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Health Risk Management for Bioenvironmental Engineering



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14. ABSTRACT This guide highlights the importance of analyzing and integrating health risk data within the risk management framework as described in AFI 48-145, <i>Occupational and Environmental Health Program</i> , and AFI 90-802, <i>Risk Management</i> , and was formerly embodied in the now-rescinded AFMAN 48-153, <i>Health Risk Assessment</i> .					
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1.0 INTRODUCTION

This document provides overarching guidance for the health risk assessment (HRA) process and standardizes HRA terminology. This guide highlights the importance of analyzing and integrating health risk data within the risk management (RM) framework as described in Air Force Instruction (AFI) 48-145, *Occupational and Environmental Health Program* (1), and AFI 90-802, *Risk Management* (2), and was formerly embodied in the now-rescinded Air Force Manual (AFMAN) 48-153, *Health Risk Assessment*. When health risks are a focus in RM, it allows commanders and decision-makers to balance operational risks with health risks (“commander” as used in this guide refers to commanders and decision-makers within the chain-of-command at all levels--use of term does not deviate from official commander responsibilities). Integrating health risks with other risks provides information on the full spectrum of risks to the mission and personnel at home station and expeditionary locations. Commanders can then weigh mission requirements against short- and long-term health risks to prevent injury and illness to personnel while managing operational risks to maximize mission success. Mission success or failure may be predicated solely on health impacts. Note: The “HRA” acronym for health risk assessment is used within the medical community for other tasks (e.g., health risk appraisal). For purposes of this guide, “HRA” refers to health risk assessment unless otherwise noted.

In numerous traditional risk assessment and risk management frameworks, initial risk assessment activities are often conducted independent of risk management activities to ensure unbiased assessments are provided. Only later in the process do risk management activities overlap with the risk assessment. HRAs, as executed by the Air Force Medical Service, must support mission and operational requirements and integrate those requirements early in the decision-making process. The goal of the HRA is to provide the commander a concise course of action (COA) that clearly articulates potential impacts, provides recommendations to maximize operations, and minimizes health threats and negative health outcomes.

1.1 Operational Health Risk Management

Commanders are required to mitigate and manage occupational and environmental health (OEH) threats and risks using RM (anticipate/identify, assess, evaluate/make control decision, implement control, and supervise and evaluate). Figure 1 lists the five steps of the RM process.

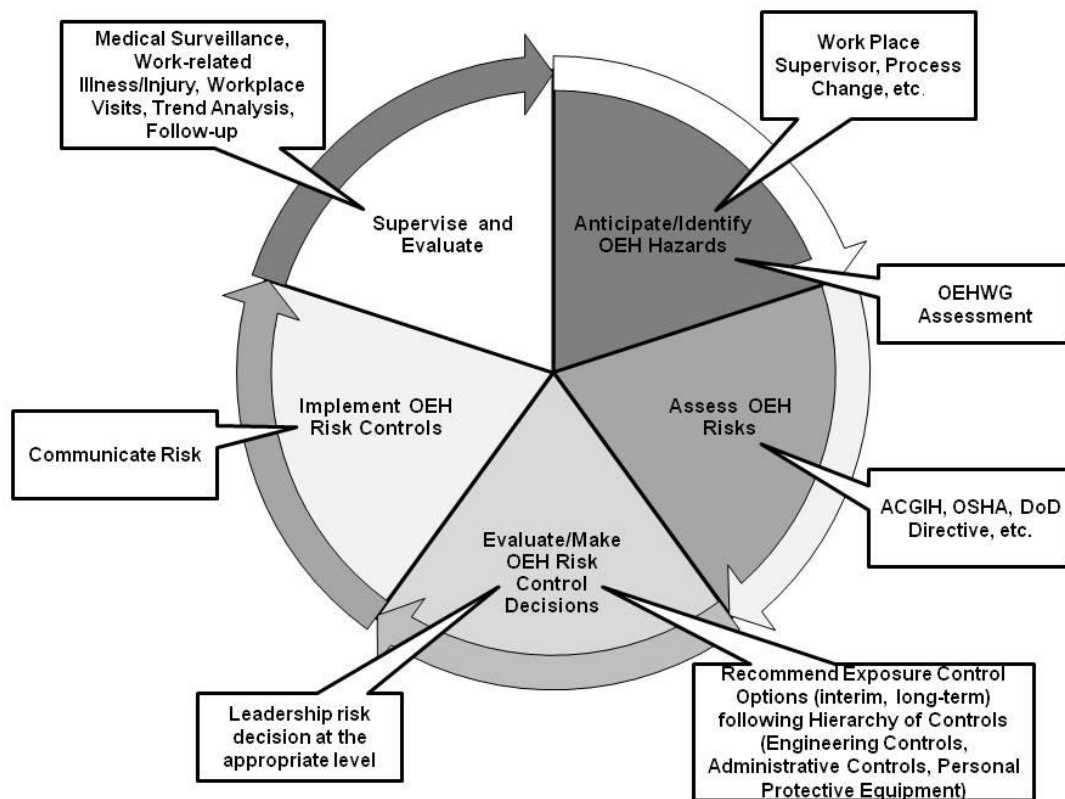


Figure 1. AF RM Program Management

Risk communication is a part of the RM process to ensure health risks are effectively communicated to all personnel including commanders, family members, and communities.

1.2 Roles

Installation or expeditionary Bioenvironmental Engineering (BE) leads HRA execution and incorporates chemical, biological, radiological, and nuclear (CBRN), including toxic industrial chemicals/materials (TIC/TIM), water vulnerability assessment, threat analyses from intelligence (e.g., National Center for Medical Intelligence), and line functions into HRAs. BE's critical role is to communicate OEH HRA information and recommend courses of action (COAs) to commanders. Although identification and monitoring of risk controls are a part of traditional risk management, BE must ensure involvement in each health risk management activity listed in Figure 1. Maintain clear lines of communication with commanders to cross talk emerging and identified health threats, risk controls, and the impact of both threats and controls to the mission.

Public Health (PH) provides HRA expertise regarding intervention strategies to prevent or mitigate health risks and assist in identifying emerging health threats through vector and disease surveillance programs, sanitation/public facility programs, force health protection data, and collaboration with civilian PH agencies.

1.3 Definitions

There are numerous terms and definitions for risk assessment and risk management. The following definitions apply to this base level guide (this document complements current regulatory guidance, but may increase the scope of definitions and associated intent).

- **Health Threat.** A health threat is the 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.
- **Health Risk.** Health risk equals threat “combined with” vulnerability. A health risk is an identified health threat and the vulnerability of the population at risk of coming into contact (e.g., completion of an exposure pathway) with the health threat. The health risk is the site picture for the commander in relation to threats that may impact mission success.
- **Health Risk Estimate (HRE).** HRE is the probability and severity of loss from exposure to the health threat (HRE is a function of probability and severity; when either or both increase the HRE increases). The HRE is also referred to as a health risk level. An HRE is a measure of the likelihood of an adverse health effect to a given individual or population based on an exposure scenario weighted by the severity or seriousness of that potential health outcome.
- **Health Risk Assessment.** HRA is the process of identifying and analyzing or evaluating (exposure and toxicity assessments) OEH threats in populations or at locations over time ($HRA = f[(\text{health risk}) “+” (HRE) “+” (COA)]$). 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 Management (HRM).** HRM 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 RM process, and HRM recommendations and decisions are integrated into the commander’s RM decision-making.
- **Health Risk Communication.** Health risk communication is the process of effectively communicating potential health effects, outcomes, and control measures to all stakeholders (e.g., commanders, supervisors, AF personnel). Health risk communication provides detailed information about the HRA and should occur throughout the RM/HRA process.
- **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. Previous estimates of exposure from similar operations (whether co-located or not) should also be considered.

- **Toxicology Assessment.** Toxicology assessment is the 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.

2.0 BACKGROUND

2.1 Health Risk Assessment

Health threats must be identified and analyzed within the operational context (e.g., specific missions or operations, geographical location, populations at risk, and time periods). Key points regarding operational context include, but are not limited to, the following:

- Type of mission
- Living conditions (e.g., field, hardened facilities, hotel)
- Geographical location and conditions (e.g., temperature, humidity, altitude)
- Threat characteristics (e.g., toxicity, volatility, transmissibility, communicability)
- Exposure parameters (e.g., pathway, frequency, duration, concentration, exposures from unrelated activities)
- Personal protective equipment (PPE) or individual protective equipment (e.g., mission oriented protective posture)
- Length of deployment and employment (both within the continental United States and outside)
- Medical treatment sources (e.g., U.S. forces, coalition, local, non-governmental organizations)
- Response capabilities

The HRE or level (extremely high, high, moderate, or low) of the health threat is determined prior to factoring in ancillary risks or transferred risks created with the implementation of controls or countermeasures (such as a safety risk created due to PPE). However, factoring in the operational context reduces the chance of the HRE overestimating or underestimating the probability and severity (e.g., the probability may be influenced by exposure of an individual vs. a population). This factoring should not negatively influence the HRE but facilitate COA development with an accurate HRE. The inclusion of the operational context also minimizes passing a single data point to the commander without a COA that does not benefit or support the mission or operations.

HRAs are to be updated as new information becomes available that may modify the COA and specific recommendations. Therefore, the push and pull of information affects the HRA and HRM decisions. As depicted in Figure 2, significant changes in operations (e.g., different mission parameters creating new exposure pathway and ineffective control) drive the need to review the HRA COA. Since RM is cross-functional, if the HRA identifies safety or

environmental risks, there is an inherent responsibility of the health risk assessor to identify these risks to other functions.

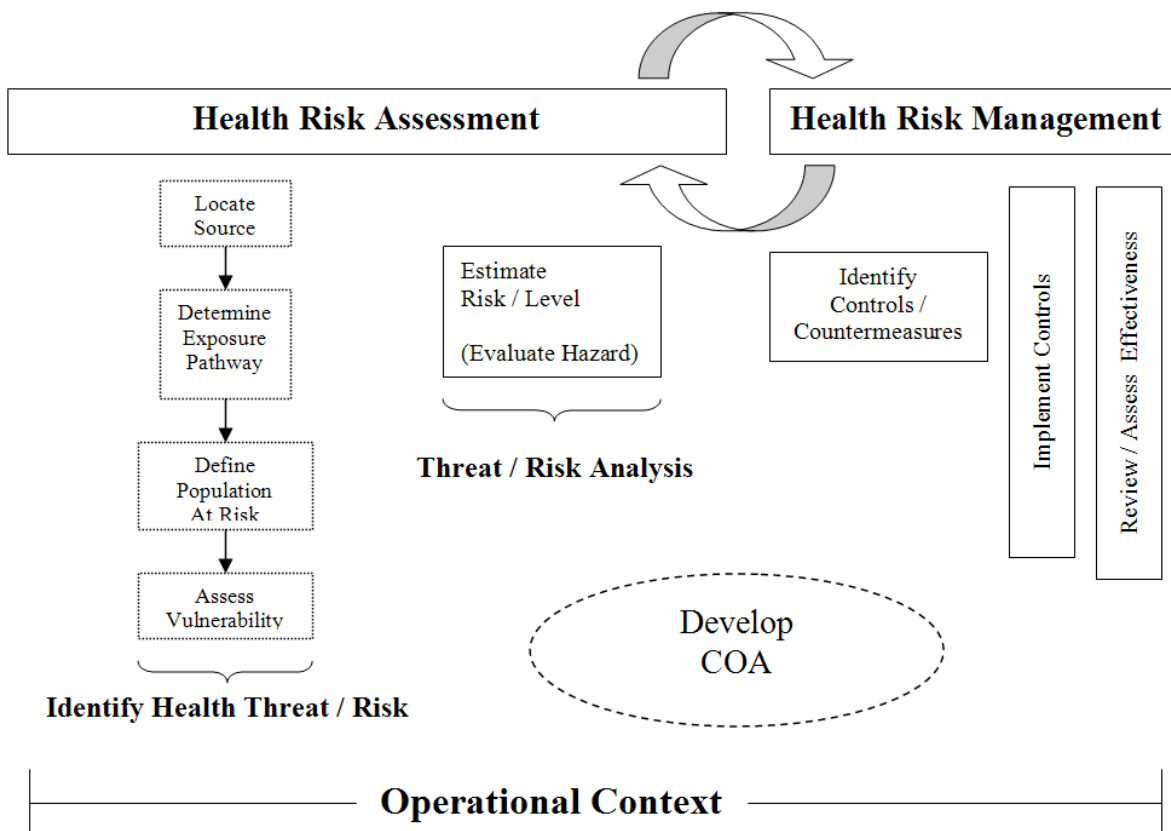


Figure 2. Health Risk Assessment and Management Relationship

2.2 Health Risk Management

Commanders will determine which control options will be implemented based on mission requirements and resources. As previously stated, it is imperative to factor in the operational context while performing the HRA in either developing or assisting with the development of the COA. In determining control options, engineering controls are the preferred option over PPE as in the traditional occupational health program; however, providing control options that are not feasible does not support the commander's objective of completing the mission. Commanders may select a COA to immediately reduce the risk to a certain level while meeting mission requirements, with the intent to provide more definitive controls once limitations from resources or current operational plans are resolved.

Control options implemented should be evaluated for their effectiveness in controlling the risk after a specified time period and their potential to create ancillary or transferred risks. The operational context may influence the evaluation and should be considered during COA development.

3.0 METHODS

3.1 Identifying Health Threats

Determine whether a potential or existing exposure poses a health threat to a specified population during a specified period and location. Understanding the duties of the populations and subpopulations is critical to identifying health threats. Health threats include, but are not limited to, the following:

- CBRN agents and materials (CBRN in this context includes “traditional” hazardous materials, TIC/TIM, and infectious diseases)
- Physical hazards (e.g., heat stress, noise)
- Animals and plants

Determine the potential or actual health threats to the population at risk without consideration of countermeasures or controls necessary to reduce the health threat (inherent ability to cause harm).

Assess the vulnerability for each potential health risk identified. This step in the sequence is essential in focusing resources on credible health threats and not tracking or assessing threats with minimal or no impact to the mission, operations, or personnel.

3.2 Analyzing Health Threats and Risks

Place the health threat into the context of the mission and operational requirements (e.g., support of sortie generation, initial bed down of forces, acceptance of follow-on forces, emergency response, OEH compliance) to influence the COA. HRAs may require quick reactions and recommendations based on limited information. Consider using available information to develop a COA rather than providing no COA when uncertainties exist; however, professional judgment must be exercised when minimal data exist. The decision to accept, reject, or attempt to control a health risk is the commander’s to make.

Determine why the health threat is a potential or actual problem (e.g., Can the health threat cause immediate or long-term health consequences? Does the threat impact operational capability or is it a nuisance?). Identify other potential threats surrounding the problem and involve other functional areas such as intelligence for CBRN threat analysis, PH for infectious disease threats, or pest management for vector threats. Determine if the potential for exposure changes due to contributing factors such as weather, movement of personnel into other locations, or working between several shops while performing similar functions.

There are numerous factors to consider during the analysis when determining health impacts.

- Determine how the health threat affects personnel, mission, and operational requirements. Discuss the risk and the consequences of accepting or controlling the health risk with commanders.

- Consider how the health threat will affect the mission, personnel, or other populations over a period of time if the health risk is accepted. Determine the adverse health effects and whether the effects are imminent, delayed, or reversible.
- Identify plausible outcomes associated with exposure levels as identified by the exposure assessment. The exposure assessment is completed by comparison to a standard as conducted in traditional industrial hygiene or environmental health activities. If a standard is not available, a qualitative exposure assessment should be completed based on available information or communicated within the context that no standard is available to quantify or better qualify the exposure assessment.
- Collect qualitative data through observations, discussions with personnel (e.g., unit commanders, host nation personnel, intelligence officers, etc.), questionnaires, and surveys (e.g., previous illness accounts, environmental contamination reports).

Provide recommendations to commanders regardless of whether a standard exists. Decision-makers require recommendations to minimize the health threat(s) identified. Negligible health threats will be briefed to the chain-of-command at the appropriate times dictated by operational tempo and available resources.

Determine the HRE by estimating the probability and severity of the health threat.

- The probability of the health threat should be estimated in terms of how often the event is expected to occur, such as frequently, likely, occasional, seldom, or unlikely (Figure 3, “Probability” column).
- The severity of the potential health threat should be estimated in terms of its potential impact (catastrophic, critical, moderate, or negligible) on personnel and the mission (Figure 3, “Severity” row). The severity declaration of the estimate includes factoring in whether completion of the pathway causes a health outcome (e.g., cell damage from radiation exposure). The health risk assessor needs to initially distinguish between the individual and the mission when calculating the severity.
- These two estimates (probability and severity) form the HRE, which is represented as a relative risk level (extremely high, high, moderate, low) (Figure 3, column and row intersects). The HRE provides a common format for determining which health risks may have the greatest impact to the individual and mission. There are other processes or estimating conventions [e.g., Department of Defense Instruction (DoDI) 6055.1, *DoD Safety and Occupational Health (SOH) Program*, Enclosure 7 (3)] that assist in deriving severity and probability based on known data (e.g., concentration greater than the action level). If another process provides greater fidelity in determining those categories, ensure the application is appropriate and translate the output into the commander’s RM format. Document use accordingly.

Risk Assessment Matrix			PROBABILITY					
			Frequency of Occurrence Over Time					
			A	B	C	D	E	
			Frequent (Continuously experienced)	Likely (Will occur frequently)	Occasional (Will occur several times)	Seldom (Unlikely; can be expected to occur)	Unlikely (Improbable; but possible to occur)	
SEVERITY	Effect of Hazard	Catastrophic (Death, Loss of Asset, Mission Capability or Unit Readiness)	I	EH	EH	H	H	M
		Critical (Severe Injury or Damage, Significantly Degraded Mission Capability or Unit Readiness)	II	EH	H	H	M	L
		Moderate (Minor Injury or Damage, Degraded Mission Capability or Unit Readiness)	III	H	M	M	L	L
		Negligible (Minimal Injury or Damage, Little or No Impact to Mission Readiness or Unit Readiness)	IV	M	L	L	L	L
			Risk Assessment Levels					
			EH=Extremely High H=High M=Medium L=Low					

Figure 3. Risk Assessment Matrix (adopted from AFI 90-802)

3.3 Risk Estimate/Level

Commanders can assist in qualifying the risk by providing information such as the number of personnel required to perform a task or activity. This type of information is beneficial to characterize the health risk. For example, the functional will not be able to perform mission essential tasks if one of the three individuals assigned is not available due to injury, illness, or death. Although this is an HRM decision point, the health risk assessor factors in these data when developing the COA if this type of information is presented during COA development.

Professional judgment is necessary in determining which assessment method(s) (e.g., quantitative or qualitative; estimates, measurements, or models) to use and to what extent previous results from similar operations should be used to represent an assessment of current threats.

3.4 Accounting for Uncertainties or New Data and Information

Account for uncertainties to include direct and indirect exposures, exposure dose, frequency, duration, and susceptible and sensitive populations. Catalog these or use them as a filter to interpret results. Key areas that need to be considered are as follows:

- Sampling or data quality
- Actual exposures of personnel
- Unit attributes (e.g., demographics, activity patterns (e.g., troop movements and actions)
- Comparability of standard guideline assumptions (e.g., exposure duration and frequency) to expected field exposure patterns
- Expected symptoms of exposure (e.g., hazard severity), including consideration of exposure to multiple hazards
- Whether the predicted health outcome is plausible, given the weight of evidence or real-world experiences

NOTE: Section 3.5 is included due to its relationship with analyzing threats and developing COAs, but it is not an actual step in the HRM process.

3.5 Recommending Control Options

Determine options for controlling or reducing the health risk, ancillary risk, or transferred risk. Options may include immediate, short-, or long-term mitigation. The term “control” in this section is used to convey control, reduction, or mitigation of the health risk.

Develop one or more options for control or countermeasures that either eliminate the risk or reduce the probability or severity. Identify resources needed to control the risk, working with available assets as much as possible. Include commanders in determining feasible control options or whether the impact of the risk is acceptable. Discuss with other functional areas to identify and deconflict control options.

Consider the following issues when determining control options and include in the COA, or internally document answers as a part of the decision-making record:

- Does controlling the health risk transfer the risk to another population or increase another health risk (e.g., reducing the risk of mosquito-borne diseases by spraying pesticides may increase the risk of exposure to pesticides)?
- Does accepting the health risk transfer the risk to another population or delay the effects in the exposed population (e.g., latent illness such as an exposure to a carcinogen due to environmental contamination)?
- Does controlling the health risks also coincidentally reduce another risk?
- Do the control measures reduce the risk with the expected benefits (e.g., how effective will the controls be in mitigating the risk)?
- Are resources to control the risk available and is implementation of the control measure timely and easy?
- What is the impact on personnel and mission objectives given the health risk, ancillary risk, and recommended controls?
- Have other functional areas provided input on how the health threat and control options impact other operational threats or activities?

Determine and discuss the level of acceptable risk and the tradeoffs for controlling or not controlling the risk.

3.6 Communicating Health Risk Assessment Results

- Communicate the HRA for integration with other operational risks.
- Ensure qualitative and quantitative data are translated into understandable information for commanders and depict the estimated health risk in relation to the mission. For example, if the risk is “one in a million” for the general population, then put the risk into the operational context for the true population at risk, such as “there is an increased risk of cancer as a long-term health effect for exposed personnel.”
- Anticipate the issues and questions the chain-of-command may have and provide the implications of the health risks based on knowledge and scientific evidence. When communicating health risks in a public forum or through the media, ensure collaboration with Public Affairs and Public Health. Provide recommendations on when the public should be notified of the identified health risk and the associated impacts to the base populace and community.
- Use caution when comparing risks. This includes (1) comparing which risk is greater between estimates from multiple scenarios and (2) the operational risk of factoring in/not factoring in the health risk COA due to resources (e.g., the cost of implementing the controls versus not implementing the controls). Programs and projects are funded based on the mitigation of the risk and the base’s ability to sustain the program or project.

4.0 DISCUSSION

4.1 Health Risk Management Interface

HRM and RM decisions are based on operations and scenarios; therefore, an HRA may provide a COA that interferes with mission objectives. Decisions that include differing objectives, knowledge, and perceptions of those affected by the decision (e.g., workplace supervisors, unit commanders, personnel, safety, and other functional areas) may appear to disregard the HRA; however, deconflicting competing risks is the responsibility of the commander. Commanders will determine if a risk will be accepted or controlled and what tradeoffs are necessary. The health risk assessor must expect tradeoffs as the chain-of-command determines the priority of the controls to be implemented, if any. BE’s responsibility is to complete the HRA without bias and clearly communicate the health risks and recommendations. If recommendations are modified or are not accepted, continue to evaluate the current situation, update the HRA as new information becomes available, and communicate increases or decreases in risk to the appropriate level within the chain-of-command.

Part of the HRA may include a cost-benefit analysis for the commander. Ensure this analysis is clearly understood and can be defended, particularly if a long-term health risk was accepted to accomplish the mission at that time.

Decisions on COAs may be influenced by indirect health-related considerations (e.g., Occupational Safety and Health Administration compliance). Noncompliance with various

requirements, when a health risk is minimal, is an option depending on the operational context; however, commanders must understand the implications and select COAs accordingly.

4.2 Implementation of Controls

Commanders mitigate risks and impacts on the mission by implementing controls and countermeasures. At the same time, commanders accept ancillary risks and impacts on the mission, if any, by implementing controls or countermeasures. Establish a clear assignment of accountability to implement, monitor, and identify controls. If controls are determined to be inadequate, redirect resources to control the health threat or reevaluate the risk. Ensure the health risk is prioritized again with the mission and operational requirements when reimplementation of a control is necessary.

Various stakeholders will perceive risks and the controlling of risks differently; therefore, anticipating any negative outcomes due to perceptions of the health risk within the population at risk, surrounding populations, or other individuals is important.

4.3 Review and Assess

Those responsible for the review process need to determine whether the risks and mission are balanced and continually evaluate the effectiveness of the controls as well as transfer of risks. BE will be available to assist the commander in adjusting the balances, if required. Monitor controls periodically to ensure the controls are mitigating the risk. As new information becomes available (e.g., sampling data), update and reevaluate health threats and update the HRA.

4.4 Documentation

Ensure decisions to accept or control the health risk are documented. In addition to conducting HRAs, OEH exposure and sampling data must be linked to exposed personnel and documented for future analyses. Presidential Review Directive 5 requires DoD “to establish mechanisms to collect and maintain military personnel data, including demographic and occupational data, and longitudinal records of service members’ military experiences, including pertinent data on OEH exposures and events” (4). These procedures are described in AFI 48-145, *Occupational and Environmental Health Program* (1).

5.0 RECOMMENDATIONS

5.1 Key Elements of Health Risk Assessment

- Accept no unnecessary risk. Unnecessary risk comes without a commensurate return in terms of real benefits or available opportunities. All Air Force missions and daily routines involve risk. The most logical choices for accomplishing a mission are those that meet all mission requirements while exposing personnel and resources to the lowest acceptable risk.
- Make risk decisions at the appropriate level. Making risk decisions at the appropriate level establishes clear accountability. Those accountable for the success or failure of the mission must be included in the risk decision process.

- Accept risk when benefits outweigh the costs. All potential benefits should be compared to all potential costs. The process of weighing risks against opportunities and benefits helps to maximize unit capability. Even high-risk endeavors may be undertaken when there is a well-founded basis to believe that the sum of the benefits exceeds the sum of the costs.
- Integrate HRA into operations and planning at all levels. To effectively apply risk management, commanders must dedicate time and resources to integrate HRA principles into planning and operational processes. Risk assessments of operations are most mission supportive when they are done as a normal way of conducting a mission, not an add-on process performed by people not otherwise involved.

5.2 Benefits

Conducting a health risk assessment has several potential benefits including identifying health risk factors, controlling health care costs, predicting employee absenteeism, encouraging individuals to take a proactive stance concerning personal health care, and monitoring the health status of the general population. Each of these factors contributes to preventing future health problems. Health risk assessments are used by a wide range of groups and for a variety of reasons.

5.3 Additional Resources

- Technical Bulletin Medical 577 describes procedures for assessing health risk associated with using water that does not meet the minimum standard and guidelines. It is also used to determine the health risk posed to personnel who continue to drink the water and recommends appropriate actions to the commander.
- Technical Guide 230 was developed as a standard tool to support established joint military risk management doctrines. It provides a consistent basis for all services to conduct chemical risk assessments during deployments.
- Technical Guide 248 introduces the processes and tools that can be used to make appropriate decisions based on the medical threat. It is written for preventative medicine personnel who are assigned the task of providing health risk assessments.
- Acute Toxicity Estimation and Operational Risk Management of Chemical Warfare Agent Exposures, USACHPPM Report No. 47-EM-5863-04, May 2004. Primary objective is to provide guidance and recommendations for chemical warfare agents.

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LIST OF ABBREVIATIONS AND ACRONYMS

AFI	Air Force instruction
AFMAN	Air Force manual
BE	Bioenvironmental Engineering
CBRN	chemical, biological, radiological, and nuclear
COA	course of action
DoD	Department of Defense
DoDI	Department of Defense instruction
HRA	health risk assessment
HRE	health risk estimate
HRM	health risk management
OEH	occupational and environmental health
PH	Public Health
PPE	personal protective equipment
RM	risk management
TIC	toxic industrial chemical
TIM	toxic industrial material