeping the HHA panel sealed, open the bottle of buffer solution and wet the applicator.
3. Swipe the sample area (10 cm x 10 cm square).
4. Remove the nozzle from the buffer solution.
5. Break off the swab tip in buffer bottle.
6. Replace and cap nozzle.
7. Shake for 30 seconds.
8. Open panel on HHA.
9. Make sure the HHA is laying on a flat surface
10. Add 3-4 drops of buffer solution to each sample well.
11. Wait 15 minutes (+/- 1 minute) for the HHA results to develop[1].
12. Read immediately, interpreting results[2].

LOCAL REQUIREMENTS:

NOTES:

1. Sample results must be read <u>within</u> this time period = 15 minutes (+/- 1 minute).

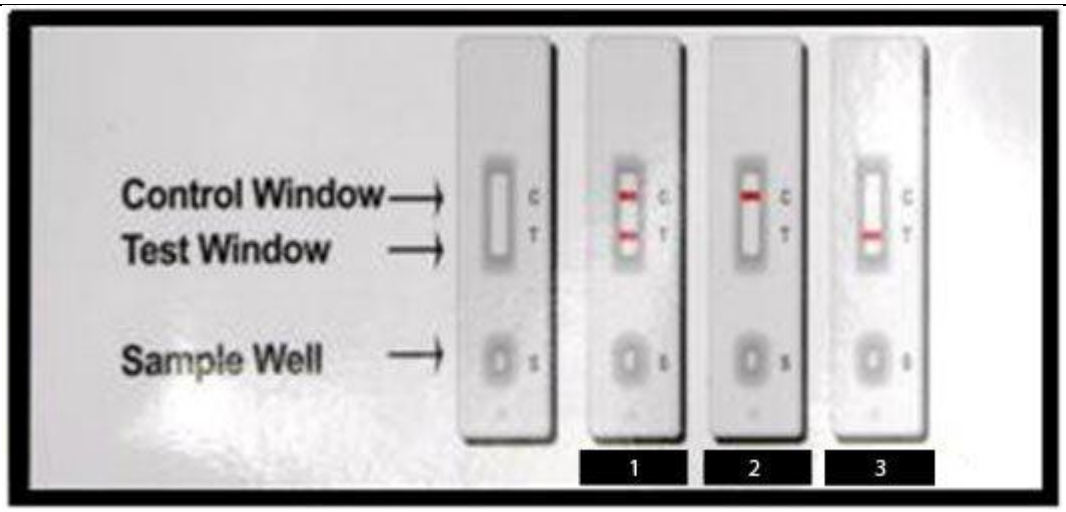
2. When reading an assay, any visible test line, even a very faint one, should be considered real. There are four potential outcomes that may be observed after running an HHA.

- The first potential outcome is two red lines indicating a positive assay. This may also be a result of matrix effects (see below) so running the sample a second time following diluting 1:10 and 1:100 in HHA buffer would be prudent.

- The second outcome is a single line, the control line. This may be a valid negative or may be the result of the "hook effect" (see below). Again, running the sample a second time following diluting 1:10 and 1:100 in HHA buffer is advised.

- The third outcome is a positive test line but no control line. This is probably due to a faulty assay which requires running the sample again with a new set of HHA's.

The fourth outcome is where no lines show up. This can be the result of a faulty assay, a matrix effect, or the assay may have been exposed to moisture. The nitrocellulose membrane must be dry in order to wick the sample. If an assay has an incomplete control or positive line after running, the assay is also faulty. To resolve this, a new HHA is used utilizing sample dilutions of 1:10 and 1:100 in HHA buffer.



1- Positive Result
2- Negative result
3- Inconclusive/faulty assay

TRAINEE REVIEW QUESTIONS

STS Line Item 4.7.2.1: Hand-Held Assays (e.g., HHA Kits)

1. When using an HHA, what size is the recommended sample area?
2. What step follows shaking the buffer solution for 30 seconds?
3. How many drops of buffer solution are added to each sample well?
4. Within what timeframe must the assay be read for results?

PERFORMANCE CHECKLIST

STS Line Item 4.7.2.1: Hand-Held Assays (e.g., HHA Kits)

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
1. Ensure HHA is at room temperature prior to use?		
2. Keeping the HHA panel sealed, open the bottle of buffer solution and wet the applicator?		
3. Swipe the sample area (10 cm x 10 cm square)?		
4. Remove the nozzle from the buffer solution?		
5. Break off the swab tip in buffer bottle?		
6. Replace and cap nozzle?		
7. Shake for 30 seconds?		
8. Open panel on HHA?		
9. Make sure the HHA is laying on a flat surface?		
10. Add 3-4 drops of buffer solution to each sample well?		
11. Wait 15 minutes (+/- 1 minute) for the HHA results to develop?		
12. Read immediately, interpreting results?		
Did the trainee successfully complete the task?		

TRAINEE NAME (PRINT) TRAINER NAME (PRINT)

ANSWERS

1. When using an HHA, what size is the recommended sample area?

   A: 100 Cm^2 (10 cm x 10 cm square)

[Source: Hand Held Assay Information Paper (ESOH Service Center Website) https://hpws.afrl.af.mil/dhp/OE/ESOHSC/)]

2. What step follows shaking the buffer solution for 30 seconds?

   A: Opening the panel on HHA

[Source: Hand Held Assay Information Paper (ESOH Service Center Website) https://hpws.afrl.af.mil/dhp/OE/ESOHSC/)]

3. How many drops of buffer solution are added to each sample well?

   A: Add 3-4 drops of buffer solution to each sample well.

[Source: Hand Held Assay Information Paper (ESOH Service Center Website) https://hpws.afrl.af.mil/dhp/OE/ESOHSC/)]

4. Within what timeframe must the assay be read for results?

   A: Sample results must be read <u>within</u> this time period = 15 minutes (+/- 1 minute).

[Source: Hand Held Assay Information Paper (ESOH Service Center Website) https://hpws.afrl.af.mil/dhp/OE/ESOHSC/)]

STS Line Item 4.7.2.2: High Volume Biological Air Samplers (e.g., XMX)

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:	• XMX/2L-MIL User's Guide. • *Final Guidance Document For The Use Of The XMX/2L-MIL Aerosol Sampler,* March 2008, Air Force Institute of Operational Health (now USAFSAM).
Additional Supporting References:	• *Fundamentals of Industrial Hygiene,* Current Edition.
CDC Reference:	4B051
Training Support Material:	• XMX*. • Impingement nozzle replacement tool. • Phillips #2 screwdriver. • Centrifuge tubes. • Retaining nuts. • Liquid capture media. • 37 millimeter filter cassette for use as solid capture media. • Canister extraction tool. • Dry impingement module (DIM). • Dry impingement module nut. • Liquid impingement module (LIM). • O-ring set. • Petroleum jelly.
Specific Techniques:	Conduct hands-on training and evaluation.
Criterion Objective:	Given an XMX/2L-MIL sampling pump, perform pre-operational check and operate instrument successfully completing all checklist items with limited trainer assistance on only the hardest parts.

Notes:

***** The XMX high volume aerosol sampling system was built in response to the need for a weatherproof, outdoor aerosol collector. The XMX is only used for collection of particulate samples, it has no detection capabilities; therefore the identification of the unknown substances must be made using another instrument or through chemical analysis. The XMX can operate with either a liquid assembly or a dry filter assembly. Aerosolized samples can be collected directly in either a liquid-impinge containing 5 milliliters of liquid or on a 37 millimeter dry filter cassette. The unit consists of two main parts: 1) the main housing that contains the vacuum pump; blower; impinge; and the first, second, and third stage particle concentration chambers, and 2) the inlet stack, which contains the rain hood and hourglass (bubble level). Additionally, the XMX is designed to operate under field conditions, while wearing MOPP gear.

The Air Force currently uses the XMX/2L-MIL high-volume air sampler (Dycor Technologies Ltd., Edmonton Canada) for threat assessment of biological warfare agents (e.g., Bacillus anthracis and Yersinia pestis) and naturally-occurring micro-organisms which may present health risks to personnel (e.g., adenovirus serotype-14) and negatively impact operations.

TASK STEPS

SET UP FOR SAMPLING OPERATION:

(The following steps are standard for setting up the XMX regardless of type of sampling operation – liquid or dry.)

1. Identify area where the XMX can be set up.[1]
2. Remove the tape and Ziploc bag, which contains the main housing o-ring.
3. Stretch the main housing o-ring.
4. **Lightly** lubricate the main housing o-ring with petroleum jelly.
5. Place the main housing o-ring on the main housing.
6. Install the primary inlet.[2]
7. Install the inlet stack.[3]
8. Install the blower exhaust elbow – ensure the open end is facing down and away from the mail inlet stack.
9. Connect the weatherproof power cable to the power receptacle.
10. Open the liquid impingement module (LIM) access door to access the LIM body.[4]
11. If the liquid impingement nozzle is not already installed, slide on the nozzle retaining nut from the TOP, and then slide on the impingement nozzle o-ring.
12. Install the impingement nozzle with the o-ring on it. Thread the nozzle retaining nut with the impingement nozzle replacement tool and tighten the nozzle retaining nut against the o-ring until the impingement nozzle is held securely by the o-ring.[5]
13. Insert the 50-ml sample vial into the vial retaining nut so that the raised threads of the vial rest against the edge of the vial retaining nut.[6]
14. Thread the vial retaining nut into the LIM body.
15. Make sure the water trap jar is installed and empty of liquid.
16. Check the operation of the water trap jar drain valve located at the bottom of the trap jar by pushing up on the valve with your finger. It should unseat and reseat as you push up and release.
17. Visually check the LIM chamber for tools and other foreign objects.
18. Close the access door.

***The XMX is now ready for a pre-operational check.*

PRE-OPERATIONAL CHECK:

1. Determine if dry or wet analytical methods will be used for identification of unknown aerosols.[7]
2. Confirm *main power* switch is OFF.
3. Check the 15-AMP circuit breaker.[8]
4. Plug the main power cable into power source.
5. Set the operation mode of the run-timer to "H" (default mode).[9]
6. Set the interval of the run-time timer to a low number (for instance "5") and the time units to "M" for minutes.[10]
7. Turn the *main power* switch to the ON position.
8. Press and release the start button.
9. If collecting a liquid sample the user has the ability to check that the secondary flow pump is working.[11]
10. Check that air is exhausting from the XMX.[12]
11. Allow the run-time timer to expire.
12. Turn the *main power* switch to the OFF position.

***The pre-operational check is complete and you are now ready for sampling run.*

LIQUID SAMPLING OPERATION:

1. Place XMX within the recommended sampling zone area.[13]
2. Confirm the *main power* switch is OFF.
3. Open the LIM access door.
4. Insert the impingement nozzle into the LIM body and thread on the nozzle retaining nut. Use the nozzle replacement tool to tighten the nozzle retaining nut while holding the nozzle up against its seat in the LIM body.
5. Fill the sample collection vial with appropriate volume of sample collection liquid – typically 5 milliliters.
6. Insert the sample collection vial with the measure of sampling liquid into the vial retaining nut and thread the vial retaining nut into the LIM body.
7. Check the security of the LIM mounting, the vial, and all line connections.
8. Close the access door.
9. Set the run-time.
10. Turn the *main power* switch ON.

11. Press and release the start button.
12. Allow the run-time to expire.
13. Turn the *main power* switch OFF.
14. Open the access door and remove sample vial from the vial retaining nut and cap the sample, following proper sample retention procedures outlined in your sampling strategy.

SWITCHING TO DRY SAMPLING OPERATION:

1. Open the access door and twist-off the nozzle retaining nut and remove the liquid impingement nozzle.
2. Remove the quick connect fitting from the water trap.
3. Using a Phillips #2 screwdriver, remove the four screws from the LIM.
4. Carefully pull the LIM down.[14]
5. Install the dry impingement module (DIM) using the Phillips #2 screwdriver and the four screws.
6. Using your hand, screw on the DIM nut and connect the quick fitting to the bottom.
7. Unscrew the DIM nut.
8. Take the dry filter cartridge apart; there should be two component pieces.
9. Remove the red filter cap from the bottom half of the dry filter.
10. Install the open face of the bottom half of the dry filter on to the DIM.[15] Ensure filter is facing up.
11. Screw on the DIM nut.[16]
12. If the quick connect fitting on the bottom of the DIM nut is not connected, attach it to the DIM nut.
13. Close the DIM.
14. Set the run-time.
15. Turn the *main power* switch ON.
16. Press and release the start button.
17. Allow the run-time to expire.
18. Turn the *main power* switch OFF.
19. Open the DIM and remove the dry filter, following proper sample retention procedures outlined in your sampling strategy.

LOCAL REQUIREMENTS: None

NOTES:

1. The XMX/2L-MIL requires access to a 110 VAC (or 220 VAC, depending on the model) power source. ONLY use a weatherproof power cable when connecting to 110V/220V AC. Also, do not connect or disconnect the power cable while the unit is operating. If a power source is not available, you can use the inverter to get power from a vehicle.

2. Engage the alignment dowel in the primary nozzle plate and alignment groove in the inlet stack when installing the inlet stack. There is a black mark or notch on the primary inlet to assist you in locating the grove.

3. There is a rain hood available for the inlet stack to protect the instrument when sampling in inclement weather.

4. When the XMX/2L-MIL is running, the secondary flow pump draws air through the LIM allowing it to impinge an output flow-stream of particles into a liquid at a rate of 12 liters per minute. The particle-enriched flow-stream is directed through an impingement nozzle (custom pipette), into the sample vial (centrifuge tube) containing a measured volume of liquid (recommended volume is 5 milliliters). LIM associated components mounted in the LIM chamber include the water tap, the sample vial, and the impingement nozzle.

5. Using your finger, push up on the impingement nozzle while threading the nozzle retaining nut, to ensure that the impingement nozzle seats against the final (output) nozzle. Once the nozzle retaining nut is tight, carefully check that the impingement nozzle is seated correctly, by gently pulling on the impingement nozzle.

6. **CAUTION:** Since centrifuge tube dimensions by various manufacturers are not standard, it is important that the correct vial retaining nut be used. The blue vial retaining but originally shipped with the XMX/2L-MIL with the word *FISHER* inscribed on the side is **ONLY** to be used with *Fisher 50 milliliter centrifuge tubes* as listed in the parts list. If other centrifuge tubes are to be used, contact Dycor Technologies for the correct vial retaining nut.

7. The XMX/2L-MIL sampler operates, as stated previously, with either a liquid impinger or dry filter assembly. During liquid sampling, particles are impinged into a sample collection vial containing a specified liquid. The sample vial size is 50 milliliters and the volume of the liquid should be 5 milliliters. Once the liquid sample is collected, the tube is removed for subsequent analysis. Dry filter paper can be used in lieu of the liquid vial impinge. During dry sampling, the particles are forced onto the dry filter instead of being impinged in a solution. The dry filter is then removed and dissolved for further analysis.

8. If the circuit breaker is popped out, reset the breaker switch.

9. The operation mode selector lets you select letters from A to H to set the mode of operation – H is the default mode.

10. The three time switches allow you to set a time amount from 0 to 999 units. The time unit selector allows you to select *S* for seconds, *M* for minutes, *H* for hours, *0.1S* for tenths of seconds, *0.1M* for tenths of minutes, or *0.1H* for tenths of hours.

11. This is accomplished through a visual inspection. If the secondary pump is working properly, you should see a the sample media in the collection tube bubbling vigorously.

12. Place your hand underneath the blower exhaust elbow to ensure air is coming out of the exhaust.

13. It is recommended that the XMX be placed in the normal breathing zone range: 5-6 feet off the ground.

14. Be careful not to damage the o-ring on the final nozzle.

15. The filter will fit around the o-ring on the DIM. The fit must be tight.

16. Make sure the DIM nut is tightly secured to ensure no vacuum leaks occur.

****If the XMX/2L-MIL is being used for laboratory or field trials, using stimulants, it is recommended the system be air-purged between trials as a precaution against cross-contamination between sampling events, by following procedures outlined in the *XMX/2L-MIL USER'S GUIDE*.**

TRAINEE REVIEW QUESTIONS

STS Line Item 4.7.2.2: High Volume Biological Air Samplers (e.g., XMX)

1. How must you prepare the main housing o-ring before placing it on the main housing?
2. After placing the o-ring on the main housing, what three items must then be installed?
3. What is the first step when performing a pre-operational check?
4. When sampling for liquid, after filling the sample vial with the appropriate amount of sample liquid, you must do what?

5. Before turning the main power switch to the ON position, you must do what?

PERFORMANCE CHECKLIST

STS Line Item 4.7.2.2: High Volume Biological Air Samplers (e.g., XMX)

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
SET UP FOR SAMPLING OPERATION:		
(The following steps are standard for setting up the XMX regardless of type of sampling operation – liquid or dry.) 1. Identify area where the XMX can be set up?		
2. Remove the tape and Ziploc bag, which contains the main housing o-ring?		
3. Stretch the main housing o-ring?		
4. **Lightly** lubricate the main housing o-ring with petroleum jelly?		
5. Place the main housing o-ring on the main housing?		
6. Install the primary inlet?		
7. Install the inlet stack?		
8. Install the blower exhaust elbow – ensure the open end is facing down and away from the mail inlet stack?		
9. Connect the weatherproof power cable to the power receptacle?		
10. Open the liquid impingement module (LIM) access door to access the LIM body?		
11. If the liquid impingement nozzle is not already installed, slide on the nozzle retaining nut from the TOP, and then slide on the impingement nozzle o-ring?		
12. Install the impingement nozzle with the o-ring on it. Thread the nozzle retaining nut with the impingement nozzle replacement tool and tighten the nozzle retaining nut against the o-ring until the impingement nozzle is held securely by the o-ring?		
13. Insert the 50-ml sample vial into the vial retaining nut so that the raised threads of the vial rest against the edge of the vial retaining nut?		
14. Thread the vial retaining nut into the LIM body?		
15. Make sure the water trap jar is installed and empty of liquid?		
16. Check the operation of the water trap jar drain valve located at the bottom of the trap jar by pushing up on the valve with your finger. It should unseat and reseat as you push up and release?		
17. Visually check the LIM chamber for tools and other foreign objects?		
18. Close the access door?		
PRE-OPERATIONAL CHECK:		
1. Determine if dry or wet analytical methods will be used for identification of unknown aerosols?		
2. Confirm *main power* switch is OFF?		
3. Check the 15-AMP circuit breaker?		

4. Plug the main power cable into power source?		
5. Set the operation mode of the run-timer to "H" (default mode)?		
6. Set the interval of the run-time timer to a low number (for instance "5") and the time units to "M" for minutes?		
7. Turn the *main power* switch to the ON position?		
8. Press and release the start button?		
9. If collecting a liquid sample the user has the ability to check that the secondary flow pump is working?		
10. Check that air is exhausting from the XMX?		
11. Allow the run-time timer to expire?		
12. Turn the *main power* switch to the OFF position?		
LIQUID SAMPLING OPERATION:		
1. Place XMX within the recommended sampling zone area?		
2. Confirm the *main power* switch is OFF?		
3. Open the LIM access door?		
4. Insert the impingement nozzle into the LIM body and thread on the nozzle retaining nut. Use the nozzle replacement tool to tighten the nozzle retaining nut while holding the nozzle up against its seat in the LIM body?		
5. Fill the sample collection vial with appropriate volume of sample collection liquid – typically 5 milliliters?		
6. Insert the sample collection vial with the measure of sampling liquid into the vial retaining nut and thread the vial retaining nut into the LIM body?		
7. Check the security of the LIM mounting, the vial, and all line connections?		
8. Close the access door?		
9. Set the run-time?		
10. Turn the *main power* switch ON?		
11. Press and release the start button?		
12. Allow the run-time to expire?		
13. Turn the *main power* switch OFF?		
14. Open the access door and remove sample vial from the vial retaining nut and cap the sample, following proper sample retention procedures outlined in your sampling strategy?		
SWITCHING TO DRY SAMPLING OPERATION:		
1. Open the access door and twist-off the nozzle retaining nut and remove the liquid impingement nozzle?		
2. Remove the quick connect fitting from the water trap?		
3. Using a Phillips #2 screwdriver, remove the four screws from the LIM?		
4. Carefully pull the LIM down?		
5. Install the dry impingement module (DIM) using the Phillips #2 screwdriver and the four screws?		
6. Using your hand, screw on the DIM nut and connect the quick fitting to the bottom?		
7. Unscrew the DIM nut?		
8. Take the dry filter cartridge apart; there should be two component pieces?		
9. Remove the red filter cap from the bottom half of the dry filter?		
10. Install the open face of the bottom half of the dry filter on to the DIM.[15] Ensure filter is facing up?		
11. Screw on the DIM nut?		

12. If the quick connect fitting on the bottom of the DIM nut is not connected, attach it to the DIM nut?		
13. Close the DIM?		
14. Set the run-time?		
15. Turn the *main power* switch ON?		
16. Press and release the start button?		
17. Allow the run-time to expire?		
18. Turn the *main power* switch OFF?		
19. Open the DIM and remove the dry filter, following proper sample retention procedures outlined in your sampling strategy?		
Did the trainee successfully complete the task?		

TRAINEE NAME (PRINT)

TRAINER NAME (PRINT)

ANSWERS

1. How must you prepare the main housing o-ring before placing it on the main housing?

   A: Stretch and lightly lubricate the o-ring with petroleum jelly.

   (Source: XMX 2L-MIL Users Guide p. 3 (p. 13 pdf) steps 2 and 3)

2. After placing the o-ring on the main housing, what three items must then be installed?

A:

1. The primary inlet;
2. The inlet stack; and
3. The blower exhaust elbow.

(Source: XMX 2L-MIL Users Guide p. 3-4 (p. 13-14 pdf) steps 5, 6, 7)

3. What is the first step when performing a pre-operational check?

   A: Determine if dry or wet analytical methods will be used for identification of unknown aerosol.

   (Source: QTP 4.7.2.2 - Pre-Op Check 1)

4. When sampling for liquid, after filling the sample vial with the appropriate amount of sample liquid, you must do what?

   A: Insert the sample collection vial with the measure of sampling liquid into the vial retaining nut and thread the vial retaining nut into the LIM body.

   (Source: XMX 2L-MIL Users Guide p. 10 (p. 20 pdf Step 6)

5. Before turning the main power switch to the ON position, you must do what?

   A: Set the run-time.

   (Source: XMX 2L-MIL Users Guide p. 8 (p. 18 pdf) steps 5 and 6)

STS Line Item 4.7.5: Determine or establish biological sampling strategies

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:	• *Fundamentals of Industrial Hygiene*, 5th Ed, Chapter 14.,15
Additional Supporting References:	• *The Occupational Environment: Its Evaluation, Control, and Management*, 2nd Ed, Chapter 10.
CDC Reference:	4B051
Training Support Material:	N/A
Specific Techniques:	Conduct hands-on training and evaluation.
Criterion Objective:	Given activity assessment data and listed references, determine or establish an air sampling strategy successfully completing all checklist items with limited instructor assistance.

Notes:

*****For this QTP the assumption has been made that if a biological sampling strategy is needed then there is a need for further (specialized) assessment, thus a less than desirable level of confidence in hazard characterization exists. To identify a course of action (strategy), you must first identify the gap in data that is causing the lack of confidence. A good sampling strategy makes use of both worst-case and typical sampling methods, each selected to answer the questions what, where, when, how, and whom to sample

TASK STEPS

1. Gather critical information about potential/existing health threats.[1]
2. Determine the type of biological agent.[2]
3. Define the risk to base population, specific group and/or individual.[3]
4. Determine what type of media you will sample (i.e. air, water, soil, food, and human specimens such as blood, urine, or stool).
5. Coordinate with the base laboratory and potentially the Laboratory Response Network (LRN)[4] for sampling requirements and confirmatory analysis capabilities.
6. Select appropriate location to collect sample(s).
7. Select appropriate collection method (i.e. air sample with XMX, bulk liquid/solid samples with quicksilver kit)
8. Define sampling boundaries (i.e. how many samples are needed and/or when will samples be collected?)
9. Determine who will collect samples.
10. Determine appropriate sample preservation methods, if applicable.
11. Determine what available equipment can provide presumptive analysis (i.e. HHA's).
12. Determine limitations of available sampling equipment.[5]
13. Consider acceptable means of shipping/transporting biological samples (i.e. IATA, DOT).
14. Determine chain-of-custody requirements.
15. Utilize DOEHRS or equivalent to document sampling strategies.

LOCAL REQUIREMENTS: None

NOTES:

1. Many potential biological health threats associated with the mission and the workplace can be identified by employing the process of an occupational and environmental health site assessment (OESHA) process. The first step is to *gather critical information* about potential/existing health threats. Review the following data:

a. Defense Occupational and Environmental Health Readiness System (DOEHRS).
b. National Center for Medical Intelligence (NCMI).
c. Intelligence reports (enemy capabilities).
d. After-action reports for the area.
e. Epidemiological data.
f. US Army Public Health Command.
g. Disenfranchised employees.
h. Extremist groups.
i. Natural disasters.

2. Types and Categories of Biological Agents:

a. Category A: agents/diseases include anthrax, botulism, plague, smallpox, tularemia, and viral hemorrhagic fevers. Category A agents are the highest priority and include organisms that have the following characteristics:

- Easily disseminated or transmitted from person to person.

- Result in high mortality rates and have the potential for major public health impact.
- Cause public panic and social disruption.
- Require special action for public health preparedness.

b. Category B: agents/diseases include brucellosis, epsilon toxin of *Clostridium perfringens*, food safety threats, glanders, melioidosis, Q fever, ricin toxin, staphylococcal enterotoxin B, typhus fever, viral encephalitis, and water safety threats. Category B agents are the second highest priority and have the following characteristics:

- Moderately easy to disseminate.
- Result in moderate morbidity rates and low mortality rates.
- Require specific enhancements of CDC's diagnostic capacity and enhanced disease surveillance.

c. Category C agents include emerging infectious agents such as Nipah virus and Hantavirus, which could be engineered for mass dissemination in the future. Category C agents are the third highest priority agents and have these characteristics:

- Availability.
- Ease of production and dissemination.
- Potential for high morbidity and mortality rates and major health impact.

3. On an installation, certain occupations have a greater chance of coming into contact with biological threats. Nurses, technicians, doctors, laboratory personnel, janitorial staff, and emergency response personnel (e.g., security forces, fire department) may come in contact with bodily fluids, exposing them to blood borne pathogens. Blood borne pathogens are microorganisms present in human blood that can cause disease. Other susceptible occupations include wastewater treatment plant operators and plumbers that are exposed to water potentially contaminated with fecal matter and other bodily fluids, thus exposing them to biological threats. Existing OEH data is a good place to start gathering your initial information on workplace processes and potential biological threats.

4. Potential samples (powders, liquids) can be screened at a site with detection equipment and collected for laboratory analysis. Sampling should be coordinated with the base laboratory and potentially the Laboratory Response Network (LRN) for positive identification. The Center for Disease Control states, "The LRN is a national security asset, that with its partners, will develop, maintain, and strengthen an integrated domestic and international network of laboratories to respond quickly to biological, chemical, and radiological threats and other high priority public health emergencies need through training, rapid testing, timely notification and secure messaging of laboratory results."

5. See available sampling equipment in CDC Volume 2, Unit3.

TRAINEE REVIEW QUESTIONS

STS Line Item 4.7.5: Determine or establish biological sampling strategies

1. What can be used to collect biological agent particles suspended in air?
2. How many potential results can occur with an HHA and what are they?
3. Who should BE coordinate with prior to biological sampling?

PERFORMANCE CHECKLIST

STS Line Item 4.7.5: Determine or establish biological sampling strategies

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
1. Gather critical information about potential/existing health threats?		
2. Determine the type of biological agent?		
3. Define the risk to base population, specific group and/or individual?		
4. Determine what type of media you will sample (i.e. air, water, soil, food, and human specimens such as blood, urine, or stool)?		
5. Coordinate with the base laboratory and potentially the Laboratory Response Network (LRN) for sampling requirements and confirmatory analysis capabilities?		
6. Select appropriate location to collect sample(s)?		
7. Select appropriate collection method (i.e. air sample with XMX, bulk liquid/solid samples with quicksilver kit)?		
8. Define sampling boundaries (i.e. how many samples are needed and/or when will samples be collected?		
9. Determine who will collect samples?		
10. Determine appropriate sample preservation methods, if applicable?		
11. Determine what available equipment can provide presumptive analysis (i.e. HHA's)?		
12. Determine limitations of available sampling equipment?		
13. Consider acceptable means of shipping/transporting biological samples (i.e IATA, DOT)?		
14. Determine chain-of-custody requirements.		
15. Utilize DOEHRS or equivalent to document sampling strategies.		
Did the trainee successfully complete the task?		

TRAINEE NAME (PRINT) TRAINER NAME (PRINT)

ANSWERS

1. What can be used to collect biological agent particles suspended in air?

   A: XMX

   (Source: Career Development Course 4B051)

2. How many potential results can occur with an HHA and what are they?

   A: Four: Positive Assay, Negative Assay, Inconclusive Assay, and Faulty Assay

   (Source: Career Development Course 4B051)

3. Who should BE coordinate with prior to biological sampling?

   A:
   - Lab Response Network
   - Local Lab

   (Source: Career Development Course 4B051)