# Bioenvironmental Engineering Site Assessment I

## *Unit 14: Chemical Health Threats*

**Unit Description:** For this unit, you will be stationed at Kahua AFB in Honolulu, HI. As you work through your assignments, you will learn how to identify and analyze chemical health threats and develop control options, including ventilation, regulated areas, and respiratory protection.

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# Lesson 1: Identifying and Analyzing Chemical Health Threats

## Lesson Description

Workers in the refueling maintenance shop on base are exposed to JP-8 jet fuel as part of their job duties. In this lesson, you will be evaluating their exposure as part of a routine assessment to identify and analyze the chemical health threats present.

## Lesson Overview (Page 1 of 8)

By identifying and analyzing chemical health threats, you play a vital role in protecting the health and welfare of Air Force personnel and the community. As you conduct the routine assessment at the refueling maintenance shop, you will:

- Determine why and when chemical health threat identification and analysis should occur.
- Explain the steps for identifying and analyzing chemical health threats.
- Determine the health risk associated with chemical health threats.
- Recall chemical health threat control options.

**Audio Script**

**NCOIC:** Your assignment for the day is the routine assessment of the refueling maintenance shop.

## Scenario Challenge Point (Page 2 of 8)

Based on the instructions from your NCOIC, choose the statement that best describes why you were assigned this assessment of the refueling maintenance shop.

A A shop worker has expressed concern and you need to determine the exposure potential.

B A new process has been introduced and control decisions or recommendations need to be made.

C A routine assessment is scheduled to determine health threats and protect the health of personnel.

D An illness report has come in, and you need to minimize chemically-induced illnesses in the workplace.

## Why and When to Identify and Analyze Chemical Health Threats
(Page 2a of 8)

Any time personnel are using chemicals or may potentially be exposed to chemicals, it is important to understand what the chemicals are, how they're being used, and what the potential health effects are. Identifying and analyzing health threats are the first two steps of a Health Risk Assessment (HRA). You will also perform these steps throughout the Occupational and Environmental Health Site Assessment (OEHSA), as a cyclical, ongoing process. Listed below are common reasons for identifying and analyzing chemical health threats, as well as when the identification and analysis typically occur.

| Why? | When? |
|---|---|
| • To protect the health of personnel on the base and in the surrounding community so the mission can be successfully accomplished.<br>• To assess the health threats and determine the exposure.<br>• To minimize the incidents of chemically-induced illnesses in the workplace.<br>• To ensure that compliance and/or accreditation issues are addressed, as appropriate.<br>• To make control decisions or recommend controls.<br>• To allow the Commander to make an informed decision about the use of chemicals based on what the threats could be, in accordance with mission requirements. | • When work is performed involving chemical health threats to which personnel could be exposed.<br>• During an initial, routine, or special occupational health assessment.<br>• When a new process involving chemicals is being introduced into the workplace, or a process involving chemicals changes.<br>• When a work request is made or a workplace requests a chemical product.<br>• When a worker expresses concern about exposure or effects.<br>• When an illness or injury report occurs that suggests a chemically related situation.<br>• When industrial or community issues near the base may affect base personnel. |

## Scenario Challenge Point (Page 3 of 8)

Choose the words from the list to complete the sentence explaining how health threats are analyzed.

> During your analysis, you must place the health threat into the context of the ____________________ and operational _____________________ to influence your course of action (COA).

**Choices**

Requirements

Recommendations

Health Effects

Mission

## Steps for Identifying Chemical Health Threats (Page 3a of 8)

A critical first step in determining whether a potential or existing chemical exposure poses a health threat to a population during a specified period at a particular location is to gather information. You can identify chemicals in use from observing and understanding worker processes, environments, and habits; reviewing shop operations; conducting interviews; reading Material Safety Data Sheets (MSDS); and consulting the HazMat Pharmacy. While identifying which chemicals are of concern, you need to be able to determine the source and path of chemical exposures based on how processes are being performed.

When identifying a potential or actual health threat to the population at risk, you should not consider any countermeasures or controls necessary to reduce the threat. Even if controls are in place that reduce the threat, all chemicals present should be identified because of their inherent ability to cause harm. To determine what potential health risks exist from the chemicals you identify, you need to research the constituents of the chemicals, identifying their toxicity and what routes of entry are associated with the chemical(s). Keep in mind that sometimes, a chemical health risk can be generated through a process rather than use of a chemical. For example, when chromate primer on an aircraft is sanded, airborne concentrations of hexavalent chromium can be released.

You must also assess the vulnerability for each potential health risk and identify the exposure pathways present. By assessing how vulnerable personnel are to the exposure, you will be able to focus resources on credible health threats instead of tracking or assessing threats with minimal or no impact to the mission, operations, or personnel.

The three steps for identifying chemical threats are

1. Gather Information
2. Determine the potential or actual health threats
3. Assess the vulnerability for each potential health risk

## Steps for Analyzing Chemical Health Threats (Page 3b of 8)

Once you have completed a routine assessment and identified a chemical health threat that requires sampling, you would follow up with a special assessment to determine if controls are required. During your analysis, you must place the health threat into the context of the mission and operational requirements to influence your course of action (COA).

During your analysis, you will determine why the health threat is a potential or actual problem. Consider whether the threat can cause immediate or long-term health consequences and how it affects operational capability. Other functional areas should participate in the assessment as needed. For example, Public Health (PH) should be involved in an assessment for an infectious disease threat. Remember that you should consider the potential for exposure changes due to contributing factors such as weather or personnel movement.

You will determine the Health Risk Estimate (HRE) for each identified chemical by estimating the probability and severity of the health threat. Then, you'll consider the effectiveness of controls that are already in place to determine if new controls are needed. You'll also identify plausible outcomes associated with exposure levels and discuss the health risks and consequences of accepting or controlling the risks with Commanders.

Before making recommendations, you will consider how the health threat will affect the mission, personnel, or other affected populations over a period of time if the risk is accepted, and whether the effects are imminent, delayed, or reversible. Your recommendations are important for Commanders as they make decisions about controlling or accepting health risks.

Remember that the steps of routine and special assessment as part of health threat analysis are components of the Health Risk Assessment (HRA) process. Ideally, the entire HRA process, as summarized above, is followed before control recommendations are made. However, there may be HRA situations which require quick reactions and recommendations based on limited information and your professional judgment.

The four steps for analyzing chemical health threats are

1. Place the health threat into the context of the mission and operational requirements.
2. Determine why the health threat is a potential or actual problem.
3. Determine the HRE.
4. Provide recommendations to commanders.

## **Scenario Challenge Point** (Page 4 of 8)

During your routine assessment, you identified fuel filter change out as a process with exposure potential to JP-8. Five workers have performed this process 50 times over the course of the last year. You now need more information to properly evaluate this exposure. Therefore, you will need to perform a special assessment for this process.

You begin your special assessment by gathering information so you can understand the potential health threats to personnel in the refueling maintenance shop. Which two of the following are appropriate sources of information on health effects of chemical exposures?

A HazMat Pharmacy

B NIOSH Pocket Guide

C Patty's *Industrial Hygiene and Toxicology*

D Bioenvironmental Engineering Field Manual

## **Scenario Challenge Point** (Page 4 of 8)

After consulting the HazMat Pharmacy and the MSDS for JP-8, you learn that it is a kerosene-like product containing a mixture of hydrocarbons, one of which is benzene. You review the NIOSH Pocket Guide and information from Patty's Industrial Hygiene and Toxicology for kerosene and benzene, the primary constituents of concern for JP-8. You find that workers may be exposed to health effects of these chemicals through inhalation, ingestion, and skin absorption. Based on this information, you work with your BEE, Captain Parker, to develop an appropriate air sampling strategy.

According to your sampling strategy, you conduct air sampling at the refueling maintenance shop to assess the inhalation threat. After you receive the air sampling results, which two actions should you take next?

A Evaluate the controls already in place.

B Gather additional information about JP-8.

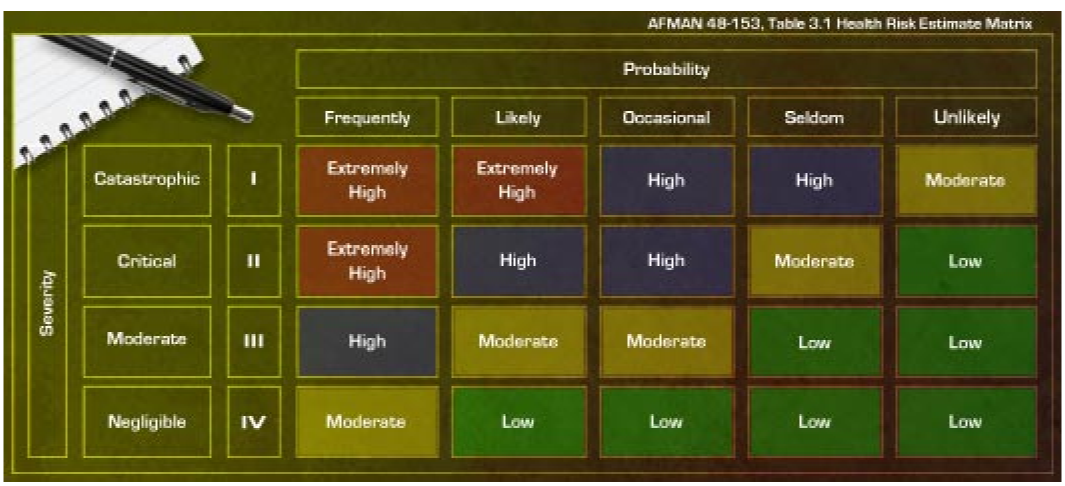
C Determine the Health Risk Estimate (HRE).

D Take more air samples to verify the results.

## **Scenario Challenge Point** (Page 6 of 8)

Screening samples indicate that exposure levels of JP-8 are sometimes above the OEL and sometimes below the action level. Use the HRE matrix to determine the health risk associated with the refueling maintenance workers' exposure to JP-8 during the fuel filter change out process.

You can review information about the health effects of JP-8 exposure by viewing the JP-8 Information in the appendix.



What is your recommended health risk level for this process?

A Low

B Moderate

C High

D Extremely High

## Assessing the Health Risk (Page 6a of 8)

In order to assess the health risks associated with a particular health threat, you must consider how the threat affects personnel, the mission, and operational requirements.

When assessing the health risk, you should develop a health risk estimate by considering the **probability** and **severity** of the health threat and the plausibility of outcomes associated with controlling or accepting the health risks.

Making an appropriate health risk determination is important to help decision-makers balance health-related risks with the mission's operational risks.

### Probability

The probability of the health threat should be estimated in terms of how often the event is expected to occur, as defined in AFPAM 90-902.

The options for probability are:

- Frequently – Occurs often in a career.
- Likely – Occurs several times in a career.
- Occasional – Will occur in a career.
- Seldom – May occur in a career.
- Unlikely – So unlikely you can assume it will not occur in a career.

### Severity

The severity of the potential health threat should be estimated in terms of its potential impact on personnel and the mission, as defined in AFPAM 90-902.
This is classified as:

- Catastrophic – Complete mission failure, death, or loss of system.
- Critical – Major mission degradation, severe injury, occupational illness, or major system damage.
- Moderate – Minor mission degradation, injury, minor occupational illness, or minor system damage.
- Negligible – Less than minor mission degradation, injury, occupational illness, or minor system damage.

## **Scenario Challenge Point** (Page 7 of 8)

Captain Parker, the Bioenvironmental Engineer to whom you report, calls you for a status check.

### Audio Script

**BEE:** What have you found out so far during your assessment of the refueling shop?

**BE Tech:** Screening samples show levels above the OEL. I'll have to wait for lab analysis to be sure of those results.

**BEE:** While you're waiting for results, be thinking about ways to control the exposure.

You consider the types of controls that are already in place at the shop, as well as other techniques or equipment that you might recommend for controlling the health threat.

According to the hierarchy of controls, which one of the following choices should be recommended first as a method of reducing worker exposure?

A Regulated area

B Personnel training

C Local exhaust ventilation

D Respiratory protection

## **Chemical Health Threat Control Options** (Page 7a of 8)

As with any health threat, when recommending control options for chemical exposures, you must follow the hierarchy of controls.

### Personal Protective Equipment (PPE)

PPE is used when engineering and administrative controls are not sufficient to control the health threat. Chemical protective clothing (CPC) is a primary PPE category. Examples of CPC include:

- Gloves.
- Chemical splash goggles.
- Chemical protective suits.

Respiratory protection is also considered PPE, and requires program implementation and management to include selection procedures and fit testing.

### Administrative Controls

If engineering controls are not feasible or are not enough to control the exposure, you should implement administrative controls such as work practice controls, regulated areas, and housekeeping. Training, another administrative control, should also be conducted whenever any control mechanism is put into place.

### Engineering Controls

The preferred method of reducing worker exposure is through engineering controls such as ventilation, isolation, product substitution, product elimination, or a process change.

## Lesson Summary (Page 8 of 8)

You have learned that you play a vital role in protecting the health and welfare of Air Force personnel and the community by identifying and analyzing chemical health threats, the first two steps of a health risk assessment (HRA).

You also learned that any time personnel are using chemicals or may potentially be exposed to chemicals, it is important to understand what the chemicals are, how they're being used, and what the potential health effects are.

In this lesson, you:

- Determined why and when chemical health threat identification and analysis should occur.
- Explained the steps for identifying and analyzing chemical health threats.
- Determined the health risk associated with chemical health threats.
- Recalled chemical health threat control options.

### Audio Script

**Narrator:** You've completed the assessment of the JP-8 exposure for the workers performing fuel filter change out in the refueling maintenance shop. Screening sample results indicate that the workers' exposure to JP-8 is above acceptable levels.

When you evaluated the existing controls, you found that the old ventilation system was broken beyond repair. Your recommendation for controlling the JP-8 exposure is to install a new ventilation system. However, you will need to recommend additional controls to be used as interim measures for protecting the workers until the ventilation system is put into operation.

# Lesson 2: Respiratory Protection

## Lesson Description

In this lesson, you will select the appropriate respiratory protection to manage the workers' exposure to JP-8 during the fuel filter change out process at the refueling maintenance shop.

## Lesson Overview (Page 1 of 13)

When engineering and administrative controls are not feasible or are insufficient, the appropriate respiratory protection (RP) must be used to control workers' exposure to airborne contaminants or oxygen-deficient environments. Respiratory protective equipment varies in design, specifications, application, and protective capability. It is important for you to understand how to select appropriate respiratory protection for the situation.

As you consider the respiratory protection needed by the workers in the refueling maintenance shop, you will:

- Describe general considerations for respirator selection and use.
- Determine why and when respiratory protection is selected.
- Select appropriate respiratory protection for a given scenario.
- Determine appropriate controls for chemical health threats in a given scenario.
- Determine if chemical PPE is used in accordance with established guidelines.

**Audio Script**

**Narrator:** You have determined that a ventilation system needs to be installed in the refueling maintenance shop for the fuel filter change out process. However, until the system is put into operation, interim controls should be established to control the workers' exposure to JP-8. This lesson will focus on the respiratory protection the workers should wear.

## Scenario Challenge Point (Page 2 of 13)

Why is it important to consider additional exposure routes when selecting respiratory protection? Choose the two best reasons.

| | |
|---|---|
| A | Because dire consequences could result if the RP fails in ILDH or oxygen-deficient conditions and the worker could not escape quickly enough. |
| B | Because the service life of the respirator cartridge may be affected by environmental conditions, such as humidity that may cause the filter to clump. |
| C | Because wearing RP may allow the worker to stay in the area for a longer period of time, thereby putting him/her at greater risk for health effects. |
| D | Because some types of RP can protect workers against exposure routes other than inhalation, such as a full-face respirator protecting the eyes from irritants. |

## Considerations for Respirator Selection and Use (Page 2a of 13)

You must select RP that will reduce exposure to a contaminant to an acceptable level and will meet the requirements of 29 CFR 1910.134(d), AFOSH Std 48-137, and the NIOSH Certified Equipment List.

Proper RP selection depends on the contaminant involved, conditions of exposure, human capabilities, and the respirator fit. When selecting RP to control exposure levels, you should generally consider the following factors:

- **Worker activity.**
- **Respirator use conditions.**
- **Distance from operation to clean air.**
- **Operational limitations.**
- **IDLH and/or O2 deficient conditions.**
- **Other exposure routes.**

### Worker Activity

When selecting the proper RP, you will take into consideration each worker's activity and location. For example, consider whether the work is continuous or intermittent and whether the work rate is light, medium, or heavy.

### Respirator Use Conditions

The period of time a respirator must be worn is an important factor when selecting a respirator. You must consider the type of respirator application, such as whether it will be used for routine, non-routine, emergency, or rescue use. Keep in mind that, while respiratory protection is designed to be beneficial for workers, it can create safety and health concerns if it adds to heat stress, results in decreased vision, or hinders communication.

How the RP will be used may be affected by the warning properties of the contaminant. Warning properties are characteristics that can be perceived by workers, such as odor, which serve as a warning of the chemical’s presence. When using air purifying respirators (APRs) to control exposure to chemicals with poor warning properties, specific change out procedures must be implemented to ensure breakthrough does not occur.

Keep in mind that workers should not rely solely on their senses to warn them of the presence of hazardous substances; however, warning properties can be an indicator for personnel that the RP they are wearing is not effectively controlling the exposure.

### Distance from Operation to Clean Air

Considering the distance from the operation to clean air is important for selecting the mode of RP because there are certain types that are appropriate for escape-only use.

Knowing this information is also important for planning for the escape of workers if an emergency occurs, and for the entry of workers to perform maintenance duties and rescue operations.

### Operational Limitations

The service life of the respirator cartridge may be affected by environmental conditions such as humidity that may cause the filter to clump. The amount of time a worker can wear the RP may also be reduced by an increased level of effort required of the respirator wearer. For example, extreme physical exertion can cause a user to deplete the air supply in a self-contained breathing apparatus (SCBA) more quickly than in normal circumstances.

### IDLH and/or $O_2$ Deficient Conditions

Conditions in which contaminant levels are immediately dangerous to life or health (IDLH) or in which oxygen ($O_2$) levels are less than 19.5% require special consideration when selecting respiratory protection. Dire consequences could result if respiratory protection failed in either of these conditions and the worker could not escape quickly enough. For these conditions, it is important to supply clean air to the workers with an SCBA.

### Other Exposure Routes

When selecting RP, you must consider additional exposure routes, most importantly skin absorption. This is because wearing RP may allow the worker to stay in the area for a longer period of time, thereby putting the worker at greater risk of health effects due to the absorption hazard.

To recognize a skin absorption threat, look for the “skin” designation in the OSHA standards. The “total” designation indicates that the REL or PEL listed is for the “total particulate,” while the “resp” designation refers to the “respirable fraction” of the airborne particulate.

## Why and When to Use Respiratory Protection (Page 3 of 13)

When all other methods of exposure control are insufficient or unavailable, RP is used to protect personnel from inhalation hazards above identified levels of concern.

RP must be used when:

- Other means of control are not feasible or cannot decrease the contaminant level below the exposure limit or other level of concern.
- Permanent controls are awaiting funding, or are being designed or installed, as an interim measure until the permanent measures are in place.
- An OSHA standard or Air Force directive specifies the use of RP.
- Exposures could potentially be greater than an exposure limit, based on the BE’s professional judgment.
- It is necessary for an emergency situation, for which escape-only respirators will be used.

### Voluntary Use of Respiratory Protection

Respiratory protection can sometimes be used to increase personal comfort. However, voluntary use of respirators by government employees in Air Force industrial workplaces is not allowed, except when BE authorizes the use of filtering facepieces, IAW AFOSH Std 48-137 and 29 CFR 1910.

Prior to wearing a voluntary use respirator, employees must request an evaluation of their individual work conditions by BE if they are not already on the respiratory protection program. Filtering facepieces are the only type of respiratory protection that may be worn at the discretion of a government employee for comfort purposes in an Air Force industrial workplace and must be approved and authorized by BE.

Voluntary RP cannot be worn for any industrial task that requires a respirator for protection against hazards specified by BE, other than exposures to airborne infectious diseases. Personnel who wear voluntary use filtering facepieces must receive initial and annual training from their supervisors on the appropriate use of the device, including its limitations, per 29 CFR 1910.134 (c)(2) and Appendix D.

## **Appraisal** (Page 4 of 13)

To check your understanding of why and when respiratory protection should be used, you will be presented with two questions. For each question, select the correct answer.

Which two of the following statements describe situations in which respiratory protection must be used?

A Employees request respiratory protection, such as a half mask, for personal comfort.

B RP is used as an interim measure while permanent controls are being installed.

C Other controls are unsuccessful at reducing the contaminant level below the exposure limit.

D Based on professional judgment, the supervisor expects exposures greater than the action level.

Choose the statement that best describes the primary purpose for the use of respiratory protection in the Air Force.

A For compliance with all applicable regulations and standards.

B For increased confidence in the characterization of the health threat.

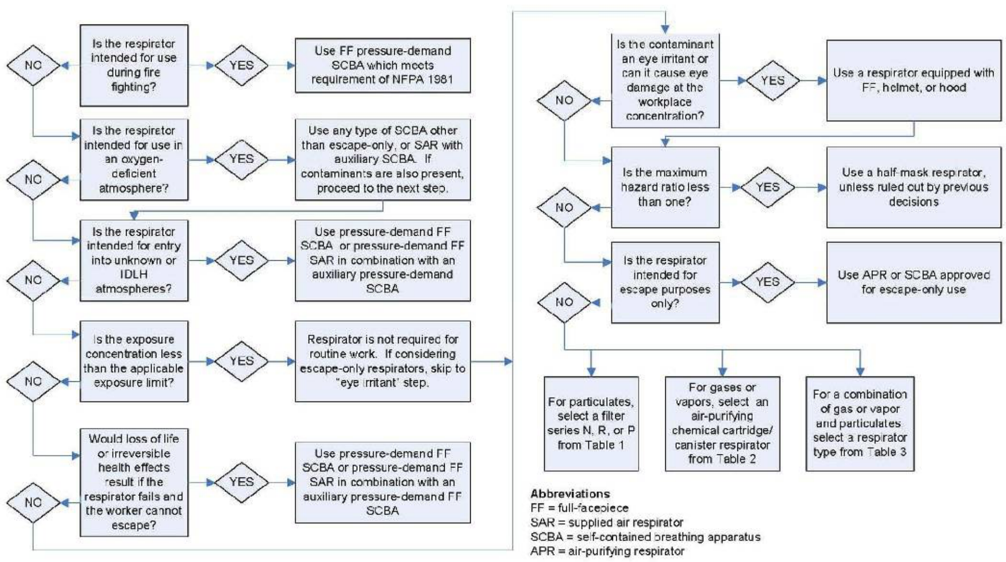
C To protect personnel from inhalation hazards above levels of concern.

D To reduce offensive odors in the workplace and increase personal comfort.

## Steps for Selecting a Respirator (Page 5 of 13)

The flowchart illustrates the process for selecting appropriate RP. You will learn more about each step on the following pages. This flowchart is included in the appendix.

**Respirator Selection**




Adapted from *NIOSH Respirator Selection Logic 2004*
http://www.cdc.gov/niosh/docs/2005-100/chapter3.html

## Consider the Intended Use of the Respirator (Page 6 of 13)

The first three questions in the RP selection process focus on the intended use of the respirator. Read the information below to learn how the selection of RP is affected by its intended use.

### Is the respirator intended for use during fire fighting?

If the respirator is to be used for fire fighting efforts, only a full-facepiece, pressure-demand, self-contained breathing apparatus (SCBA) may be used. The device must meet the requirement of the NFPA 1981, Standard on Open-circuit Self-contained Breathing Apparatus for Fire and Emergency Services. Consult the resources page at the end of this unit for a link to more information.

#### Is the respirator intended for use in an oxygen-deficient atmosphere?

If the oxygen levels in the workplace are less than 19.5%, an SCBA is preferred. You may select any type of SCBA other than escape-only. A supplied-air respirator (SAR) with an **auxiliary SCBA** may be necessary instead, depending on whether or not there is a contaminant present.

If contaminants are present, continuing through the RP selection process will help you determine whether the health threat requires the SCBA or SAR/SCBA to meet a specific APF level.

**Auxiliary SCBA**

An auxiliary unit means that the SAR unit includes a separate air bottle to provide a reserve source of air in case the airline becomes damaged. The auxiliary unit shares the same mask and regulator, and it enables the SAR to function as an SCBA if needed.

#### Is the respirator intended for entry into unknown or IDLH atmospheres?

It is important to understand the level at which a substance becomes immediately dangerous to life or health (IDLH). You can find this information in the *NIOSH Pocket Guide to Chemical Hazards* or on the NIOSH website.

If the environment contains IDLH concentrations of a contaminant, or if a worker is entering an unknown, potentially hazardous atmosphere, you must select either a pressure-demand SCBA with a full facepiece or a pressure-demand SAR with a full facepiece in combination with an auxiliary pressure-demand SCBA. If an auxiliary SCBA is used, it must be of sufficient duration to permit escape to safety if the air supply is interrupted. OSHA has additional **requirements** for respiratory protection to be used in IDLH conditions.

**OSHA Requirements**

29 CFR 1910.134(e) requires that a standby person be present with suitable rescue equipment when SCBA or hose masks with blowers are used in IDLH atmospheres. Furthermore, persons using air-line respirators in IDLH atmospheres must be equipped with safety harnesses and safety lines for lifting or removing workers from hazardous atmospheres.

### Consider the Potential Effects of Exposure (Page 7 of 13)

The next two questions on the RP selection process flowchart relate to the potential effects of the exposure. Read the information below to learn how the potential effects of the exposure are considered during the selection process.

#### Is the exposure concentration less than the applicable exposure limit?

It is important to understand the airborne concentration of the contaminant(s) present, as measured during air sampling, so you can make an educated decision about respirator selection. Although the need for RP is not necessarily driven by exposure limits, they are important to keep in mind and can determine whether or not the RP is necessary for routine work. Consider whether any other standards apply, such as OSHA expanded standards for carcinogens or AFOSH Std 91-25 for confined spaces.

You also need to be sure exposure levels are significantly below the **lower explosive limit (LEL)** because RP cannot protect workers against the explosive properties of the contaminant.

**Lower Explosive Limit (LEL)**

The LEL is the minimum concentration of vapor in air below which propagation of a flame does not occur in the presence of an ignition source. The LEL for a specific chemical can be found in the "Chemical & Physical Properties" section of the contaminant's *NIOSH Pocket Guide to Chemical Hazards* listing.

**Would loss of life or irreversible health effects result if the respirator fails and the worker cannot escape?**

Conditions in which a worker who is required to wear a respirator cannot escape the work area alive without suffering immediate or delayed irreversible health effects if the respirator fails are considered IDLH. For these conditions, you should select either a pressure-demand full facepiece SCBA or a pressure-demand full facepiece SAR in combination with an auxiliary pressure-demand full facepiece SCBA.

If an auxiliary SCBA is used, it must be of sufficient duration to permit escape to safety if the air supply is interrupted.

## Additional Considerations (Page 8 of 13)

The next three questions narrow down the selection process further by considering the possibilities for eye irritation, how hazardous the exposure is, and whether an escape-only respirator is needed.

**Is the contamination an eye irritant or can it cause eye damage at the workplace concentration?**

Eye irritation can be an indicator for personnel that they are remaining too long in a hazardous area, and it's also an important consideration for RP selection. If the contaminant is an **eye irritant**, you should select a respirator equipped with a full facepiece, helmet, or hood. If not, a half-mask respirator may still be an option, depending on the exposure concentration.

**Eye Irritants**

See the Resources section at the end of this unit for more information about eye irritation, available on the International Chemical Safety Cards published by the International Program on Chemical Safety. You can also determine whether a chemical causes eye irritation or damage by looking in the "Respirator Recommendations" section of the chemical's listing in the NIOSH Pocket Guide. Substances marked with an asterisk (*) may require eye protection, while the pound symbol (£) indicates that eye protection is needed.

### Is the maximum hazard ratio less than one?

The hazard ratio (HR) indicates the minimum **assigned protection factor (APF)** required for the respirator. Unless you are planning for emergency egress situations, you must select a respirator with an APF greater than the value of the hazard ratio. To determine the HR, follow these steps:

1. Divide the time-weighted average (TWA) exposure concentrationby the applicable exposure limit.
2. If the contaminant has a ceiling limit, divide the maximum exposure concentration by the ceiling limit.
3. If the contaminant has a short-term exposure limit (OEL-STEL), divide the maximum 15-minute TWA exposure concentration by the OEL-STEL.

If the HR is less than one, RP is not necessary for routine exposures.

| **Step 1** | **Step 2** | **Step 3** |
|---|---|---|
| $\frac{8hr\ TWA}{OEL}$ | $\frac{MaximumExposureConcentration}{OEL\text{-}C}$ | $\frac{15min\ TWA}{OEL\text{-}STEL}$ |

#### Assigned protection factor (APF)

See the appendix of this document for the Assigned Protection Factor table.

### Is the respirator intended for escape purposes only?

For **escape-only respirators**, determine the potential for generation of a hazardous condition caused by an accident or equipment failure. If a potentially hazardous condition could occur, or if the HR is greater than one, continue through the RP selection process. If the HR is less than one, RP is not necessary for routine exposures.

## Selection Options for Escape-only Respirators

| Escape Conditions | Type of Respirator[1] |
|---|---|
| Short distance to exit, no obstacles (no oxygen deficiency) | Any escape-only respirator[2] (canister respirator) or half mask or facepiece (canister repirator) |
| | Any escape SCBA having a suitable service life[3] |
| | Any acceptable device for entry into emergency situations |
| Long distance to exit or obstacles along the way (no oxygen deficiency) | Any air purifying respirator |
| | Any escape SCBA having a suitable service life[3] |
| | Any self-contained self-rescuer having a suitable service life |
| Potential oxygen deficiency | Any escape SCBA having a suitable service life[3] |
| | Any self-contained self-rescuer having a suitable service life |

[1] Respirators provided only for escape from IDLH atmospheres shall be NIOSH-certified for escape from the atmosphere in which they will be used.

[2] Escape-only respirators are designed for use during escape from IDLH or non-IDLH atmospheres. It may consist of a half-mask facepiece or mouthpiece, appropriate air-purifying element for the contaminant, and associated connections. The manufacturer designates maximum use concentrations for these types of respirators.

[3] Escape SCBA can have rated service lives of 3 to 60 minutes.

*From AFOSH Std 48-137*

## **Physical Form of the Contaminant** (Page 9 of 13)

After you have worked through each decision point, you must consider the physical form of the contaminant. Read the information below to learn how the form of the contaminant affects your selection. The tables referenced are from NIOSH Publication Number 2005-100: *NIOSH Respirator Selection Logic 2004*.

**Tab: For particulates, select a filter series N, R, or P from Table 1**

**Particulates**

If the contaminant is a particulate, you will use a HEPA filter series N, R, or P. When making the determination about **which series to use**, you must consider whether the contaminant is solid or liquid and whether it is oil-based.

Selection of filter efficiency depends on how much filter leakage is acceptable. Higher filter efficiency means lower filter leakage.

Remember to select a respirator that has an APF equal to or greater than the maximum hazard ratio you calculated and be sure to consider the **maximum use concentration (MUC).**

### Selection of N, R, and P Series Filters

To determine which filter to use, follow these steps:

- If no oil particles are present in the work environment, use a filter of any series (N, R, or P).
- If oil particles such as lubricants or cutting fluids are present, use an R or P series filter.
- If oil particles are present and the filter is to be used for more than one work shift, use only a P series filter.

To help you remember the filter series, use the following guide:

- N is Not resistant to oil.
- R is Resistant to oil.
- P is oil Proof.

For liquid contaminants, you should use an R or P series filter, depending on whether the contaminant is degrading

### Maximum Use Concentration (MUC)

The maximum use concentration (MUC) is the maximum atmospheric concentration of a hazardous substance from which a worker can be expected to be protected by a class of respirator. The MUC is determined by the lesser of the calculated MUC, the respirator manufacturer’s MUC for a hazardous substance (if any), or the IDLH concentration.

You can calculate the MUC for a single contaminant by multiplying the APF by the exposure limit. For multi-component mixtures, the MUC can be calculated with the following equation:

$$\frac{C1}{MUC1} + \frac{C2}{MUC2} + \ldots \frac{Cn}{MUCn} = 1$$

*Where C = contaminant*

## Tab: For gases or vapors, select an air-purifying chemical cartridge/canister respirator from Table 2

### Gases or Vapors

When the contaminant is a gas or vapor only, an air-purifying chemical cartridge or canister respirator is recommended that has a sorbent efficiency suitable for the chemical **properties** of the anticipated gas/vapor contaminant and for the anticipated exposure levels. You can find information about cartridges or canisters approved for use for classes of chemicals or for specific gases or vapors by consulting the NIOSH Certified Equipment List.

You will select a device with an assigned protection factor that is *greater* than the hazard ratio. You must also ensure that the concentration is less than the MUC of the cartridge or canister.

#### Special Considerations for Gases and Vapors with Poor Warning Properties

If the gas or vapor has poor warning properties, you must use an atmosphere-supplying respirator, unless one cannot be used because of the lack of a feasible air supply or because of the need for worker mobility. In those circumstances, you may use air-purifying devices, but only if the respirator has a reliable end of service life indicator that will warn the user prior to contaminant breakthrough, or if the cartridge change schedule is implemented based on cartridge service data. APRs cannot be used to control exposure to a chemical that has a ceiling limit.

## Tab: For a combination of gas or vapor and particulates, select a respirator type from Table 3

### Combination of Gas or Vapor and Particulates

If the contaminant is a combination of gas or vapor and particulates, you should select a respirator type that has not been eliminated by the previous steps and has an APF equal to or greater than the maximum hazard ratio you calculated. Remember to also consider the MUC.

**Table 1. Particulate Respirators**

| Assigned protection[1] factor | Type of Respirator |
|---|---|
| 5 | Quarter mask respirator |
| 10 | Any air-purifying elastomeric half-mask respirator equipped with appropriate type of particulate filter.[2]<br>Appropriate filtering facepiece respirator.[2,3]<br>Any air-purifying full facepiece respirator equipped with appropriate type of particulate filter.[2]<br>Any negative pressure (demand) supplied-air respirator equipped with a half-mask. |
| 25 | Any powered air-purifying respirator equipped with a hood or helmet and a high efficiency (HEPA) filter.<br>Any continuous flow supplied-air respirator equipped with a hood or helmet. |
| 50 | Any air-purifying full facepiece respirator equipped with N-100, R-100, or P-100 filter(s).<br>Any powered air-purifying respirator equipped with a tight-fitting facepiece (half or full facepiece) and a high-efficiency filter.<br>Any negative pressure (demand) supplied-air respirator equipped with a full facepiece.<br>Any continuous flow supplied-air respirator equipped with a tight-fitting facepiece (half or full facepiece).<br>Any negative pressure (demand) self-contained respirator equipped with a full facepiece. |
| 1,000 | Any pressure-demand supplied-air respirator equipped with a half-mask. |
| 2,000 | Any pressure-demand supplied-air respirator equipped with a full facepiece. |
| 10,000 | Any pressure-demand self-contained respirator equipped with a full facepiece. |

[1] The protection offered by a given respirator is contingent upon (1) the respirator user adhering to complete program requirements (such as the ones required by OSHA in 29CFR1910.134), (2) the use of NIOSH-certified respirators in their approved configuration, and (3) individual fit testing to rule out those respirators that cannot achieve a good fit on individual workers.

[2] Appropriate means that the filter medium will provide protection against the particulate in question.

[3] An APF of 10 can only be achieved if the

**Table 2. Gas/Vapor Respirators**

| Assigned protection[1] factor | Type of Respirator |
|---|---|
| 10 | Any air-purifying half mask respirator equipped with appropriate gas/vapor cartridges.[2]<br>Any negative pressure (demand) supplied-air respirator equipped with a half mask. |
| 25 | Any powered air-purifying respirator with a loose-fitting hood or helmet equipped with appropriate gas/vapor cartridges.[2]<br>Any continuous flow supplied-air respirator equipped with a hood or helmet. |
| 50 | Any air-purifying full facepiece respirator equipped with appropriate gas/vapor cartridges[2] or gas mask (canister respirator).[2]<br>Any powered air-purifying respirator equipped with a tight-fitting facepiece (half or full facepiece) and appropriate gas/vapor cartridges or canisters.[2]<br>Any negative pressure (demand) supplied-air respirator equipped with a full facepiece.<br>Any continuous flow supplied-air respirator equipped with a tight-fitting facepiece (half or full facepiece).<br>Any negative pressure (demand) self-contained respirator equipped with a full facepiece. |
| 1,000 | Any pressure-demand supplied-air respirator equipped with a half-mask. |
| 2,000 | Any pressure-demand supplied-air respirator equipped with a full facepiece. |
| 10,000 | Any pressure-demand self-contained respirator equipped with a full facepiece.<br>Any pressure-demand supplied-air respirator equipped with a full facepiece in combination with an auxiliary pressure-demand self-contained breathing apparatus. |

[1] The protection offered by a given respirator is contingent upon (1) the respirator user adhering to complete program requirements (such as the ones required by OSHA in 29CFR1910.134), (2) the use of NIOSH-certified respirators in their approved configuration, and (3) individual fit testing to rule out those respirators that cannot achieve a good fit on individual workers.

[2] Select a cartridge/canister certified to be used for the specific class of chemicals or the specific gas/vapor found in your workplace.

**Table 3. Combination Gas / Vapor and Particulate Respirators**

| Assigned protection factor [1] | Type of Respirator |
|---|---|
| 10 | Any air-purifying half-mask respirator equipped with appropriate gas/vapor cartridges[2] in combination with appropriate type of particulate filter.[3]<br>Any full facepiece respirator with appropriate gas/vapor cartridges[2] in combination with appropriate type of particulate filter.[3]<br>Any negative pressure (demand) supplied-air respirator equipped with a half-mask. |
| 25 | Any powered air-purifying respirator with a loose-fitting hood or helmet that is equipped with an appropriate gas/vapor cartridge[2] in combination with a high-efficiency particulate filter.<br>Any continuous flow supplied-air respirator equipped with a hood or helmet. |
| 50 | Any air-purifying full facepiece respirator equipped with appropriate gas/vapor cartridges[2] in combination with an N-100, R-100 or P-100 filter or an appropriate canister[2] incorporating an N-100, P-100 or R-100 filter.<br>Any powered air-purifying respirator with a tight-fitting facepiece (half or full facepiece) equipped with appropriate gas/vapor cartridges[2] in combination with a high-efficiency filter or an appropriate canister[2] incorporating a high-efficiency filter.<br>Any negative pressure (demand) supplied-air respirator equipped with a full facepiece.<br>Any continuous flow supplied-air respirator equipped with a tight-fitting facepiece (half or full facepiece).<br>Any negative pressure (demand) self-contained respirator equipped with a full facepiece. |
| 1,000 | Any pressure-demand supplied-air respirator equipped with a half-mask. |
| 2,000 | Any pressure-demand supplied-air respirator equipped with a full facepiece. |
| 10,000 | Any pressure-demand self-contained respirator equipped with a full facepiece.<br>Any pressure-demand supplied-air respirator equipped with a full facepiece in combination with an auxiliary |

[1] The protection offered by a given respirator is contingent upon (1) the respirator user adhering to complete program requirements (such as the ones required by OSHA in 29CFR1910.134), (2) the use of NIOSH-certified respirators in their approved configuration, and (3) individual fit testing to rule out those respirators that cannot achieve a good fit on individual workers.
[2] Select a cartridge/canister certified to be used for the specific class of chemicals or the specific gas/vapor found in your workplace.
[3] Appropriate means that the filter medium will provide protection against the particulate in question.

## Scenario Challenge Point (Page 10 of 13)

You will now use the RP selection decision logic to choose appropriate respiratory protection for the workers who are exposed to JP-8 while performing the fuel filter change out process in the refueling maintenance shop.

Is the respirator intended for use during fire fighting?

A Yes

B No

Is the respirator intended for use in an oxygen-deficient atmosphere?

A Yes

B No

Is the respirator intended for entry into unknown or IDLH atmospheres?

A Yes

B No

Air sampling results in the refueling maintenance shop indicated JP-8 levels of 365.83 $mg/m^3$ as an 8-hour TWA. The OEL for JP-8 is 200 $mg/m^3$.

Is the exposure concentration less than the applicable exposure limit?

A Yes

B No

Would loss of life or irreversible health effects result if the respirator fails and the worker cannot escape?

A Yes

B No

See the appendix of this document for USACHPPM information on JP8.

Is the contaminant an eye irritant or can it cause eye damage at the workplace concentration?

A Yes

B No

Air sampling results indicate that JP-8 is present at levels of 365.83 $mg/m^3$ during the fuel filter change out process. The exposure limit is 200 $mg/m^3$.

Is the maximum hazard ratio less than one?

A Yes

B No

Is the respirator intended for escape purposes only?

A Yes

B No

Select the physical form of the contaminant.

A Particulate

B Gas or Vapor

C Combination of gas or vapor and particulate

## Scenario Challenge Point (Page 11 of 13)

Because JP-8 is present as a gas or vapor, you should select a respirator type for the refueling maintenance shop workers that has an APF equal to or greater than the maximum hazard ratio you calculated, 1.83. Remember to also consider the MUC and the potential for eye irritation.

Use Table 2 of the *NIOSH Respirator Selection Logic,* below.

**Table 2. Gas / Vapor Respirators**

| Assigned protection[1] factor | Type of Respirator |
|---|---|
| 10 | Any air-purifying half mask respirator equipped with appropriate gas/vapor cartridges.[2]<br>Any negative pressure (demand) supplied-air respirator equipped with a half mask. |
| 25 | Any powered air-purifying respirator with a loose-fitting hood or helmet equipped with appropriate gas/vapor cartridges.[2]<br>Any continuous flow supplied-air respirator equipped with a hood or helmet. |
| 50 | Any air-purifying full facepiece respirator equipped with appropriate gas/vapor cartridges[2] or gas mask (canister respirator).[2]<br>Any powered air-purifying respirator equipped with a tight-fitting facepiece (half or full facepiece) and appropriate gas/vapor cartridges or canisters.[2]<br>Any negative pressure (demand) supplied-air respirator equipped with a full facepiece.<br>Any continuous flow supplied-air respirator equipped with a tight-fitting facepiece (half or full facepiece).<br>Any negative pressure (demand) self-contained respirator equipped with a full facepiece. |
| 1,000 | Any pressure-demand supplied-air respirator equipped with a half-mask. |
| 2,000 | Any pressure-demand supplied-air respirator equipped with a full facepiece. |
| 10,000 | Any pressure-demand self-contained respirator equipped with a full facepiece.<br>Any pressure-demand supplied-air respirator equipped with a full facepiece in combination with an auxiliary pressure-demand self-contained breathing apparatus. |

[1] The protection offered by a given respirator is contingent upon (1) the respirator user adhering to complete program requirements (such as the ones required by OSHA in 29CFR1910.134), (2) the use of NIOSH-certified respirators in their approved configuration, and (3) individual fit testing to rule out those respirators that cannot achieve a good fit on individual workers.

[2] Select a cartridge/canister certified to be used for the specific class of chemicals or the specific gas/vapor found in your workplace.

Which type of respirator would be most appropriate to recommend for the workers performing the fuel filter change out process?

A Air-purifying quarter-mask respirator

B Half facepiece atmosphere-supplying respirator

C Full-facepiece respirator with an organic vapor cartridge

D Pressure-demand supplied-air respirator equipped with a half-mask

## **Scenario Challenge Point** (Page 12 of 13)

You visit the refueling maintenance shop to issue respiratory protection to the workers and train them on its proper care.

Which two of the following statements are *true* regarding the proper care of RP?

A BE should inspect the respirator immediately before each use by the worker.

B The worker should clean, disinfect, and inspect the respirator at the end of each day of use.

C Respirators worn on a daily basis must be inspected by the worker at least once per month.

D BE is responsible for developing change-out schedules for cartridges, filters, or canisters of APRs.

## **Proper Care of Respiratory Protection** (Page 12a of 13)

Generally, each individual issued a respirator is responsible for its primary maintenance and care. This includes cleaning and disinfecting the respirators by, at a minimum, using a respirator wipe at the end of each day in which the respirator is used. If a worker is going to wear a respirator that has been worn by a different individual, it must be thoroughly cleaned and disinfected prior to use. Emergency use respirators shall be thoroughly cleaned and disinfected after being used. Refer to 29 CFR 1910.134, Appendix B-2, for more information about requirements for cleaning and disinfection of respirators.

A respirator must also be inspected immediately before each use and during cleaning to ensure that it is in proper working condition and determine whether it needs replacement of parts or repairs, or whether it needs to be discarded. Because the workers wearing the respirators are the one who handle them daily, it is their responsibility to perform these routine inspections. Each respirator stored for emergency or rescue use shall be inspected prior to carrying it into the workplace, and at least monthly. Refer to 29 CFR 1910.134 (h)(3) for more information about inspection of respirators.

## Lesson Summary (Page 13 of 13)

You have learned that respirators must be used to protect workers from contact with airborne contaminants or oxygen-deficient environments when engineering and administrative controls are not feasible or are insufficient. The selection of appropriate RP can be affected by worker activity, respirator use conditions and location, operational limitations, IDLH conditions, and other exposure routes. You've also learned the steps for selecting a respirator.

In this lesson, you:

- Described general considerations for respirator selection and use.
- Determined why and when respiratory protection is selected.
- Selected appropriate respiratory protection for a given scenario.
- Determined appropriate controls for chemical health threats in a given scenario.
- Determined if chemical PPE was used in accordance with established guidelines.

**Audio Script**

**Narrator:** You have issued full facepiece respirators with organic vapor cartridges for the workers performing the fuel filter change out process in the refueling maintenance shop. This interim measure will help control the workers' exposure to JP-8 until the ventilation system is installed.

# Lesson 3: Regulated Areas

## Lesson Description

In this lesson, you will decide whether a regulated area is an appropriate interim control for the filter change out process at the refueling maintenance stop on base. When you finish, you'll be able to explain the procedures for determining regulated areas.

## Lesson Overview (Page 1 of 5)

When chemical health threats are present in a workplace, it may be necessary to establish a regulated area to safeguard against exposure.

As you evaluate the refueling maintenance shop, you will:

- Define regulated area.
- Outline the criteria for establishing regulated areas.

**Audio Script**

**Narrator:** Because the ventilation system you are planning to put into operation for the filter change out process at the refueling maintenance shop is not yet ready, you recommended respiratory protection as an interim measure for the exposed workers. Now you need to determine if any other interim controls are required.

## Kahua AFB Scenario (Page 2 of 5)

You visit the refueling maintenance shop to verify that the workers are wearing their respiratory protection properly while performing the fuel filter change out process. While you're there, you notice several other personnel who aren't wearing any PPE enter the fuel filter change out area to talk to those workers.

## Scenario Challenge Point (Page 3 of 5)

You continue your evaluation of interim controls by determining whether a regulated area should be established.

Select the statement that is *true* regarding regulated areas.

| | |
|---|---|
| A | Whenever a regulated area is established, the supervisor is required to maintain a written log of everyone who enters and exits the area. |
| B | A regulated area is a location to which access is restricted in order to prevent disclosure of classified information to unauthorized personnel. |
| C | A regulated area is an area where hazardous materials are or may be present and access is restricted to prevent exposure for people not required to be in the area. |
| D | Regulated areas are defined according to the supervisor's professional judgment to prevent access to any area that he/she deems to be potentially dangerous for personnel. |

## Regulated Areas (Page 3a of 5)

A regulated area is an area where hazardous materials are or may be present and access is restricted to prevent exposure for people not required to be in the area. BE is responsible for determining whether a regulated area is needed and the extent of the regulated area. BE advises the supervisor, in writing, of areas where the OEL is either exceeded or can reasonably be expected to be exceeded, thereby defining the recommended regulated area.

The supervisor then establishes the regulated area and allows only trained, protected personnel into the area. Certain areas, such as those established to control exposures to confirmed human carcinogens, require the supervisor to maintain a log of everyone who enters the area. Log requirements and area management specifications are provided in 29 CFR 1910, *Occupational Safety and Health Standards,* and 29 CFR 1926, *Safety and Health Regulations for Construction*.

You must also assess the vulnerability for each potential health risk and identify the exposure pathways present. By assessing how vulnerable personnel are to the exposure, you will be able to focus resources on credible health threats instead of tracking or assessing threats with minimal or no impact to the mission, operations, or personnel.

## Regulated Areas (Page 3b of 5)

Regulated areas must be established:

- Where 29 CFR 1910 or 1926 requires a regulated area.
- In areas where the OEL is exceeded and/or where threshold amounts of carcinogen use is exceeded.
- In areas where personal protective equipment (PPE) is required to avoid skin or eye contact hazards.
- In areas where respiratory protection (RP) must be worn to prevent exposure.
- In any other area where exposure at unacceptable levels could occur if access is not controlled.

**OSHA Requirements for Establishing a Regulated Area for Benzene Exposure**

According to Title 29 CFR 1910.1028, a regulated area must be established where airborne concentrations of benzene exceed (or can reasonably be expected to exceed) the permissible exposure limits of either an 8-hour time-weighted average exposure of 1 ppm or the short-term exposure limit of 5 ppm for 15 minutes.

Air sampling results in the refueling maintenance shop indicated JP-8 exposures well over the OEL during the fuel filter change out process. Because benzene is a constituent of JP-8, you can reasonably expect the airborne concentrations of benzene to also exceed acceptable limits.

To mark the regulated area, signs must be posted at entrances, with the following text:

DANGER
BENZENE
CANCER HAZARD
FLAMMABLE - NO SMOKING
AUTHORIZED PERSONNEL ONLY
RESPIRATOR REQUIRED

## Scenario Challenge Point (Page 4 of 5)

Based on all the information you have, including sampling results that indicate JP-8 exposures above the OEL, you need to determine whether a regulated area should be established. Which two of the following statements do NOT apply to this situation?

A A regulated area must be established because exposure is above acceptable levels.

B Hazardous exposure could occur if access to the area is not effectively controlled.

C A regulated area is not necessary because of ventilation system has been ordered.

D Unregulated access to the area is acceptable because personnel are wearing respirators.

## Lesson Summary (Page 5 of 5)

You have learned that a regulated area is an area where hazardous materials are or may be present and access is restricted to prevent exposure for people not required to be in the area. You've also learned that regulated areas must be established in any area where exposures above acceptable levels could occur if access is not controlled, particularly when PPE is required to avoid skin or eye contact hazards or respiratory protection must be worn. A regulated area must also be established in areas where the OEL is exceeded and/or where threshold amounts of carcinogen use is exceeded.

In this lesson, you:

- Defined regulated area.
- Outlined the criteria for establishing regulated areas.

### Audio Script

**Narrator**: After determining that a regulated area is needed, you provided your recommendations in writing to the supervisor, delineating areas where levels are over the OEL or expected to exceed the OEL. The supervisor then established the regulated area to allow only trained, protected personnel to enter.

# Lesson 4: Ventilation

## Lesson Description

The ventilation system you recommended for the refueling maintenance shop has come in and is being installed. Now you'll need to make sure that it can effectively control the workers' exposure to JP-8 during the fuel filter change out process. In this lesson, you will learn about ventilation principles and types of ventilation, as well as ventilation survey sequence and frequency.

## Lesson Overview (Page 1 of 8)

Ventilation systems are the primary method for controlling exposure levels for airborne contaminants. Your duties concerning ventilation involve determining the need for it, recommending new systems or changes to existing ones, and evaluating systems to see that they perform as intended.

As you evaluate the ventilation system in the refueling maintenance shop, you will:

- Describe ventilation principles.
- List examples where dilution ventilation is an effective measure of control.
- List examples where local exhaust ventilation is an effective measure of control.
- Recall the relationship of contaminant control to survey frequency.
- Apply the concepts of contaminant control and survey frequency to a given scenario.

### Audio Script

**Narrator:** The new ventilation system for the filter change out process at the refueling maintenance shop is ready to be put into operation. You will need to be involved with several aspects of the implementation process. Before proceeding, you decide to review some information about ventilation principles.

## Ventilation Principles (Page 2 of 8)

It is important for you to understand how ventilation systems work to move air and minimize workers' exposure levels. Ventilation is used to reduce worker exposure to below OELs or other levels that require further action. Because air moves from areas of greater pressure to areas of lesser pressure, ventilation works to move air through changes in pressure. The pressure generated by the fan is called **total pressure,** which is the sum of two components.

Your role in relation to ventilation is to evaluate the efficiency and effectiveness of the ventilation system. You will also recommend design modifications and/or improvements as needed. You may perform troubleshooting and be called on to assist the Civil Engineer in the design of appropriate ventilation solutions.

### Total Pressure (TP)

Total pressure is the sum of the velocity pressure and the static pressure at a given point.

### Static Pressure (SP)

SP exists even where there is no air motion and acts equally in all directions. In a ventilation system, negative pressure tends to collapse the walls of the duct upstream of the fan, like someone trying to suck a thick milkshake through a straw. Downstream from the fan, the positive pressure tends to expand the walls of the duct, like someone blowing up a balloon. A change in static pressure (SP) produces air velocity.

### Velocity Pressure (VP)

Air flows from areas of higher to lower static pressure. This air motion exerts a pressure called velocity pressure (VP), which is always positive in sign.

## Dilution Ventilation vs. Local Exhaust Ventilation (Page 3 of 8)

### Tab: Dilution Ventilation

Dilution ventilation involves pulling air into a space and is used to provide enough clean air to a room to mix and dilute the contaminant to safe levels. In industrial situations, it is usually accomplished with large exhaust fans in the walls or roof. Some examples of dilution ventilation include heating and cooling systems and downdraft systems. This type of ventilation could also be as simple as opening doors and windows, a technique commonly referred to as natural dilution ventilation.

Dilution ventilation is not an effective method for controlling highly **toxic** contaminants because air movement is not regulated. For example, in a hangar used for painting aircraft, large fans on both sides of the hangar work to push contaminated air out and pull cleaner air in. The workers remain “inside” the system; therefore, the contaminant is not removed before reaching them.

Because this type of ventilation may also result in increased heating or cooling costs, it is best used in temperate climates to control a contaminant of low toxicity that is generated in small concentrations at a fairly uniform rate.
Examples of occupational settings where dilution ventilation is appropriate include:

- Pesticide storage.
- Aircraft maintenance hangar.
- Photo processing in the non-destructive inspection (NDI) shop.

#### Toxicity

As a guideline, volatile chemicals with OELs over 500 ppm are considered only slightly toxic. Those with OELs from 100 ppm to 500 ppm are called moderately toxic, and those with OELs below 100 ppm are considered highly toxic.

**Tab: Local Exhaust Ventilation**

Local exhaust ventilation is designed to capture and remove the contaminant at or near its source, before it reaches the worker. Local exhaust ventilation is generally more expensive to install than dilution ventilation and typically requires more maintenance. However, because it practically eliminates the exposure, it is used when the chemicals to which employees are exposed are highly toxic or when large amounts of dusts, welding fumes, gases, or vapors are generated.

A typical local exhaust ventilation system is composed of a hood, duct, air cleaner (optional), fan, and stack. Examples of local exhaust ventilation include lab hoods and welding hoods. Occupational settings in which local exhaust ventilation is appropriate include vehicle exhaust testing shops and corrosion control shops where processes such as degreasing or abrasive blasting take place.

## Appraisal (Page 4 of 8)

You will see several questions to check your understanding of ventilation principles. For each question, select the correct answer.

Which of the following types of pressure exists even when there is no air motion and acts equally in all directions?

A Duct pressure

B Total pressure

C Static pressure

D Velocity pressure

Which of the following types of pressure is always positive in sign and is exerted by air in motion?

A Duct pressure

B Total pressure

C Static pressure

D Velocity pressure

Which of the following statements best describes dilution ventilation?

A This system is used when the chemicals to which employees are exposed are highly toxic.

B This type of ventilation system is generally composed of a hood, duct, air cleaner, fan, and stack.

C It involves pulling air in and is used to provide clean air to a room to mix with the contaminated air.

D It is designed to capture the contaminant close to the source and remove it prior to reaching the worker.

Which of the following is an example of an occupational setting where local exhaust ventilation is most likely to be used?

A Pesticide storage

B Metalworking/welding shop

C Aircraft maintenance hangar

D Photo processing in the NDI shop

## **Scenario Challenge Point** (Page 5 of 8)

The ventilation system being put into operation in the refueling maintenance shop is designed to control the workers' exposure to the chemicals in JP-8 jet fuel because air sampling results indicated levels above the OEL.

Which survey should be conducted before the new system is put into operation to determine whether it meets design specifications?

A Pesticide storage

B Metalworking/welding shop

C Aircraft maintenance hangar

D Photo processing in the NDI shop

## Contaminant Control and Survey Frequency (Page 5a of 8)

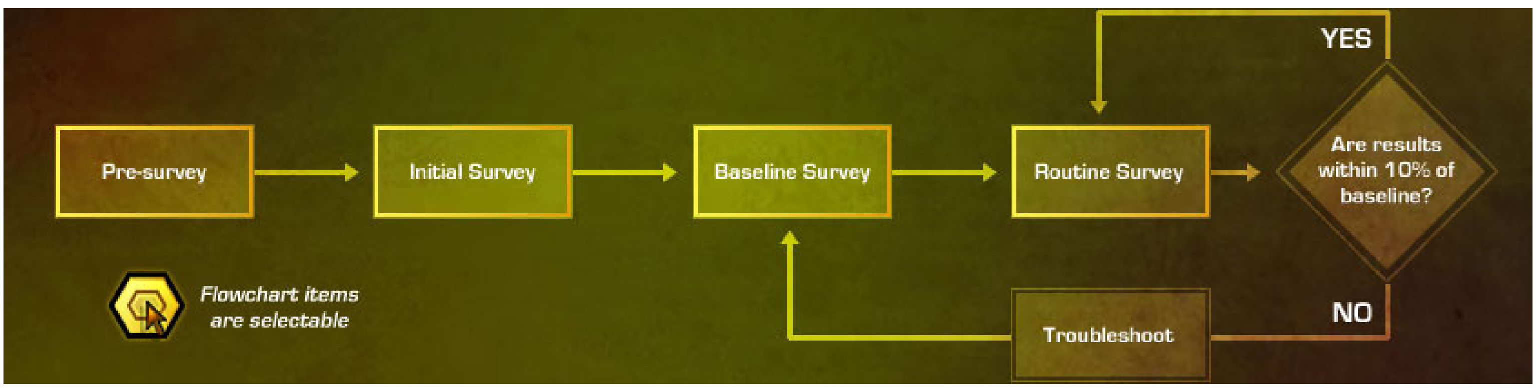
When deciding whether an evaluation of existing ventilation systems is necessary, you will need to determine the purpose of the system. Some ventilation systems are used for housekeeping or comfort issues, and some systems may be in place when one isn't even necessary. If the system is in place to control a contaminant, you must perform a survey to evaluate how effectively the system keeps contaminant levels below acceptable levels. Periodic surveying is then required to ensure that it continues to control the contaminant appropriately.

When survey results indicate that the system is allowing higher contaminant levels into the workspace than are acceptable, you must take action. This could include increasing survey frequency, understanding whether or not the process has changed, and/or determining if a new system or system modification is needed.

If there is no contaminant to control, surveying is not required unless new processes or contaminant possibilities are introduced to the environment. Then, you will determine whether ventilation systems should be put into place or whether existing systems meet the new needs.

## Types of Surveys (Page 5b of 8)

When a ventilation system is in place or being put into operation, there are three types of ventilation surveys you may perform to determine whether the system is operating effectively.




### Pre- Survey

When considering installation of a ventilation system, you will perform a pre-survey for planning purposes. During the pre-survey, you will document design criteria of the system, define how the system should perform, and identify key parameters.

### Initial Survey

Ideally, an initial test is done before any ventilation system is put into operation to determine whether the system meets design specifications. By performing the test before the process it has been designed to control has started, you avoid putting workers at risk of being exposed to contaminants if the ventilation system does not work properly.

Systems installed on the basis of air sampling results would require an initial survey. Systems that have been in place for some time may also need an initial test if they were not correctly evaluated or if they have not been in use.

To determine whether initial survey results are within standards, you will reference your design criteria which are typically from the most current *Industrial Ventilation* manual.

### Baseline Survey

The baseline test is done after a local exhaust ventilation system has been put into operation, to evaluate the system's performance while conducting the process for which it was installed. Essentially, you are evaluating how well it controls the contaminant. Air sampling is an integral part of the baseline test and will be used to ensure that contaminant levels are maintained at desired levels, typically below the OEL. As you collect personal breathing zone air samples, you will also take a measurement that indicates the airflow in the system at that time, typically a static pressure (SP) check. The SP check, which reflects the airflow volume, should always be taken at the same location in a given branch so the measurement can serve as a baseline for later comparisons during routine tests. For a system without a duct, or one with a duct that is not easily accessible, you will instead take face velocity measurements.

At times, the initial and baseline surveys may have to be performed at the same time if BE was not notified prior to the new system being installed.

### Routine Survey

Local exhaust ventilation systems that are controlling a contaminant are checked on a routine basis to ensure that the systems continue to operate adequately. This reduces the need for routine air sampling and identifies any maintenance needs.

During the routine check, you replicate the ventilation measurements taken during the baseline survey. Therefore, if you checked static pressure (SP) during the baseline survey, you will take another SP measurement. If you took face velocity measurements during the baseline survey because of a nonexistent or inaccessible duct, you will take the same kind of measurements during the routine check.

As a guideline, results should be within 10% of the baseline value and should not be compared to initial survey results. If results are not within 10% of the baseline, you should perform troubleshooting procedures before conducting another baseline test.

You will conduct air sampling in addition to taking ventilation measurements to determine whether the system continues to effectively capture the contaminant(s) of concern.

If there is no contaminant to control, routine surveying is not required unless new processes or contaminant possibilities are introduced to the environment.

## Kahua AFB Scenario (Page 6 of 8)

Now that you've completed your initial survey and the ventilation system has been put into operation, you need to conduct a baseline survey. During your survey, you take SP measurements 6 duct diameters upstream or 2 duct diameters downstream from a change in air flow direction or speed, such as an elbow or change in duct size. Once you've selected the appropriate locations, you're ready to take the ventilation measurements. You do this on the same day that you collect air samples during the fuel filter change out process. By doing so, the exposure measurements will directly correlate with the performance of the ventilation system.

## Scenario Challenge Point (Page 7 of 8)

Your involvement does not end after a ventilation system is put into operation.

Following are some questions about further actions you should take regarding the ventilation system in the refueling maintenance shop.

As you review the survey results for the refueling maintenance shop, you notice that the baseline ventilation measurements are markedly different from your initial survey. However, air sampling results are below the action level.

What action should you take based on this information?

A Perform troubleshooting procedures and another baseline survey.

B Perform troubleshooting procedures and do a routine survey.

C Remove the workers from the respiratory protection program.

D Take more air samples and measurements to verify the results.

Six months after the ventilation system was installed in the refueling maintenance shop, you return to conduct a routine survey. These results are not within 10% of the baseline value.

What action should you take?

A Perform troubleshooting procedures and another baseline survey.

B Perform troubleshooting procedures and do a routine survey.

C Remove the workers from the respiratory protection program.

D Take more air samples and measurements to verify the results.

## Lesson Summary (Page 8 of 8)

You have learned that the primary method for controlling worker exposure to airborne contaminants is through ventilation, which works by moving air through changes in pressure. Your role in relation to ventilation is to evaluate the efficiency and effectiveness of the ventilation system. In some situations, dilution ventilation is appropriate, and in others, local exhaust ventilation is preferred. Remember that how effectively a ventilation system controls a contaminant will influence your decision of how frequently to conduct surveys or assessments.

In this lesson, you:

- Described ventilation principles.
- Listed examples where dilution ventilation is an effective measure of control.
- Listed examples where local exhaust ventilation is an effective measure of control.
- Described the relationship of contaminant control to survey frequency.
- Applied the concepts of contaminant control and survey frequency to a given scenario.

**Audio Script**

**Narrator:** Now that the ventilation system in the refueling maintenance shop is controlling contaminant levels to acceptable levels, the workers have been removed from the respiratory protection program, and the shop is no longer classified as a regulated area. Thanks to your skillful application of controls, the personnel are no longer being exposed to harmful levels of JP-8 while performing the fuel filter change out process.

# Resources

- AFMAN 48-155, Occupational and Environmental Health Exposure Controls
- AFOSH Std 48-137, Respiratory Protection Program
- AFPAM 90-902, Operational Risk Management
- Bioenvironmental Engineering Field Manual, 2008
- AFI 32-7086, Hazardous Materials Management
- ACGIH Manual, *Industrial Ventilation*, 25th edition
- ACGIH *Threshold Limit Values and Biological Exposure Indices* book or CD
- Patty's *Industrial Hygiene and Toxicology*
- AIHA *Odor Thresholds for Chemicals with Established Occupational Health Standards*
- 29 CFR 1910, *Occupational Safety and Health Standards*
- 29 CFR 1926, *Safety and Health Regulations for Construction*
- 29 CFR 1910.134, *Respiratory Protection*
- *Quick Selection Guide to Chemical Protective Clothing,* 5th edition, by Krister Forsberg
- NIOSH Certified Equipment List
- Electronic Code of Federal Regulations
- NFPA 1981
- IPCS International Chemical Safety Cards
- NIOSH Pocket Guide to Chemical Hazards
- NIOSH Respirator Selections Logic 2004

# Answer Key: Appraisals / Scenario Challenge Points

## Lesson 1: Identifying and Analyzing Chemical Health Threats

### Page 2 of 8

Based on the instructions from your NCOIC, choose the statement that best describes why you were assigned this assessment of the refueling maintenance shop.

**C A routine assessment is scheduled to determine health threats and protect the health of personnel.**

Rationale: While you could perform an assessment for any of the situations and reasons given, this assignment is for a routine occupational health risk assessment.

### Page 3 of 8

During your analysis, you must place the health threat into the context of the **mission** and operational **requirements** to influence your course of action (COA).

Rationale: During your analysis, you must place the health threat into the context of the mission and operational requirements to influence your course of action (COA).

### Page 4 of 8

Which two of the following are appropriate sources of information on health effects of chemical exposures?

**B NIOSH Pocket Guide**

**C Patty's Industrial Hygiene and Toxicology**

Rationale: The NIOSH Pocket Guide and Patty's *Industrial Hygiene and Toxicology* can be important references to find the health effects of various chemicals. The BE Field Manual contains valuable information for completing assessments, and the HazMat Pharmacy is helpful for compiling inventories of chemicals used on base, but neither of these resources is meant to provide information about the health effects of chemicals used on base.

### Page 5 of 8

According to your sampling strategy, you conduct air sampling at the refueling maintenance shop to assess the inhalation threat. After you receive the air sampling results, which two actions should you take next?

**A Evaluate the controls already in place.**

**C Determine the Health Risk Estimate (HRE).**

Rationale: After receiving sampling results, you should analyze them to determine the health risk estimate (HRE) for the exposure by estimating the probability and severity of the health threat. Then, you'll consider the effectiveness of controls that are already in place to determine if new controls are needed. You'll also identify plausible outcomes associated with exposure levels and discuss the health risks and consequences of accepting or controlling the risks with Commanders. At this time, no further sampling is necessary, and you have enough information about JP-8 to be able to analyze the risk.

**Page 6 of 8**

What is your recommended health risk level for this process?

**B Moderate**

**C High**

Rationale: Personnel working in the refueling maintenance shop will frequently be exposed to the JP-8 fuel. Because the exposures are not always over the action level, the effects on the mission will be negligible to moderate. Therefore, the health risk could be estimated at moderate or high.

**Page 7 of 8**

According to the hierarchy of controls, which one of the following choices should be recommended first as a method of reducing worker exposure?

**C Local exhaust ventilation**

Rationale: Using engineering controls, such as a local exhaust ventilation system, is the preferred method of reducing worker exposure. Administrative controls such as worker training and regulated areas should be implemented when engineering controls are not feasible or not enough to control the exposure. Personal protective equipment (PPE) such as respiratory protection is used when neither of the other two types of controls is sufficient to control the health threat.

# Lesson 2: Respiratory Protection

**Page 2 of 13**

Why is it important to consider additional exposure routes when selecting respiratory protection? Choose the two best reasons.

C **Because wearing RP may allow the worker to stay in the area for a longer period of time, thereby putting him / her at greater risk for health effects.**

D **Because some types of RP can protect workers against exposure routes other than inhalation, such as a full-face respirator protecting the eyes from irritants.**

Rationale: When selecting RP, you must consider additional exposure routes, most importantly skin absorption. This is because wearing RP may allow the worker to stay in the area for a longer period of time, thereby putting the worker at greater risk of health effects due to the absorption hazard.

**Page 4 of 13**

Which two of the following statements describe situations in which respiratory protection must be used?

B **RP is used as an interim measure while permanent controls are being installed.**

C **Other controls are unsuccessful at reducing the contaminant level below the exposure limit.**

Rationale: Respiratory protection must be used when other means of control are not feasible or cannot decrease the contaminant levels below the exposure limit or other level of concern; when an OSHA standard or Air Force directive specifies its use; while permanent controls are awaiting funding or are being designed or installed; when BE personnel expect exposures to be greater than the exposure limit or other level of concern, and when necessary for an emergency situation.

Choose the statement that best describes the primary purpose for the use of respiratory protection in the Air Force.

C **To protect personnel from inhalation hazards above levels of concern.**

Rationale: Although filtering facepieces may be worn for personal comfort in some circumstances, the primary purpose of RP in the Air Force is to protect personnel from inhalation hazards above levels of concern. When RP is worn to protect workers from contaminants, compliance with regulations and standards is a by-product, not the primary goal. RP does not increase confidence in health threat characterization.

**Page 10 of 13**

Is the respirator intended for use during fire fighting?

**B No**

Rationale: The respirator is intended to be worn by workers performing fuel filter change out in the refueling maintenance shop.

Is the respirator intended for use in an oxygen-deficient atmosphere?

**B No**

Rationale: The refueling maintenance shop is not an oxygen-deficient atmosphere.

Is the respirator intended for entry into unknown or IDLH atmospheres?

**B No**

Rationale: The refueling maintenance shop is not an unknown or IDLH atmosphere.

Air sampling results in the refueling maintenance shop indicated JP-8 levels of 365.83 $mg/m^3$ as an 8-hour TWA. The OEL for JP-8 is 200 $mg/m^3$.

Is the exposure concentration less than the applicable exposure limit?

**B No**

Rationale: Air sampling during the fuel filter change out process indicates that concentrations are above the exposure limits.

Would loss of life or irreversible health effects result if the respirator fails and the worker cannot escape?

**B No**

Rationale: A worker performing the fuel filter change out would be able to leave the area safely without irreversible health effects if the respirator were to fail.

Would loss of life or irreversible health effects result if the respirator fails and the worker cannot escape?

**B No**

Rationale: A worker performing the fuel filter change out would be able to leave the area safely without irreversible health effects if the respirator were to fail.

Is the contaminant an eye irritant or can it cause eye damage at the workplace concentration?

**A Yes**

Rationale: Because JP-8 can be harmful to the workers' eyes, particularly if splashed, you will need to select a respirator equipped with a full facepiece, helmet, or hood.

Air sampling results indicate that JP-8 is present at levels of 365.83 mg/m$^3$ during the fuel filter change out process. The exposure limit is 200 mg/m$^3$. Is the maximum hazard ratio less than one?

**B No**

Rationale: To figure the hazard ratio, you divide the contaminant concentration by the exposure limit, so for a chemical with a concentration of 365.83 mg/m$^3$ and an exposure limit of 200 mg/m$^3$, the hazard ratio is 1.83.

Is the respirator intended for escape purposes only?

**B No**

Rationale: The respirator is intended for routine use, until the ventilation system is installed in the refueling maintenance shop.

Select the physical form of the contaminant.

**B Gas or Vapor**

Rationale: JP-8 is present as a gas or vapor.

**Page 11 of 13**

Determine which type of respirator would be most appropriate to recommend for the workers performing the fuel filter change out process.

**C Full-facepiece respirator with an organic vapor cartridge**

Rationale: You should recommend the use of a full-facepiece respirator with an organic vapor cartridge.

**Page 12 of 13**

You visit the refueling maintenance shop to issue respiratory protection to the workers and train them on its proper care. Which two of the following statements are *true* regarding the proper care of RP?

**B** **The worker should clean, disinfect, and inspect the respirator at the end of each day of use.**

**D** **BE is responsible for developing change-out schedules for cartridges, filters, or canisters of APRs.**

Rationale: The employee should clean and disinfect the respirator at the end of each day, inspecting it for damage and defects during cleaning and before each use. BE is responsible for developing change-out schedules for cartridges, filters, or canisters of APRs.

## Lesson 3: Regulated Areas

### Page 3 of 5

Select the statement that is *true* regarding regulated areas.

| | |
|---|---|
| **C** | **A regulated area is an area where hazardous materials are or may be present and access is restricted to prevent exposure for people not required to be in the area.** |

Rationale: A regulated area is an area where access is restricted to prevent exposure for people who are not required to be in an area where hazardous materials are or may be present.

### Page 4 of 5

Which two of the following statements do NOT apply to this situation?

| | |
|---|---|
| **C** | **A regulated area is not necessary because of ventilation system has been ordered.** |
| **D** | **Unregulated access to the area is acceptable because personnel are wearing respirators.** |

Rationale: A regulated area is required as an interim measure until the ventilation system is being put into operation because exposure is above acceptable levels, and hazardous exposure could occur if access by personnel not wearing the appropriate PPE is not controlled.

# Lesson 4: Ventilation

## Page 4 of 8

Which of the following types of pressure exists even when there is no air motion and acts equally in all directions?

**C Static pressure**

Rationale: Static pressure exists even when there is no air motion and acts equally in all directions.

Which of the following types of pressure is always positive in sign and is exerted by air in motion?

**D Velocity pressure**

Rationale: Velocity pressure is exerted by air in motion and is always positive in sign.

Which of the following statements best describes dilution ventilation?

**C It involves pulling air in and is used to provide clean air to a room to mix with the contaminated air.**

Rationale: Dilution ventilation involves pulling air into a space and is used to provide enough clean air to a room to dilute the contaminated air.

Which of the following is an example of an occupational setting where local exhaust ventilation is most likely to be used?

**B Metalworking / welding shop**

Rationale: Examples of occupational settings in which local exhaust ventilation is likely to be used include lab hoods, welding hoods, or vehicle exhaust testing shops.

**Page 5 of 8**

Which survey should be conducted before the new system is put into operation to determine whether it meets design specifications?

**B Metalworking / welding shop**

Rationale: An initial survey is done before a new ventilation system is put into operation, to ensure that it meets design specifications. A baseline survey will be performed after the system is put into operation to verify that it can control the contaminants. Local exhaust ventilation systems that are controlling a contaminant are checked on a routine basis to ensure that the system continues to operate adequately. A pre-survey should also be done as a planning step prior to performing the initial survey.

**Page 7 of 8**

What action should you take based on this information?

**C Remove the workers from the respiratory protection program.**

Rationale: As long as the system is controlling the contaminant, as indicated by the air sampling results, no further surveying is required at this time. Now that contaminant levels are within acceptable levels, the workers can be removed from the RP program.

These results are not within 10% of the baseline value. What action should you take?

**B Perform troubleshooting procedures and do a routine survey.**

Rationale: If results are not within 10% of the baseline, you should perform troubleshooting procedures and conduct another baseline test.

# Course Glossary

## Acronyms

**AAR**
After Action Report

**ACADA**
Automatic Chemical Agent Detection Alarm

**AFI**
Air Force Instruction

**AFMIC**
Armed Forces Medical Intelligence Center

**AFMS**
Air Force Medical Service

**AFMSA**
Air Force Medical Support Agency

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

**AFRRAD**
Air Force Radiation and Radioactive Recycling and Disposal

**ALARA**
As Low As Reasonably Achievable

**AMC**
Aerospace Medicine Council

**amu**
Atomic Mass Unit

**AO**
Area of Operations

**AOC**
Area of Concern

**AOR**
Area of Responsibility

**BE**
Bioenvironmental Engineering Flight

**CBRN**
Chemical, Biological, Radiological, Nuclear

**CE**
Civil Engineering

**COA**
Course of Action

**COC**
Contaminant of Concern or Constituent of Concern

**CONUS**
Continental United States

**CSM**
Conceptual Site Model

**CV**
Coefficient of Variability

**DIA**
Defense Intelligence Agency

**DF**
Duty Factor

**DOD**
Department of Defense

**DOE**
Department of Energy

**DOS**
Department of State

**DOT**
Department of Transportation

**$D_{pel}$**
Estimated Hazard Distance

**DRI**
Direct Reading Instruments

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

**EMR**
Electromagnetic Radiation

**EPA**
Environmental Protection Agency

**EPD**
Electronic Personal Dosimeters

**FPWG**
Force Protection Working Group

**$G_{abs}$**
Absolute Gain

**HF**
High Frequency (Occurs between 3 and 30 MHz)

**HRA**
Health Risk Assessment

**HRE**
Health Risk Estimate

**HRM**
Health Risk Management

**IATA**
International Air Transport Association

**IPE**
Individual Protection Equipment

**LCL**
Lower Confidence Limits

**LET**
Linear Energy Transfer

**LF**
Low Frequency (Occurs between 30 and 300 kHz)

**MAJCOM**
Major Command

**MEDIC CD**
Medical Environmental Disease Intelligence and Countermeasure CD

**MIO**
Medical Intelligence Officer

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

**MOPP**
Mission Oriented Protection Posture

**MPE**
Maximum Permissible Exposure

**MSP**
Mission Support Plan

**NFB**
Near-Field Boundary

**NGIC**
National Ground Intelligence Center

**NHZ**
Nominal Hazard Zone

**NIOSH**
National Institute for Occupational Safety and Health

**NOHD**
Nominal Ocular Hazard Distance

**NRC**
Nuclear Regulatory Commission

**OCONUS**
Outside the Continental United States

**OEH**
Occupational and Environmental Health

**OEHSA**
Occupational and Environmental Health Site Assessment

**OEL**
Occupational Exposure Limits

**OEL-C**
Occupational Exposure Limits-Ceiling

**OEL-STEL**
Occupational Exposure Limits-Short Term Exposure Limit

**OEL-TWA**
Occupational Exposure Limits-Time Weighted Average

**OH**
Occupational Health

**ORM**
Operational Risk Management

**OSHA**
Occupational Safety and Health Administration

**OSI**
Office of Special Investigation

**$P_{avg}$**
Average Power

**PEL**
Permissible Exposure Limit

**PH**
Public Health

**$P_p$**
Peak Power

**PPBS**
Planning, Programming and Budgeting System

**PPE**
Personal Protective Equipment

**PPM**
Parts per million

**PRF**
Pulse Repetition Frequency

**PW**
Pulse Width

**RFR**
Radio Frequency Radiation

**RSO**
Radiation Safety Officer

**S**
Main-Beam Power Density

**SAR**
Specific Absorption Rate

**$S_{avg}$**
Power Density Average

**SEG**
Similar Exposure Group

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

**SLM**
Sound Level Meter

**$S_{max}$**
Maximum Power Density

**SPL**
Sound Pressure Level

**TLD**
Thermoluminescent Dosimeters

**TWG**
Threat Working Group

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

**USACHPPM**
United States Army Center for Health Promotion and Preventive Medicine

**UTC**
Unit Type Code

**VA**
Vulnerability Assessments

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

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

# Definitions

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

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

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

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

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

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

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

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

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

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

**Carcinogens**
Hazardous materials that stimulate the formation of cancer.

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

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

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

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

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

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

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

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

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

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

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

**Dose**
The quantity of radiation absorbed.

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

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

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

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

**Energy**
The ability to do work.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

**Kinetic Energy**
Energy of motion.

**Laser**
Light amplification by stimulated emission of radiation.

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

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

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

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

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

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

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

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

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

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

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

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

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

**Optical Cavity**
The component that houses the laser.

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

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

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

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

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

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

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

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

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

**Potential Energy**
Energy of position.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

# Appendices

- USACHPPM JP-8 Information
- Respirator Selection Flowchart
- Assigned Protection Factors Table

USACHPPM

Readiness thru Health

65-028-0503

# Just the Facts... JP-8 - Medical

| | |
|---|---|
| **GENERAL INFORMATION** | JP-8 is an abbreviation for "jet propellant-8". It is similar to the fuel that replaces, JP-5, but there are some differences. Both of these fuels are colorless liquids made up of over two hundred identifiable hydrocarbons and many other trace substances. The largest constituent by far is de-sulfurized "kerosene", which makes up more than 98% of the total volume of both JP-5 and JP-8. "Aromatic hydrocarbons" (benzene, toluene, and mixed xylenes) make up a very small fraction of JP-5 and JP-8 fuels. JP-8 contains less benzene than JP-5. Regular automobile gasoline typically contains more benzene than do the kerosene-based jet fuels. JP-8 and commercial jet fuel (jet fuel-A) are chemically identical, but they have different additives.<br>Since the 1990s, the military services and NATO forces have been changing to JP-8 as a single engine basic fuel. This fuel is used to power diesel engines and turbines in land vehicles, aircraft, vessels, and generators, as well as, to burn in tent heaters and field kitchens. Due to the Navy's shipboard fire safety concerns, carrier-based aircraft have not made the switch from JP-5.<br>For specific uses, such as a fuel for a high performance jet aircraft engine or a fuel for a tent heater, different chemical additives are blended into the basic JP-8 fuel. These additives include stabilizers, corrosion and ice inhibitors, anti-static agents, biocides, and gum and varnish cleaners.<br>JP-8 has performance and health advantages over previously used fuels. It is thicker and less volatile than JP-5, and it contains less benzene--a known cancer-causing chemical. However, it evaporates slowly resulting in prolonged skin contact. Some of the chemical additives give additional toxicity to the basic fuel. |
| **ROUTINE USES IN THE DEPLOYED SETTING** | Diesel and turbine powered Army land vehicles, aircraft, water vessels, and auxiliary equipment (large generators) use JP-8 as a fuel. Passenger vehicles, drone aircraft, and some small engine use gasoline. The vehicles, aircraft, and vessels using JP-8 include the Abrams M1A1/M1A2 Main Battle Tanks, Bradley Fighting Vehicles, HumVees, as well as, heavy trucks, helicopters, and most Army "boats".<br>Exposure to JP-8 can occur during use, fueling, maintenance, and repair operations. During the current deployment, soldiers have used cans with JP-8 to clean gas plugs. This could result in skin exposure when they retrieve the plugs. Additionally, fuel handling and transportation, spill clean-up, and use in stoves, heaters, and generators are other potential sources of JP-8 exposure.<br>*JP-8 must not be used as an obscurant or for dust/sand suppression. This would result in high exposures to personnel.* |
| **PERSONAL PROTECTIVE EQUIPMENT (PPE) and COUNTERMEASURES AVAILABLE FOR DEPLOYED PERSONNEL** | Eye and skin contact should be avoided through the use of protective eyewear, gloves, and protective outer garments that do not absorb the organic liquid for those with regular and prolonged contact with JP-8. Inhalation exposure can occur from the vapor or aerosol mist during "cold" turbine engine start-up. Nearby personnel should be positioned away from the vapor/aerosol plume. Handling and transfer of fuel should be performed in well-ventilated areas.<br>Aircraft maintenance personnel must wear appropriate respiratory protection and clothing when working with or entering fuel cells.<br>Clothing should be promptly removed if it becomes wet with JP-8. Clothing should be laundered before wearing again. |
| **QUESTIONS TO ASK REGARDING EXPOSURE** | • How did exposure occur and how long did it last? Did it happen on more than one occasion?<br>• Was/Were there any acute effect(s) associated with the exposure(s); how long did it/they last?<br>• Were any other individuals affected?<br>• Was the exposure situation evaluated by the medical department?<br>• Determine if JP-8 was used for a non-approved application (obscurant or dust/sand suppression. |

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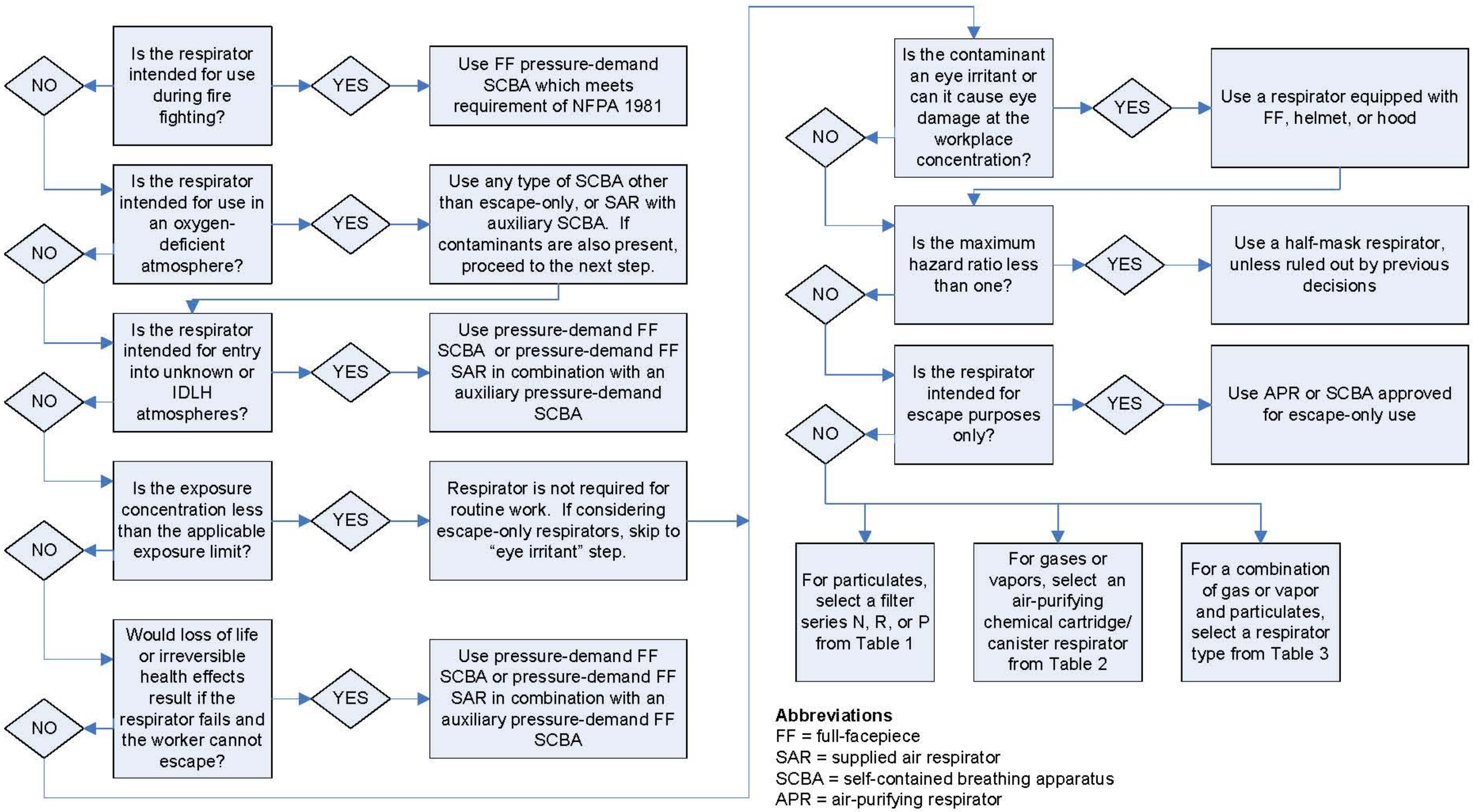
| | |
|---|---|
| **EXPOSURE LEVELS HISTORICALLY ENCOUNTERED** | During aircraft fuel cell maintenance, the USAF has found that levels of total JP-8 and benzene (found in JP-8) may exceed the occupational exposure limits recommended by the National Academy of Science. These unique tasks represent the highest exposure levels for military personnel. The exposures occurred during brief 15-minute periods, as well as, whole day exposures. Using appropriate clothing and respiratory protection, these exposures did not result in elevated levels of JP-8 component chemicals in the personnel when medical surveillance was conducted. |
| **AVAILABLE EXPOSURE DATA** | For personnel exposed to concentrations above one-half of the occupational exposure level (time-weighted average (TWA): 350 mg/m$^3$; short-term exposure level (STEL) 1,000 mg/m$^3$), medical monitoring has been recommended by individuals outside of the DoD, but this has not been established as policy by the armed services. Before entry into a medical surveillance program, exposure levels must be determined and assessed by qualified personnel. |
| **COMMON ACUTE AND CHRONIC HEALTH EFFECTS** | Generally, the acute and chronic effects of JP-8 are similar to those following exposure to hydrocarbons (kerosene) or solvents (PD 680; Stoddard). Much of the information on human health effects is based upon experience and research with kerosene—the major component of jet fuels, and comparison to JP-5. Additionally, the vapor (gaseous) state is often used in studies, and in this form the toxicity varies from that of an aerosol (liquid particulate). The synergistic actions (both additive and subtractive) between the base JP-8 fuel and chemical additives have been studied only to a limited degree. Most information regarding human health effects is restricted to data developed for single agent constituents found in the fuels and additives.<br>JP-8 can irritate the eyes, nose, throat, and lungs. Dizziness, lightheadedness, skin irritation, and an objectionable taste in the mouth and odor on the breath were some of the more commonly reported complaints during an extensive USAF study. This study also found that there were no increases in respiratory illnesses, nor were any long-term health hazards associated with JP-8 exposure.<br>Studies in animals have demonstrated immune suppression with high-level exposures by the dermal and inhalation routes. This was not seen in the USAF study of workers. |
| **REVERSIBILITY OF HEALTH EFFECTS** | The acute effects are reversible when exposure is stopped. High-level exposures causing eye irritation may take several days to resolve. Simple dermatitis may progress if exposure continues and the condition is not adequately treated.<br>Results for a USAF study have not found and long-term health effects from routine JP-8 exposure. |
| **TREATMENT REQUIRED/AVAILABLE FOR EXPOSURE** | The immediate treatment for any hydrocarbon exposure is to stop the exposure (irrigate eyes, rinse skin, move to fresh air) when contact or effects occur. For acute situations, symptomatic treatment is usually the mainstay of medical care. After emergent issues are taken care of, reducing the intensity or eliminating exposure altogether is the appropriate goal of the clinician.<br>Generally, there is no medical treatment required for past routine exposure. |
| **LONG TERM MEDICAL SURVEILLANCE REQUIREMENTS OF HEALTH EFFECTS MONITORING** | Medical surveillance is not required for routine exposure.<br>Following significant acute or chronic exposure, medical evaluation/surveillance can be based upon a known component of the fuel—benzene, toluene, xylenes, naphthalene, or polynuclear aromatic hydrocarbons (PAHs). Benzene, and its metabolites, and 1-hydroxypyrene can be used as biomarkers of fuel exposure, if warranted. These chemicals do not persist in the body. They must be measured in the immediate period following exposure and correlated back to the exposure with serial level, as necessary..<br>*For personnel exposed to concentrations above one-half of the occupational exposure level, medical surveillance has been recommended. The National Academy of Science has recommended a time-weighted average of 350 mg/m$^3$; short-term exposure level (STEL) of 1,000 mg/m$^3$.* |
| **SPECIAL RISK COMMUNICATION ISSUES** | Some individuals working with JP-8 note an objectionable taste in their mouth and odor on their breath after exposure. This is an undesirable condition, but it is temporary and not harmful. It will go away within several hours, but it is a possible indication of excessive exposure. Precautions taken to decrease exposure and contact with JP-8 will likely prevent this from recurring.<br>JP-8 has not been shown to be a carcinogen in humans. |

# Respirator Selection




**Abbreviations**
FF = full-facepiece
SAR = supplied air respirator
SCBA = self-contained breathing apparatus
APR = air-purifying respirator

Adapted from *NIOSH Respirator Selection Logic 2004*
http://www.cdc.gov/niosh/docs/2005-100/chapter3.html

# Assigned Protection Factors

| Type of Respirator[1,2] | Half mask | Full facepiece | Helmet / Hood | Loose Fitting Facepiece |
|---|---|---|---|---|
| Air-Purifying Respirator | [3]10 | 50 | -- | -- |
| Powered Air-Purifying (PAPR) | 50 | 1,000 | [4]25/1,000 | 25 |
| Supplied-Air Respirator | | | | |
| Demand Mode | 10 | 50 | -- | -- |
| Continuous Flow Mode | 50 | 1,000 | [4]25/1,000 | 25 |
| Pressure-demand/other positive-pressure mode | 50 | 1,000 | -- | -- |
| Self-contained breathing apparatus | | | | |
| Demand Mode | 10 | 50 | 50 | -- |
| Pressure-demand/other positive-pressure mode | -- | 10,000 | 10,000 | -- |

[1] Employers may select respirators assigned for use in higher workplace concentrations of a hazardous substance for use at lower concentrations of that substance, or when required respirator use is independent of concentration.

[2] The assigned protection factors in Table 1 are only effective when the employer implements a continuing, effective respirator program as required by this section (29 CFR 1910.134), including training, fit testing, maintenance, and use requirements.

[3] This APF category includes filtering facepieces, and half masks with elastomeric facepieces.

[4] The employer must have evidence provided by the respirator manufacturer that testing of these respirators demonstrates performance at a level of protection of 1,000 or greater to receive an APF of 1,000. This level of performance can best be demonstrated by performing a WPF or SWPF study or equivalent testing. Absent such testing, all other PAPRs and SARs with helmets/hoods are to be treated as loose-fitting facepiece respirators, and receive an APF of 25.

*From AFI 48-137, as excerpted from 29 CFR 1910.134*