Bioenvironmental Engineering Site Assessment I

Unit 15: Toxic Industrial Materials

Unit Description: In this unit, you will be stationed at Hoyt AFB in Lompoc, California, where you'll be helping to perform a vulnerability assessment for Toxic Industrial Chemicals and Toxic Industrial Materials (TICs/TIMs) on and near the base. When you've completed your assignment, you'll be able to describe the procedures necessary to perform a TIC/TIM vulnerability assessment.

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Lesson 1: TIC/TIM Vulnerability Assessment

Lesson Description

In this lesson, you will be evaluating risks associated with Toxic Industrial Chemicals and Toxic Industrial Materials (TICs/TIMs) on and around Hoyt AFB. When you finish, you'll be able to describe the procedures necessary to perform a TIC/TIM vulnerability assessment.

Lesson Overview (Page 1 of 16)

Toxic Industrial Chemicals and Toxic Industrial Materials (TICs/TIMs) are often present on and around military bases. Because these substances can pose serious risks to base personnel and the surrounding community, it is important to identify TIC/TIM sources and evaluate the associated risks.

As you perform the TIC/TIM vulnerability assessment for Hoyt AFB, you will:

- Recall the classifications of TIC/TIM.
- Define the TIC/TIM vulnerability assessment methodology.
- Determine why and when a TIC/TIM vulnerability assessment should be conducted.
- Describe the steps of the TIC/TIM vulnerability assessment process.

Audio Script

Narrator: You've been asked to help identify potential threats from Toxic Industrial Chemicals and Toxic Industrial Materials on and around the base and then evaluate the risks associated with the threats. You will be assisting Captain Campbell to complete the TIC/TIM vulnerability assessment.

Classifications of TICs/TIMs (Page 2 of 16)

TICs/TIMs are industrial substances that have the potential to negatively affect base populations through outdoor air, indoor air, or water. These substances may be caustic, explosive, flammable, or radioactive and can be in gas, liquid, or solid form (including particles). Because gas spreads easily, this form tends to be of greatest concern.

The three types of TICs/TIMs that will be inventoried are:

- **Toxic Industrial Chemicals (TICs).**
- **Toxic Industrial Biologicals (TIBs).**
- **Toxic Industrial Radiologicals (TIRs).**

Toxic Industrial Chemicals (TICs)

TICs are chemical compounds used or produced in industrial processes that are toxic to humans and animals or that cause damage to plants. TICs that are evaluated in the TIC/TIM assessment methodology include toxic gases and highly volatile liquids. Toxic solids and toxic non-volatile liquids are inventoried but are not evaluated in this methodology.

Some examples of TICs include ammonia, chlorine, formaldehyde, and sulfuric acid.

Toxic Industrial Biologicals (TIBs)

TIBs are biological materials such as bacteria, viruses, and toxins found in medical research, pharmaceutical, or other manufacturing processes that are toxic to humans and animals, or that cause damage to plants. In the TIC/TIM assessment methodology, TIBs are inventoried, but because of their imprecise nature, they are not evaluated.

Toxic Industrial Radiologicals (TIRs)

TIRs are radiation-emitting materials used in research, power generation, medical treatment, and other non-weapon developmental activities that are harmful to humans and animals if released outside their controlled environment. TIRs evaluated with the TIC/TIM assessment methodology include the most common isotopes found in radiological equipment, Cesium-137 and Cobalt-60. Nuclear fuel and weapons-grade material are not inventoried or evaluated in this methodology.

How Personnel May Be Exposed to TICs/TIMs (Page 3 of 16)

Exposure to TICs/TIMs may be the result of accidental release, collateral damage from explosions or attacks near stored chemicals, or intentional dispersion with explosives such as Improvised Explosive Devices (IEDs).

Although TICs/TIMs can be found almost anywhere, they are primarily used in:

- Chemical plants.
- Industrial manufacturing facilities.
- Waste water treatment plants.
- Chemical/waste storage facilities or landfills.
- Laboratory settings.
- Large fuel storage areas.
- Major transportation centers, including in the vehicles.

Example of Catastrophic Effects from TICs/TIMs

One of the worst industrial accidents in history occurred in 1984, when 40 tons of methyl isocyanate gas escaped from a pesticide plant in Bhopal, India, and killed at least 3,000 people within a few days. Because of long-term health effects caused by the leakage and failure to clean up the toxic remains, many more people have died over the years. Thousands have also become ill from breathing the toxic air, drinking tainted water, or handling contaminated soil. The total number of deaths and injuries is unknown.

Appraisal (Page 4 of 16)

Match each component of a laser system with its function by marking the appropriate block in the table.

Description	Toxic Industrial Chemical	Toxic Industrial Biological	Toxic Industrial Radiological
Substances evaluated in this category include Cesium-137 and Cobalt-60, but not weapons-grade material.			
Substances in this category are inventoried but are not evaluated, due to their imprecise nature.			
Substances evaluated in this category include toxic gases and highly volatile liquids.			

Scenario Challenge Point (Page 5 of 16)

Audio Script

BEE: This is your first TIC/TIM assessment, isn't it?

BE Tech: Yes, Ma'am, it is.

BEE: Well then, let's make sure you understand what it's all about. Tell me about the process we're going to use to conduct the risk assessment.

Choose the two statements that *best* define the TIC/TIM vulnerability assessment methodology.

A It is used as a high-level screening tool for evaluating TIC/TIM risks and providing rough estimates of the potential magnitude of consequences.

B It allows for modifications and improvements as necessary to meet specific needs so individual bases can prioritize their risks and plan accordingly.

C It is used to predict consequences of actual chemical releases or explosions and evaluate the full range of scenarios that may occur on or near a base.

D It enables personnel to accurately calculate hazard zones, particularly for long distances, and predict consequences of chemical release or explosions.

TIC/TIM Vulnerability Assessment Methodology (Page 5a of 16)

The TIC/TIM vulnerability assessment methodology is a process for conducting a risk assessment that is intended to be used as a high-level screening tool for evaluating TIC/TIM risks and providing rough estimates of the potential magnitude of consequences. This methodology allows for modifications and improvements as necessary to meet specific needs so individual bases can prioritize their risks and plan accordingly. It is not intended to be used for fully predicting consequences of actual chemical releases or explosions in an emergency response situation. Nor is it intended to represent the full range of possible scenarios that may occur on or near an Air Force base.

When determining the health risk from TICs/TIMs, you must consider the probability of the exposure occurring as well as its severity, or impact on the population. To perform the TIC/TIM assessment, you will collect and evaluate accurate and detailed information regarding the:

- Potential threat from TICs/TIMs on or near the base.
- Characterization of worst-case and alternative scenarios.
- Severity of releases.
- Probability of releases.
- Relative risks.

Why and When to Conduct a TIC/ TIM Vulnerability Assessment (Page 6 of 16)

AFI 41-106, *Unit Level Management of Medical Readiness Programs* requires the Bioenvironmental Engineer or Bioenvironmental Engineering Technician to conduct an annual assessment of local industrial facilities, both on and off base that may be of consequence to base operations if TICs/TIMs were to be released. The TIC/TIM vulnerability assessment is conducted IAW AFPD 90-9, *Air Force Operational Risk Management (ORM)*, which establishes general principles for risk management and assessment.

The TIC/TIM vulnerability assessment is conducted as part of the larger Air Force vulnerability assessment program with the goals of staying abreast of current situations and assisting with force health protection. The assessment is performed every year to assess whether the risks have remained the same or have changed, evaluate new risks, and adjust the plan as necessary to address the current situation. Under certain circumstances, a special assessment may be needed in addition to the annual evaluation. For example, if a large chemical plant opens near the base midyear, an assessment would be conducted at that time to evaluate the new risks.

Appraisal (Page 7 of 16)

Select the statement that is NOT true regarding why and when TIC/TIM vulnerability assessments are conducted.

Choices	Answer
The BEE or BE Tech is required to conduct an annual assessment of local industrial facilities.	______________________________
The goals of the assessment are to stay abreast of current situations and assist with force health protection.	
The assessment facilitates evaluating the TICs/TIMs that could potentially impact the base.	
The assessment is done to create a document that tells first-responders exactly what to do if a TIC/TIM incident occurs around the base.	

Conducting the TIC/ TIM Vulnerability Assessment (Page 8 of 16)

The TIC/TIM vulnerability assessment is conducted in four phases:

- Phase 1: Planning and Coordination
- Phase 2: Data Collection
- Phase 3: Analysis
- Phase 4: Report

You will learn more about each of these phases as you assist Captain Campbell with the assessment.

During data gathering and analyses, assessors shall not name the specific base, buildings, or local facilities being evaluated. Other identifiers shall be used until deemed necessary, at which time documents and discussions may become classified as Secret. If any documents generated during the assessment can reasonably be expected to cause damage to national security if disclosed without authorization, it is critical that these documents be protected as Classified/Secret.

Phase 1: Planning and Coordination (Page 9 of 16)

Planning and coordinating activities are vital for ensuring that the assessment is carried out efficiently and according to schedule. The tabbed information below will help you learn about the steps performed in Phase 1 of the TIC/TIM vulnerability assessment for Hoyt AFB.

Tab: Identify the Lead Assessor

First, a lead assessor must be identified to manage the assessment team and to perform overall coordination. The lead assessor assigns tasks associated with all phases of the assessment and ensures that the assessment is completed according to schedule.

The lead assessor in this case is Captain Campbell, the BEE with whom you are working. She assigns tasks associated with all phases of the assessment and ensures that the assessment is completed according to schedule.

Tab: Identify the Team and Assign Roles and Responsibilities

Next, the lead assessor identifies a multi-disciplinary team to assist in the completion of the assessment. Because the expertise and composition of the assessment team are vital to the success of the assessment, Captain Campbell takes care to ensure that the team includes members with strong technical backgrounds and familiarity with:

- TIC/TIM assessment methodology.
- Site-specific TICs/TIMs, installation infrastructure, base operations, and off-base industries.
- TIC/TIM characteristics and health effects.
- Transport of contaminants via air.

Tab: Develop a List of Stakeholders

The final step in the Planning and Coordination Phase is to develop a list of stakeholders, who are individuals able to support data collection requests. As the lead assessor, Captain Campbell documents the team and distributes a list to the team members and team advisors. The organizations and individuals involved include:

- Bioenvironmental Engineering (BE)
- Office of Security Investigations (OSI)/Intel
- Security Forces
- The Safety Office
- The Antiterrorism Officer (ATO)
- The Weather Office
- Contractor Support
- **Civil Engineering (CE).**

Civil Engineering (CE)

There are several organizations and individuals within CE that may be involved in a TIC/TIM assessment, including:

- Emergency Management.
- A Local Emergency Planning Committee (LEPC) representative.
- The Emergency Planning and Community Right-to-Know Act (EPCRA) point-of-contact (POC).
- The Fire Department.
- Pest Management.
- The GeoBase POC.
- The Hazardous Waste Program Manager.
- The Real Property Officer.

Phase 2: Data Collection (Page 10 of 16)

The information below will help you learn about the steps you and the rest of the assessment team perform during Phase 2 of the TIC/TIM vulnerability assessment.

Tab: Collect TIC/TIM Data and Obtain Base Map

As the first step in the second phase of the assessment, the team **conducts an inventory** of TICs/TIMs located and/or routinely transported within 20 miles of the base. **Specific data** needs to be collected on each TIC/TIM in order to accomplish the Analysis Phase. In addition, the team must procure a base map, preferably an electronic map, which shows the base and the surrounding area. This map will be used in the Analysis Phase to show the potential impact of any TIC/TIM releases.

Conduct an Inventory

As you begin creating an inventory of TIC/TIM threats on and around Hoyt AFB, you include the toxic chemicals regulated under the Environmental Protection Agency (EPA) Risk Management Program (RMP) and those listed in Tier II reports. You check with Local Emergency Planning Committees (LEPCs) and State Emergency Response Commissions (SERCs) for data about TICs/TIMs located off base. You also conduct visual observation of facilities within the vicinity of the base, and include information regarding HazMat routes near the base, such as railways, waterways, and highways.

Once the off-base TIC/TIM information is collected, you and the rest of the assessment team conduct an inventory of TICs/TIMs stored on the base or piped into populated base facilities. Some sources you can check for information about TICs/TIMs located on base include the:

- Base Civil Engineering bulk storage inventory.
- Base HazMat inventory.
- Base Radiation Safety Officer (RSO).
- AF Radio-Isotope Committee.

Specific Data

Your TIC/TIM inventory includes the following:

- The source and ownership of each TIC/TIM.
- The quantity (volume, mass, or radioactivity) and type of storage (e.g., one-ton cylinders) of each TIC/TIM.
- The specific location of each TIC/TIM, including building numbers for on-base TIC/TIM or proximity to the base. GPS coordinates for the location are also useful when attempting to plot the location and evaluate the risks posed by any TIC/TIM release.

You can view an example of a TIC/TIM Inventory in the Appendix of this document.

Tab: Collect Meteorological Data

During Phase 2, you and the rest of the assessment team obtain meteorological information spanning a minimum of 12 months. Information you gather from the base weather office or from nearby airports and commercial airfields include prevailing wind direction, average wind speed, average temperature, and average relative humidity. This information is collected to characterize both worst-case and alternate meteorological conditions specific to the base location.

You also work with the base weather office to characterize the **atmospheric stability** of the site based on wind speed, time of day (daytime or nighttime), and amount of solar radiation (daytime) or cloud cover (nighttime).

Meteorological Conditions Characterized by Pasquill Stability Classes

WIND SPEED		DAYTIME SOLAR RADIATION			NIGHTTIME CLOUD COVER	
meters/second	miles/hour	strong	moderate	slight	> 50%	< 50%
< 2	< 5	A	A - B	B	E	F
2 - 3	5 - 7	A - B	B	C	E	F
3 - 5	7 - 11	B	B - C	C	D	E
5 - 6	11 - 13	C	C - D	D	D	D
> 6	> 13	C	D	D	D	D

Pasquill Atmospheric Stability Classes (Pasquill, 1961)

STABILITY CLASS	DEFINITION
A	Very Unstable
B	Unstable
C	Slightly Unstable
D	Neutral
E	Slightly Stable
F	Stable

Tab: Collect Natural Disaster and Accident Information

You and the rest of the assessment team collect data on past accidents, operation or maintenance failures, and natural disasters, including information on the history of events on or near the base and the propensity for natural disasters in the region. For example, because Hoyt AFB is located in California, you collect information about the potential for earthquakes in the area.

You use the National Climatic Data Center (NCDC) Storm Event Database as a tool to identify the history of natural disasters in the region. If you were outside the U.S., you could query the Emergency Events Database (EM-DAT), maintained by the Center for Research on the Epidemiology of Disasters (CRED), to help characterize the region's history in experiencing disasters.

You check with base response personnel and local emergency planning and response organizations, such as fire departments, because they can provide logs and other information regarding incidents that have occurred in the past and may occur in the future. You also query the U.S. Environmental Protection Agency's (EPA's) Toxic Release Inventory (TRI) database and Risk Management Program (RMP) Offsite Consequence Analyses (OCA) database.

Because the purpose of this data collection effort is to provide a general indication as to the type of events that may occur, it is not necessary to conduct a detailed inventory or analysis of past accidents or other unintentional events.

Tab: Verify the Data and Compile the Inventory

Once all of the data has been collected, it needs to be verified for accuracy and completeness. During this step, the team ensures that the information collected is accurate by contacting the agencies storing TICs/TIMs. You then verify the completeness of the data by driving around the outer perimeter of the base to look for any additional sources. During this physical verification, your search should encompass everything within at least a half mile of the base boundary.

After the data is verified, the team compiles all of the identified TICs/TIMs into a combined inventory. The purpose of this step is to put all of the data together so it can be readily available for the Analysis Phase of the TIC/TIM vulnerability assessment process.

Tab: Collect Data on TIC/TIM Characteristics

To prepare for the Analysis Phase of the TIC/TIM vulnerability assessment, you must understand the **potential effects** of the TICs/TIMs that have been identified.

You check the following sources for information about toxic gas concentrations:

- Emergency Response Planning Guideline (ERPG) values published by the American Industrial Hygiene Association (AIHA).
- Acute Exposure Guideline Levels (AEGLs) for a 60-minute exposure published by the National Research Council.
- Temporary Emergency Exposure Limit (TEEL) values published by the U.S. Department of Energy.

In deployed settings, Air Military Exposure Guidelines (Air-MEGs) for a 60-minute exposure for each chemical may be applied. Air-MEGS can be found in USACHPPM Technical Guide 230, *Chemical Exposure Guidelines for Deployed Military Personnel*.

Potential Effects

TICs/TIMs are evaluated in the assessment methodology with respect to their potential to cause deaths, severe injuries/illnesses, or minor injuries/illnesses. The chemical amounts or concentrations that can cause these varied effects are referred to by their levels of concern (LOCs):

- LOC_1: The threshold concentration at or above which may cause minor injury/illness or non-negligible impacts.
- LOC_2: The threshold concentration at or above which may cause severe injury/illness.
- LOC_3: The threshold concentration at or above which may cause death.

Appraisal (Page 11 of 16)

Build a list of sources which can provide information about TICs/TIMs located on base.

Word Bank	**List**
Radiation Safety Officer	________________________________
HazMat Inventory	________________________________
Local Emergency Planning Committees	________________________________
State Emergency Response Commissions	________________________________
AF Radio-Isotope Committee	
Civil Engineering Bulk Storage Inventory	

Phase 3: Analysis (Page 12 of 16)

During the third phase of the assessment, you and the rest of the assessment team evaluate the TICs/TIMs you've identified to determine their potential impact to the base. From this point on, the data and analysis is treated as **classified.**

Classified

Any information linking a vulnerability or concern with a specific U.S. military site should be classified as CONFIDENTIAL (C) or SECRET (S), IAW *DoDI*

2000.15, DoD Antiterrorism Standards, and the *Defense Threat Reduction Agency (DTRA) Security Classification Guide for Vulnerability Assessments (SCG).* All due caution should be taken to protect this information, to include working on a computer designed to handle SECRET documents, such as one connected to the Secret Internet Protocol Router Network (SIPRNet).

Tab: Screen Toxic Substances with Potential to Impact the Base

Once the TIC/TIM inventory is complete and the necessary data have been collected, you and the rest of the assessment team begin screening the TICs/TIMs to determine which are likely to impact the base, so you can focus on the relevant threats rather than analyzing every TIC/TIM on the large inventory. These relevant threats that must be analyzed during the third phase of the vulnerability assessment include all radioactive materials identified in the inventory.

To screen the threats, the team uses worst-case scenario conditions to model the potential impact of a particular TIC/TIM. The lowest concentration level expected to have any effect on the population is LOC1, so the team uses this concentration level in this screening phase to determine the potential impact of each TIC/TIM to the base. Using the LOC1, the potential plume of the TIC/TIM is determined using worst-case conditions. If the resultant plume will impact the base, the TIC/TIM must be analyzed further in later stages of this phase. If the resultant plume does not reach the base boundary, then there is no further analysis required for this TIC/TIM.

Tab: Develop Location Maps

Next, the assessment team develops area maps to assist in locating the TICs/TIMs that pose the greatest risks to the base and identifying specific locations that may be affected by TIC/TIM events. The team ensures that, at a minimum, the maps illustrate the entire extent of the base cantonment area and include infrastructure relevant to the evaluation of TIC/TIM releases. The following data elements are included on these maps:

- TIC/TIM identifiers and locations.
- Base facilities and critical assets.
- Transportation assets (including roads, railroads, and base access points).

Another element the team includes on the maps is the location of on-base natural gas lines and other distribution lines of interest. For example, your maps of Hoyt AFB include chemical feed lines from a laboratory complex with bulk chemicals stored outside.

Tab: Develop Worst-Case and Alternate Scenarios

During the next step of the Analysis Phase, you and the rest of the team evaluate a **worst-case scenario** and an **alternate scenario** for each TIC/TIM. The major distinctions between the two types of scenarios are the amount of a chemical substance or radioactive material involved in the exposure and the meteorological conditions.

For the purpose of these assessments, the location where a scenario takes place is the location in which the TIC/TIM is normally used. However, you note in the assessment reports that the scenario could potentially take place in a more damaging location because TICs/TIMs are generally transportable.

The team does not develop scenarios with multiple TIC/TIM interactions such as a situation in which numerous substances are released and produce a new toxic material through mixing and reaction. Additionally, radioactive releases evaluated in this methodology do not include radioactive materials that are detonated or aerosolized such as dirty bombs. However, the team includes a statement in the assessment report about the potentials for these scenarios.

Worst-case Scenario

As you would expect, a worst-case scenario is one which takes into account the worst possible conditions that could be associated with a release or exposure.

For this type of scenario, you consider a potential release of the maximum available quantity of a substance, such as completely full storage containers or vessels at full capacity. Because a railway is included in your TIC/TIM inventory for Hoyt AFB, you consider the railcars at their maximum capacities, and you assume that two railcars will be carrying each chemical, since you don't have data indicating otherwise.

In a situation involving a tanker truck, if the specific capacity of the tanker truck cannot be determined, a capacity of 34,000 lbs may be used.

In addition to the amount of the substance, you must also consider the meteorological conditions which may exacerbate the effects of a release. For example, your scenarios include the likely impact if the wind blows the chemicals or radioactive material in the direction of the highest-populated base location within range.

CONDITION	WORST-CASE
Wind Direction	Toward Base
Wind Speed (mph)	3.35
Temperature (°F)	77
Relative Humidity	50%
Stability Class	F
Roughness	Most Appropriate[1]

[1]Rural may be used for worst-case scenarios.

Alternate Scenario

An alternate scenario is intended to be representative of a situation that is more likely than a worst-case scenario. Because it is difficult to know the exact amount of chemicals in a certain location at a given time, there are some general guidelines you can use when developing these alternate scenarios. The amount of chemicals released during an alternate scenario may be assumed to be equivalent to the volume of one of the following:

- The largest single container if there are multiple containers stored at one location.
- Two-thirds of the maximum amount if only a single container exists.
- Two-thirds of the capacity of a vessel.

If you had additional site-specific information, you could evaluate a release of different amounts of chemicals. For example, structural or automated controls may be in place to limit the amount of the chemical that can be released.

Railway data will typically reveal how many railcars per year carry a specific chemical, but not how many railcars per train. Because the quantity being transported may vary, an estimate of 90 tons per railcar may be used if no data is available.

Because you should consider the most probable circumstances under which an exposure or release could occur, for alternate scenarios, you assume that the wind blows in the prevalent direction.

CONDITION	ALTERNATE CASE
Wind Direction	Prevailing
Wind Speed (mph)	Annual Avg
Temperature (°F)	Annual Avg
Relative Humidity	Annual Avg
Stability Class	Most Appropriate
Roughness	Most Appropriate

EXAMPLE SCENARIOS

TIC / TIM SOURCE NO.	SOURCE NAME	TIC / TIM STORED	WORST-CASE SCENARIO	ALTERNATE SCENARIO
1	Base Water Treatment Plan	Chlorine	Full contents of two one-ton cylinders of chlorine gas	Full contents of single one-ton cylinder of chlorine gas
2	Base Chemical Storage Facility	Phosgene	Full contents of one 50-lb cylinder of phosgene gas	Two-thirds contents of one 50 lb cylinder of phosgene gas
3	Base Hospital Complex	Cobalt-60	2,000 pellets of Cobalt-60	One pellet of Cobalt-60

Tab: Determine the Risk Level for Each Scenario

During the next step of the Analysis Phase, the team evaluates the relative risks associated with each TIC/TIM scenario in order to prioritize planning and response measures. This evaluation is based on the severity and probability of the exposure.

The team determines severities for the worst-case and alternate scenarios based on how the **hazard zones** that result from a toxic release or radioactive exposure affect the base. To estimate the severity, you consider the acute effects of the toxic release and/or radioactive exposure without considering secondary casualties such as injuries that could be sustained by first-responders who are evacuating workers from an affected area. You also apply the severity ratings to the general populace associated with the base and not the individuals who work directly with the TIC/TIM being assessed. This is because these personnel are assumed to follow appropriate procedures such as using PPE when handling the TIC/TIM.

After determining the severity of each worst-case and alternate scenario, you estimate the relative **probabilities** of occurrence by comparing the various worst-case and alternate scenarios and seeking a consensus among all team members.

After the severity and probability ratings of each worst-case and alternate scenario have been determined, the team uses the **Health Risk Estimate (HRE)** matrix to identify the overall risk category for each scenario. Then, you assist Captain Campbell to present your findings in a risk summary.

Hazard Zones

A hazard zone is a zone originating from a release or exposure that can potentially cause injury or death. For chemical releases and radioactive exposures in an unobstructed environment, the zones are depicted as three concentric circles. When evaluating the worst-case scenario, the TIC/TIM would be considered a hazard if any part of the base falls within a hazard zone. For alternate case scenarios, the TIC/TIM is only a hazard if the base is located downwind (based on prevailing winds) of the TIC/TIM location. In other words, the prevailing winds will blow the TIC/TIM toward the base.) For radioactive exposures where building walls and other shielding exist, the zones take on irregular shapes. Hazard zones are delineated using hand calculations or modeling software, using the downwind distances as the radii of the three hazard zones.

Zone 1, which is equivalent to LOC3, is an area where death may result from the release or exposure. For a chemical release, if a portion of the base will be in Zone 1, then the scenario is rated as “Catastrophic”. A radioactive exposure would also receive this rating if the closest regularly-occupied location is in Zone 1. This means the release or exposure may cause death, loss of facility or assets, or grave damage to national interests.

Zone 2, which is equivalent to LOC2, is an area where severe injuries and/or illnesses may result. For a chemical release, if a portion of the base will be in Zone 2, then the scenario is rated as “Critical”. A radioactive exposure would also receive this rating if the closest regularly-occupied location is in Zone 2. This means the release or exposure may cause major injury, illness, property damage, damage to national service or command interests, or degradation to efficient use of assets.

Zone 3, which is equivalent to LOC1, is an area where minor injuries and/or illnesses may result. For a chemical release, if a portion of the base will be in Zone 3, then the scenario is rated as "Moderate". A radioactive exposure would also receive this rating if the closest regularly-occupied location is in Zone 3. This means the release or exposure may cause minor injury, illness, property damage, damage to national service or command interest or degradation to efficient use of assets.

If the base is located beyond Zone 3 for a chemical release, or if the closest regularly-occupied location is beyond Zone 3 for a radioactive exposure, then the scenario is rated as "Negligible." This means the release or exposure represents a minimal threat to safety or health, property, national service or command interests, or efficient use of assets.

Probabilities

A scenario is given a probability rating of frequent and/or likely if it is likely to occur immediately or within a short period of time. To make this determination, you should consider whether the scenario has a demonstrated history of occurrence at the specific site. For example, if a particular type of release or exposure happens on average more than once every two years, the scenario would receive the frequent/likely rating.

A scenario is given a probability rating of occasional if it will probably occur in time. To make this determination, you should consider whether the scenario has an isolated history of occurrence at the specific site.

A scenario is given a probability rating of seldom if it is possible to occur in time. To make this determination, you should consider whether there is documented evidence of poor handling or unsafe practices, or whether the scenario has some history of occurrence within the industry.

For situations that are not expected to occur based on historical data, a scenario is given a probability rating of unlikely.

Health Risk Estimate (HRE) Matrix

AFMAN 48-153, Table 3.1 Health Risk Estimate Matrix

			Probability				
			Frequently	Likely	Occasional	Seldom	Unlikely
Severity	Catastrophic	I	Extremely High	Extremely High	High	High	Moderate
	Critical	II	Extremely High	High	High	Moderate	Low
	Moderate	III	High	Moderate	Moderate	Low	Low
	Negligible	IV	Moderate	Low	Low	Low	Low

Appraisal (Page 13 of 16)

You are working with an assessment team to develop a worst-case scenario involving a TIC/TIM release near a railway. Which two of the following statements are true regarding the assumptions you can make when creating this type of scenario?

A Two railcars will be fully loaded with the TIC/TIM.

B Each of the railcars will be filled to two-thirds capacity.

C The atmospheric stability class that should be considered is C.

D The wind will blow the chemicals toward a highly populated area.

Phase 4: Report (Page 14 of 16)

After the field assessment, you work with the rest of the assessment team to document and consolidate the results of the field assessment and develop a report. Maintaining records of expert opinions and judgments made during each step of the process is important because risk assessment is not an exact science. The documentation may be used for further analysis or as a baseline for follow-on or future analyses and assessments. It can also be provided to decision-makers for review and be used to support proposed recommendations and alternatives.

The report includes the following elements:

- Executive Summary
- Introduction
- Scope and Limitations
- Methodology
- TIC/TIM Inventory
- Risk Assessment
- Conclusion
- References
- Appendices (workbooks, maps)

You and Captain Campbell, as representatives of the BE Office, present the results of the assessment to the Medical Readiness Staff Function (MRSF) and the Force-Protection Working Group (FPWG) in accordance with AFI 41-106. You also provide briefing materials as an overview of the major types of TICs/TIMs and their associated risk levels.

Appraisal (Page 15 of 16)

Following is a series of questions to check your understanding of the TIC/TIM vulnerability assessment methodology. Select the correct answer for each question.

During the Analysis Phase of the TIC/TIM vulnerability assessment process, which two steps must be performed?

A Develop location maps.

B Determine the risk level.

C Collect meteorological data.

D Develop a list of stakeholders.

During which phase of the TIC/TIM vulnerability assessment process should you compile the combined TIC/TIM inventory?

A Planning and Coordination

B Data Collection

C Analysis

D Report

During which phase of the TIC/TIM vulnerability assessment methodology does the assessment team consider how the hazard zones resulting from a toxic release or radioactive exposure affect the base?

A Planning and Coordination

B Data Collection

C Analysis

D Report

Which two of the following are ways in which documentation of the judgments made during the TIC/TIM assessment process can be used?

A As a reference for the surrounding community to use.

B To assist Local Emergency Planning Committees (LEPCs).

C To support proposed recommendations and alternatives.

D As a baseline for follow-on or future analyses and assessments.

Lesson Summary (Page 16 of 16)

You have learned that TICs/TIMs are industrial substances classified as toxic industrial chemicals, toxic industrial biologicals, and toxic industrial radiologicals, which can negatively impact the population of a base.

The TIC/TIM vulnerability assessment methodology is a process for conducting a risk assessment that is intended to be used as a high-level screening tool for evaluating TIC/TIM risks and providing rough estimates of the potential magnitude of consequences. The assessment must be conducted annually for any local industrial facilities that could pose a threat to the base if TICs/TIMs were to be released. The assessment is done to stay abreast of current situations and ensure force health protection, and it is conducted in four stages: planning and coordination, data collection, analysis, and reporting.

In this lesson, you:

- Recalled the classifications of TIC/TIM.
- Defined the TIC/TIM vulnerability assessment methodology.
- Determined why and when a TIC/TIM vulnerability assessment should be conducted.
- Described the steps of the TIC/TIM vulnerability assessment process.

Audio Script

Narrator: You have completed the TIC/TIM vulnerability assessment as part of the assessment team, identifying several potential threats and evaluating the risks associated with each threat. Because of the information the assessment team has gathered and the scenarios you created, the base decision-makers are now better prepared to plan for potential incidents involving the TIC/TIM threats on and around Hoyt Air Force Base.

Resources

- AFPD 90-9, Air Force Operation Risk Management (ORM)
- AFI 41-106, Unit Level Management of Medical Readiness Programs, 14 April 2008
- AFTTP(I) 3-2.44 Multiservice Tactics, Techniques, and Procedures for Nuclear, Biological, and Chemical Reconnaissance
- NIOSH Pocket Guide to Chemical Hazards
- **Other Resources You Might Need**
    - *Assessment Methodology for Toxic Industrial Chemicals/Toxic Industrial Materials (TICs/TIMs)* Guidance Manual
    - TIC/TIM Assessment Workbook
    - TIC/TIM Reference Guide
    - NCDC Storm Event Database
    - CRED's Emergency Events Database
    - LEPCs Database
    - National Oceanic and Atmospheric Administration
    - NIOSH IDLH Database
    - CDC Toxicological Profile Information
    - DLIS Hazardous Material Information Resource System

Answer Key: Appraisals / Scenario Challenge Points

Lesson 1: TIC/TIM Vulnerability Assessment

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Match each component of a laser system with its function by marking the appropriate block in the table.

Description	Toxic Industrial Chemical	Toxic Industrial Biological	Toxic Industrial Radiological
Substances evaluated in this category include Cesium-137 and Cobalt-60, but not weapons-grade material.			X
Substances in this category are inventoried but are not evaluated, due to their imprecise nature.		X	
Substances evaluated in this category include toxic gases and highly volatile liquids.	X		

Rationale: TICs evaluated using the TIC/TIM assessment methodology include toxic gases and highly volatile liquids. TIRs evaluated include Cesium-137 and Cobalt-60, but not nuclear fuel or weapons-grade material. TIBs are inventoried but are not evaluated.

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Choose the two statements that *best* define the TIC/TIM vulnerability assessment methodology.

A **It is used as a high-level screening tool for evaluating TIC/TIM risks and providing rough estimates of the potential magnitude of consequences.**

B **It allows for modifications and improvements as necessary to meet specific needs so individual bases can prioritize their risks and plan accordingly.**

Rationale: The TIC/TIM vulnerability assessment methodology is a process for conducting a risk assessment that is intended to be used as a high-level screening tool for evaluating TIC/TIM risks and providing rough estimates of the potential magnitude of consequences. This methodology allows for modifications and improvements as necessary to meet specific needs so individual bases can prioritize their risks and plan accordingly. It is not intended to be used for fully predicting consequences of actual chemical releases or explosions in an emergency response situation. Nor is it intended to represent the full range of potential scenarios that may occur on or near an Air Force base. Uncertainty related to calculated hazard zones is high, particularly for longer distances (i.e., over six miles).

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Select the statement that is NOT true regarding why and when TIC/TIM vulnerability assessments are conducted.

> **The assessment is done to create a document that tells first-responders exactly what to do if a TIC/TIM incident occurs around the base.**

Rationale: AFI 41-106 requires the BEE or BE Tech to conduct a TIC/TIM vulnerability assessment annually which allows you to stay abreast of current situations, assist with force health protection, evaluate new risks, and adjust the plan as necessary to address the current situation.

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Build a list of sources which can provide information about TICs/TIMs located on base.

List
AF Radio-Isotope Committee
Civil Engineering Bulk Storage Inventory
Radiation Safety Officer
HazMat Inventory

Rationale: The sources of information about TICs/TIMs located on base include the RSO, CE bulk storage inventory, HazMat inventory, and the AF Radio-Isotope Committee. The LEPCs and SERCs can provide information about TICs/TIMs located off base.

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You are working with an assessment team to develop a worst-case scenario involving a TIC/TIM release near a railway. Which two of the following statements are true regarding the assumptions you can make when creating this type of scenario?

A Two railcars will be fully loaded with the TIC/TIM.

D The wind will blow the chemicals toward a highly populated area.

Rationale: When developing worst-case scenarios, you should consider a potential release of the maximum available quantity of a substance and the meteorological conditions that could worsen the effects of the release. For a scenario involving a railway, you should assume that two railcars will be carrying each chemical, at maximum capacity.

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During the Analysis Phase of the TIC/TIM vulnerability assessment process, which two steps must be performed?

A Develop location maps.

B Determine the risk level.

Rationale: During the Analysis Phase, you must screen toxic substances with the potential to impact the base, develop location maps, develop worst-case and alternate scenarios, and determine the risk of each scenario.

During which phase of the TIC/TIM vulnerability assessment process should you compile the combined TIC/TIM inventory?

B Data Collection

Rationale: The final steps of the Data Collection Phase of the TIC/TIM vulnerability assessment are to compile the combined TIC/TIM inventory and to collect data on the characteristics of the TICs/TIMs on that inventory.

During which phase of the TIC/TIM vulnerability assessment methodology does the assessment team consider how the hazard zones resulting from a toxic release or radioactive exposure affect the base?

C Analysis

Rationale: You will consider how the hazard zones resulting from a toxic release or radioactive exposure affect the base during the Analysis Phase of the TIC/TIM vulnerability assessment.

Which two of the following are ways in which documentation of the judgments made during the TIC/TIM assessment process can be used?

C To support proposed recommendations and alternatives.

D As a baseline for follow-on or future analyses and assessments.

Rationale: The documentation gathered during the TIC/TIM vulnerability assessment can be used for further analysis or as a baseline for follow-on or future analyses and assessments. It can also be provided to decision-makers for review and be used to support proposed recommendations and alternatives.

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

- Example TIC/TIM Inventory
- Example Risk Summary

(FOUO) Form 1-3: Toxic Industrial Chemical/Toxic Industrial Material (TIC/TIM) Inventory

No.	TIC/TIM Name	Facility/Location	Lat./ Long.	Container			Max. Quantity (lbs)	Dist. (mi)/ Dir. to Base	Notes:
				Type	Size	No.			
1	Chlorine	Base Water Treatment Plant (Bldg 13)	34.761923, -120.550919	Cylinder	1 ton	2	2 tons	On Base	
2	Phosgene	Base Chemical Storage Facility (Bldg 17)	34.76023, -120.577011	Cylinder	50 lb	1	50 lbs	On Base	
3	Cobalt-60	Base Hospital Complex (Bldg 24)	34.744434, -120.543365	N/A	100-GBq pellets	2	200 GBq	On Base	
4	Chlorine	Base Hospital Complex (Bldg 24)	34.744434, -120.543365	Cylinder	150 lb	1	150 lbs	On Base	
5	Ammonia	County Wastewater Treatment Plant	34.834659, -120.4953	Cylinder	1 ton	2	2 tons	2.5 miles NW	
6	Chlorine	Railroad Chemical Transport	34.825641, -120.545425	Railcars	90 tons	2	180 tons	1.2 miles N	
7	Hydrazine	Railroad Chemical Transport	34.825641, -120.545425	Cargo tanks	2,500 gallons	6	15,000 gallons	1.2 miles N	
8	Methane	Natural Gas Pipes	Sitewide	Above- and below-ground pipes			Varies	On Base	
9	Ammonia	Parkson Manufacturing Ammonia Storage	34.778844, -120.443115	Above-ground storage tank	10,000 gallons	1	10,000 gallons	2.9 miles W	
10	Hydrazine	Base Hangar (Bldg 19)	34.798581, -120.50766	Drums	440 lbs	12	5,280 lbs	On Base	

EXAMPLE RISK SUMMARY

TIC/TIM NUMBER	SCENARIO DESCRIPTION	SCENARIO TYPE	SEVERITY	PROBABILITY	RISK LEVEL
1	Chlorine release at base Water Treatment Plant (Building 13)	Worst Case; 4,000-lb release	Catastrophic	Unlikely	Moderate
		Alternate; 2,000-lb release	Critical	Seldom	Moderate
2	Phosgene release at base Chemical Storage Facility (Building 17)	Worst Case; 50-lb release	Catastrophic	Unlikely	Moderate
		Alternate; 33.3-lb release	Catastrophic	Unlikely	Moderate
3	Cobalt-60 radiation exposure at base Hospital Complex (Building 24)	Worst Case; Exposure of 2,000 pellets	Critical	Unlikely	Low
		Alternate; Exposure of 1 pellet	Negligible	Unlikely	Low