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Operations

CIVIL ENGINEER DISASTER AND ATTACK PREPARATIONS

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This volume provides information to help Air Force civil engineers prepare their installations and units for disasters and attacks. It outlines standard civil engineer preparations and focuses on methods to protect life and support and sustain installation and unit operations. This volume is not intended to provide detailed construction or other "how to" procedures, rather its purpose is to provide civil engineers with the background and actions necessary to save lives and reduce facility damage resulting from accidents, disasters, terrorism, and war. This publication applies to all Air Force active, Air National Guard (ANG), and Air Force Reserve Command Civil Engineer units. The pamphlet supports Air Force Instruction (AFI) 10-210, *Prime Base Engineer Emergency Force (BEEF) Program*, AFI 10-211, *Civil Engineer Contingency Response Planning*, and AFI 10-2501, *Air Force Emergency Management (EM) Program Planning and Operation*. Refer recommended changes and questions about this publication to the Office of Primary Responsibility (OPR) using the AF IMT 847, *Recommendation for Change of Publication*; route AF IMTs 847 from the field through Major Command (MAJCOM) publications/forms managers. Ensure that all records created as a result of processes prescribed in this publication are maintained in accordance with Air Force Manual (AFMAN) 33-363, *Management of Records*, and disposed of in accordance with Air Force Records Information Management System (AFRIMS) Records Disposition Schedule (RDS) located at **https://afrims.amc.af.mil/rds_series.cfm**. The use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this publication does not imply endorsement by the Air Force. See **Attachment 1** for a glossary of references and supporting information.

SUMMARY OF CHANGES

This document has been substantially revised and must be completely reviewed. Major changes include a new publication title, the addition of spill response considerations, base denial preparations, and new AF incident management terms. The following topic areas were deleted and are addressed in other publications. Expedient erection and construction methods for soil berms and dikes are discussed in AFPAM 10-219, Volume 7, *Expedient Methods*. Erection and construction methods for defensive fighting positions and bunkers; camouflage and concealment techniques, and expedient hardening methods (such as revetments and obstacles) are addressed in Air Force Handbook (AFH) 10-222, Volume 14, *Guide to Fighting Positions, Obstacles, and Revetments*.

Chapter 1
INTRODUCTION

1.1. General Information. Air Force civil engineers are often tasked to respond to crises around the globe, and the capabilities they bring to the table are crucial to mitigating the effects of an attack or disaster. Yet their duties to prepare their installation and local units *before* a crisis occurs are equally important. Sound preparations before a disaster or attack improve mission performance and survivability, are cost-effective, and involve installation-wide unit participation (**Figure 1.1.**). To prepare for an emergency, civil engineers focus on protecting personnel, equipment, and facilities and on posturing emergency response and base recovery capabilities. These duties are significant and although no book covers everything that must be done, this volume offers some specific preparation ideas.

Figure 1.1. Installation Agencies Train Together on Emergency Preparations.

1.2. Overview. This pamphlet introduces common civil engineer (CE) preparations for war and disaster, including preparations for CE units and those preparations in support of other installation agencies and units. It outlines both standard preparations and specific preparation activities that should be accomplished prior to an attack or natural disaster. Further, it provides a clear perspective how base and unit preparations protect personnel and property and preserve mission-critical functions. Although not all inclusive, specific disaster and attack preparations addressed here include: (1) vulnerability reduction, (2) communications systems, (3) utility system isolation, (4) emergency and backup utilities, (5) beddown operations, (6) environmental hazards, (7) CE support to and from others, and (8) base denial preparations. CE roles discussed for these areas consist of the following:

1.2.1. **Vulnerability Reduction.** Assist base organizations in identifying and programming requirements to reduce vulnerability of critical base facilities, equipment, and personnel. Perform site-specific risk assessments and identify resources to provide the level of protection needed.

1.2.2. **Communications Systems.** Work with the Communications Squadron to design and install installation notification and warning systems (INWS) and individual building mass notification systems (MNS) for operation throughout disaster conditions. The system must be redundant, hardened, or splinter-protected and operate using both commercial and emergency power. Ensure the CE Damage Control Center (DCC), Fire Alarm Communications Center (FACC), and Mobile Emergency Operations Center (MEOC) have survivable and interoperable communications among the primary and alternate Emergency Communications Center (ECC), Installation Control Center (ICC), Emergency Operations Center (EOC), Security Forces (SF) desk, and Medical dispatch (if applicable). Also, establish manual communication procedures to collect damage assessment information during disruptions to installation communication and computer systems.

1.2.3. **Utility System Isolation.** Maintain accurate utility distribution system drawings within the CE DCC and FACC, showing the locations of all cutoff valves and switches. Periodically have the appropriate personnel locate and operate these valves and switches to ensure they are operational and control the desired systems. When possible, implement the GeoBase Mapping System to aid in identifying and locating critical equipment or resources.

1.2.4. **Emergency and Backup Utilities.** Develop plans and identify resources required to promptly reestablish utilities or provide backup systems for critical facilities before or immediately after an attack or disaster.

1.2.5. **Beddown Operations.** Provide expedient beddown support for incoming forces or disaster victims. Civil engineers erect, modify, or construct many of the facilities, including utilities that Air Force units need for military deployment and disaster relief. CE also provides on-site guidance and expertise to other units to erect their own portable shelters and defensive measures.

1.2.6. **Environmental Hazard Reduction.** Provide trained personnel and available equipment and materials to help the Base Spill Response Team with containment, cleanup, and site restoration for hazardous substance spills.

1.2.7. **CE Support To and From Others.** Provide training, guidance, labor, equipment, maps, and expertise as necessary. CE receives assistance with vehicles, fuels, and other logistics from support agencies and units.

1.2.8. **Base Denial.** Plan appropriate denial methods, including item evacuation, selective component removal, destruction, and use of obstacles. Also prepare in advance a candidate list of select base systems, equipment, and supplies for potential destruction should the commander direct base evacuation and denial action.

Chapter 2

STANDARD INSTALLATION PREPARATIONS

2.1. Introduction. Smart disaster or attack preparations can be made at every installation—whether main bases, collocated operating bases, bare bases, or remote sites. Many preparations can be completed in the luxury of peacetime, but some can only be done at the last minute when a disaster or war threatens. There is no "one correct way" to prepare all installations, because the threat, mission, and location of each installation differs; however, each installation, following MAJCOM guidance, takes appropriate action to prepare for contingencies. CE planners must understand their installation's mission and threats to effectively plan for contingencies, and they should continually seek answers to specific questions that impact their emergency planning.

2.2. Preparation Considerations.

2.2.1. Protect functions versus individual resources. Certainly this translates into protecting personnel, equipment, facilities, and utility service, but always find out specifically what must be protected to preserve a mission-critical function. For some key units, all assets must be protected. For others, only personnel and their tools must be preserved—not facilities. If you lose sight of this, you can expend effort and resources protecting assets which are not critical to the protected function. Conversely, you can fail to protect assets in "low priority" units which provide key support to critical functions.

2.2.2. Focus on both cost and effectiveness when deciding what to do. Cheap solutions are quickly embraced, but make sure the cheap fixes really work. Even valid preparations can be ineffective when done poorly. Ineffective efforts waste time and resources and may draw an enemy's unwanted attention. In that case, doing nothing may be preferable to doing something poorly. Preparations can be expensive and elaborate, but not all have to be. Less effective, lower cost options may be "good enough." Maintaining this focus usually minimizes the total time and resources spent on preparations.

2.2.3. To avoid making insufficient preparations, units need to be part of the installation-wide planning effort, to determine what must be done, to what quality, and why. Many preparations can be mutually supportive. Look for opportunities to integrate efforts.

2.2.4. Keep a long-range perspective at permanent installations. Develop protective measures over time— a little each year pays off. When possible, choose actions which have multiple benefits. Improving installation appearance is always a winning "secondary" benefit. Multiple benefits improve the likelihood that permanent preparations will be approved.

2.2.5. Every unit needs to prepare its personnel, equipment, and facilities, but not all facility preparations must be done by civil engineers. With prior instruction or on-the-spot CE guidance, units can do many non-technical tasks such as sandbagging and erecting tents (**Figure 2.1.**). If an installation relies entirely on its civil engineers for preparations, especially the last minute ones, the entire effort is slowed.

2.2.6. Have an occasional reality check. Make sure efforts don't conflict with those of other units. This requires more than a review of plans. It also means looking at what is being done in the field.

Figure 2.1. Services Squadron Personnel Erect Modular Tent in Iraq.

2.3. Choosing Solutions and Determining Priorities. With much to do and limited time or resources to do it, an installation and its units must set priorities. **Table 2.1.** lists a number of factors to consider when deciding what should be done, determining the extent of preparations, selecting methods, and establishing task priorities and phases.

Table 2.1. Factors to Consider When Choosing Solutions and Determining Priorities.

Threat: What are the potential enemies, likely disasters, and accidents to consider? What is the intensity and areas affected by each threat? How much advance warning time is likely?
Base Missions: How important is the contribution of the host wing's mission to the overall theater warfighting capability or to MAJCOM peacetime activities? Which tenant unit missions are also critical base missions? How do they rank with the host wing's mission with respect to overall theater warfighting capability and/or MAJCOM, AF, or DOD peacetime activities? What functions of theirs must be protected?
Unit/Facility Function: How important is the function to base mission?

Vulnerability of the Function: How vulnerable are the assets of the critical functions? What is the location of assets for key functions versus other high-priority targets? Are those assets concentrated or dispersed? Do they need to be located in the threat zone or likely target areas? (Because they must be close to critical activities which cannot be relocated, or the function is tied to a facility or equipment in that facility.) Can the function be quickly and easily relocated on or off base? How long would it take to get a function partially and fully operational following relocation?
Alternatives: What options are available for protecting assets? Are the resources available for employing those options?
Effectiveness of a Preparation: How effective is an option? Can it be combined with one or more other options to further improve the effectiveness of the preparations?
Cost: What can the base afford?

2.4. An Approach to Preparing Your Installation. Preparations usually focus on protecting the most important base functions, protecting personnel and key assets, and getting units ready to quickly respond. Timely preparations should include a "whole base" look at the base's important functions. Integrate all host and tenant unit functions into a prioritized list for further planning actions. One method of prioritizing is to look at the function's level (national level strategic, theater level strategic, theater level tactical, or strictly tactical) when considering it's importance. An installation and its units should have game plans for accomplishing short-notice and long-term preparations. Both are important and can be developed concurrently. Short-notice preparations focus on expedient measures and response team preparations.

2.4.1. **Short-Notice Preparations.** For each likely threat, decide what last-minute preparations are most important to make when given little advance warning. Consider dividing short-notice actions into phases, and include the most important tasks and the long-lead-time tasks in the early phases. When logical, tie each phase to a specific threat or defense condition. Then, in theory, the tasks in a phase are started when the corresponding threat/defense condition is declared. Plans for short-notice preparations should specify what is to be done, by whom, with what resources, and when.

2.4.1.1. First-phase efforts often involve rounding up resources (personnel, equipment, vehicles, and supplies) to be used in subsequent phases if an increase in the threat/defense condition is declared.

2.4.1.2. Early preparations need not provide the final solution. They can be added to or modified in later phases. For example, to protect an unhardened installation command and control node, civil engineers push up a 6-foot high earth berm around it in phase one. In phase two, with one CE person to train them, operational support squadron personnel place sandbags on the berm and extend its height to 8 feet. This phased approach may be necessary to ensure the work which is most important to the installation gets done first. However, phasing work can be inefficient because of the time required to relocate CE personnel, equipment, and materials to a previous work site. This inefficiency is reduced when other units do some or most of their own preparations.

2.4.1.3. When executing short-notice preparations, set up a work control function in the CE control center (or Damage Control Center) to keep track of what CE is supposed to do and what it is actually doing. Follow the plan unless you get modifying guidance from the commander. In your short-notice preparation checklists, be sure to include actions targeted just for your unit as well as those which support other installation units.

2.4.1.4. Keep short-notice preparation plans and checklists current. Add and delete actions as events trigger the need for changes. Such events include threat changes, mission changes, and unit moves to different or new facilities. Threats can change quickly; e.g., when a nation chooses to become antagonistic or an adversary chooses peace. More often threats change slowly, such as when a threatening nation gradually improves the number and quality of its weapons.

2.4.1.5. Keep emergency response and base recovery skills sharp. Preparations can mitigate the effects of an enemy attack or of a natural disaster or peacetime accident, but no amount of preparation can eliminate the need to respond to those crises. Preparations should enable teams to respond well and quickly. Unlike many preparations which can be done once, practicing emergency response and base recovery procedures must be an ongoing effort. Response teams should practice often and realistically with the vehicles, equipment, tools, and materials they are expected to use (**Figure 2.2.**).

Figure 2.2. Keep Response Teams' Skills Sharp Through Realistic Practice.

2.4.1.6. Teach a core of personnel in other units how to prepare their facilities and protect their personnel and key resources. Examples include laying sandbags and erecting tents. This makes those units more self-reliant and less dependent on limited CE resources. This also makes your personnel better, because they have to learn the tasks well enough to teach others. You may have to advertise and push this service, because other units are not likely to call you. They tend to think many preparations are your job. The lessons give you a chance to educate them.

2.4.2. **Long-Term Preparations.** Make long-term preparations for each likely threat—decide what permanent preparations make sense. An installation needs a multi-year improvement plan for preparations that are extensive, expensive, or require major construction. A plan provides focus and continuity since base personnel will likely change many times during the life of the plan. It should be self-explanatory, because new personnel must understand what was intended and what they must do.

2.5. Standard Preparation Actions. **Table 2.2.** through **Table 2.7.** are common disaster and attack preparation actions that civil engineers might make on their installation, and each will be discussed in depth in subsequent chapters. In many cases, these preparations apply to both disaster and attack activities; however, some preparations may be unnecessary or impractical to do at every installation. In other cases, the preparations may only apply to overseas installations and then only when there is a credible enemy threat. The lists are offered to stimulate ideas when developing unit plans; they are not comprehensive. Look at the wing's Emergency Action Procedures and support plans for specific tasks. Understand that preparations will never be complete. There is always something more which can be done. To keep preparations in perspective, bases and units need to have preparation plans and continue to build on those plans as circumstances change.

Table 2.2. Vulnerability Reduction/Resource Protection Preparations.

FUNCTION/ ACTIVITY	APPLICATION		PREPARATION
	Attack	Disaster	
Shelters	X	X	Identify all facilities on the installation that could be used as shelters to protect personnel, equipment, aircraft, and armament from the effects of chemical, biological, radiological, nuclear and high-yield explosives (CBRNE) weapons, accidents involving hazardous materials, and the consequences of natural disasters where shelter in place concerns apply. (see AFI 10-2501, AFMAN 10-2602 (until rescinded), and AFMAN 10-2502 Series publications (when published).
	X	X	Determine the capacity for each shelter and list in the CE contingency response plan and Comprehensive Emergency Management Plan 10-2.
Beddown Facilities and Utilities	X	X	Identify existing facilities or potential cantonment areas, potable water sources, electricity, latrines, showers, refuse collection and disposal, and contaminated waste collection and disposal points that can be used for expedient beddown of deploying forces, federal assistance teams, pre-bundled medical supplies, and disaster victims.
Redundancy	X	X	Consider redundancy when designing/redesigning critical utility systems or permitting reconfiguration for continued operations, and identify facilities that can be used as substitutes if prime facilities are destroyed.

FUNCTION/ ACTIVITY	APPLICATION		PREPARATION
	Attack	**Disaster**	
Hardening	X		Consider hardening command and control nodes, access and perimeter gates, utility generating plants, and mission-essential shelters during initial construction or renovation of existing facilities. Hardening requirements for facilities located in CBRNE medium- and high-threat areas can be found in AFMAN 10-2602 until rescinded by AFMAN 10-2502 Series publications.
	X		Provide design, labor, equipment, and materials to help base organizations install and repair bunkers and revetments in threat areas to protect personnel, equipment, and weapon systems from the effects of CBRNE attacks; see AFMAN 10-2602 until rescinded by AFMAN 10-2502 Series publications, and Unified Facilities Criteria (UFC) 3-340-01, *Design and Analysis of Hardened Structures to Conventional Weapons Effects*.
Dispersal	X	X	Survey and identify dispersal and evacuation sites on and off base that meet security, access, and service requirements for storing essential resources and decreasing vulnerability from a single-point attack or natural disaster. Include background data on both dispersal and evacuation sites as part of the CE contingency response plan.
Antiterrorism	X		Implement actions to increase a facility's physical and passive protection against terrorist activities; see AFI 10-245, *Air Force Antiterrorism (AT) Standards*, UFC 4-010-01, *Design: DOD Minimum Antiterrorism Standards for Buildings*, and UFC 4-021-01, *Design and O&M: Mass Notification Systems*. The installation Force Protection Working Group or security forces should identify the appropriate requirements.
CBRN Passive Defensive Measures	X		Implement CBRN defense actions that focus on attack detection and warning, protection, and mitigation of specific threats and threat weapons.
Base Evacuation	X	X	Coordinate on-base evacuation plans. Develop unit evacuation plans and procedures. Implement base evacuation preparations according to local Comprehensive Emergency Management Plan (CEMP) 10-2 and CE Contingency Response Plan (CRP).

Table 2.3. Communications-Computer Systems Preparations.

FUNCTION/ ACTIVITY	APPLICATION		PREPARATION
	Attack	Disaster	
Warning and Communications Systems	X	X	Work with base communications squadron to provide the installation primary and secondary warning systems and communications among the primary and alternate Installation Control Center (ICC), Emergency Operations Center (EOC), CE Damage Control Centers (DCC), and the Fire Alarm Communications Center (FACC).
	X	X	Establish manual procedures, such as the use of runners or signal flags, for collecting information on damage to facilities, utilities, and pavements during disruptions in installation communications and computer systems.

Table 2.4. Emergency and Backup Utilities Preparations.

FUNCTION/ ACTIVITY	APPLICATION		PREPARATION
	Attack	Disaster	
Water Sources	X	X	Firefighting and contamination control operations require a great amount of water. The CE contingency response plan should identify all available water sources, both on base and nearby off base, to support these operations during a contingency.
Electric Power	X	X	Electrical power should be continuous to essential base functions. CE must have emergency-essential backup power sources when primary service to these essential functions or facilities is disrupted.
Waste Disposal	X	X	CE must identify alternate or emergency waste disposal methods. See AFMAN 10-2602 (until rescinded by AFMAN 10-2502 Series publications) for wartime contaminated waste disposal consideration.

Table 2.5. Environmental Hazard Reduction Preparations.

FUNCTION/ ACTIVITY	APPLICATION		PREPARATION
	Attack	Disaster	
Spill Response	X	X	Provide trained personnel or contractors and available equipment and materials to help the Base Spill Response Team with containment, cleanup, and site restoration for hazardous substance spills.

Table 2.6. Utility System Isolation Preparations.

FUNCTION/ ACTIVITY	APPLICATION		PREPARATION
	Attack	Disaster	
Utility Distribution System	X	X	Civil Engineer DCC and FACC maintain accurate utility distribution system drawings, showing the locations of all cutoff valves and switches.
	X	X	Periodically, appropriate personnel should locate and operate cutoff valves and switches to ensure they are operational and control the desired systems.
	X	X	When possible, implement GeoBase Mapping System to aid in identifying and locating critical equipment or resources.

Table 2.7. CE Support To Others.

FUNCTION/ ACTIVITY	APPLICATION		PREPARATION
	Attack	Disaster	
Individual Unit Assistance	X	X	Provide prior instruction in shelter management, CBRN defense, contamination control, specialized teams, and other wartime and emergency management activities. Offer units on-the-spot guidance for shelter siting and erecting tents, sandbagging, and defensive fighting positions. Construct berms, revetments, and ditches to support unit passive defensive measures.
Mortuary Officer	X	X	Provide labor and equipment to assist the mortuary officer in preparing temporary cemeteries and mass burial sites for contaminated and non-contaminated remains.
Casualty and Damage Reports	X	X	Assist the base in developing unit casualty and damage reporting procedures.
Maps	X	X	Prepare a master standard grid map or maps for installation command and control, disaster response forces, damage assessment teams, and CBRN Control Center.
	X	X	Prepare airfield surface maps for minimum operating strip (MOS) selection teams.
	X	X	Put copies of all maps in primary and alternate EOCs and DCCs; see AFI 10-2501, para A2.3.
Hazardous Chemicals	X	X	Assist in the installation's annual assessment of the hazardous chemicals it regularly uses, stores, or ships.

Table 2.8. Base Denial Preparations (Overseas Theater Task Only).

FUNCTION/ ACTIVITY	APPLICATION		PREPARATION
	Attack	**Disaster**	
Base Denial	X		CE prepares in advance a candidate list of select base systems, equipment, and supplies for potential destruction should the commander direct base evacuation and denial action.
	X		Plan appropriate denial methods: Item Evacuation. Selective Component Removal. Destruction. Use of Obstacles.

Chapter 3

VULNERABILITY REDUCTION AND RESOURCE PROTECTION

3.1. Introduction. Reducing the vulnerability of personnel and key resources to attacks and natural disasters is an important installation preparation action. Civil engineers assist in this endeavor by helping installation organizations identify and program requirements to reduce the vulnerability of critical facilities, equipment, and personnel. Specific actions include identifying and determining the capacity of all facilities that could be used as shelters; identifying facilities, utilities, and waste collection and disposal points for expedient beddown operations; identifying facilities that can be reconfigured or substituted for destroyed facilities; considering hardening command and control facilities, access and perimeter gates, utility generating plants, and mission-essential shelters; and determining other facility hardening requirements; surveying and identifying dispersal and evacuation sites; assisting organizations with the construction and repair of bunkers and revetments; and implementing actions to increase a facility's physical and passive protection against terrorist activities.

3.2. Shelters. Identifying and determining the capacity of existing and potential shelters on an installation can be a daunting task. It can certainly be overwhelming during the midst of a crisis. Knowing the type and duration (long or short term) of protection needed is critical when identifying prospective shelters. Keep in mind that shelters used to protect personnel, equipment, aircraft, and armament from the effects of CBRNE may vary greatly from shelters used to protect personnel from accidents involving HAZMAT or the consequences of natural disasters. If protection against CBRNE is a primary criterion for shelter selection, review AFH 10-222 Volume 3, *Guide to Civil Engineer Force Protection*, and UFC 3-340-01, *Design and Analysis of Hardened Structures to Conventional Weapons Effects,* for detailed information on blast effects, blast standoff distances, and other planning factors. The following paragraphs offer some factors to consider when identifying potential shelters.

3.2.1. **Personnel Shelters.** Depending on construction, these shelters can provide personnel protection for short or long periods. Shelters intended for short-term use are generally employed for immediate disaster protection or to shelter personnel from the effects of weapon attacks. Short-term shelters generally offer expedient protection and are normally occupied just before and during a disaster or attack and may not provide protection and utilities for extended living. In contrast, long-term shelters (often used for disaster relief and incoming personnel) may be occupied for extended periods, offer protection from the elements, and when appropriately hardened, may provide limited protection from small arms weapons fire, shell fragments, and the effects of chemical, biological, radiological, and nuclear (CBRN) weapons.

3.2.1.1. **Short-Term Shelters.** Such shelters may be existing permanent facilities (Shelter in Place) or temporary structures constructed from locally available materials. They may also be constructed using prefabricated concrete modular forms, commercial off-the-shelf (COTS) items, or built by local contractors. These shelters may be the only alternative when there are not enough permanently hardened facilities in the right locations. This is especially true in bare base or dispersed operations. The best short-term shelter is usually one that provides the most protection but requires the least amount of effort to construct. Shelters should have as much overhead cover as possible. They should be limited to about 25 personnel and dispersed. When possible, shelters should be hidden next to buildings, on the back sides of hills, in woods, or in natural depressions in the terrain; but out of drainage paths. Below-ground shelters require the most construction effort but generally provide the highest level of protection from conventional and chemical weapons. Aboveground shelters provide the best observation and are easier to enter and exit than below-ground shelters. They provide the least amount of protection from conventional weapons; however, they do provide protection against liquid droplets of chemical agents. Aboveground shelters are used when water levels are close to the ground surface or when the ground is so hard that digging a below-ground shelter is impractical. Defensive bunkers and fighting positions for base defense and antiterrorism measures are also short-term shelters and are addressed in AFH 10-222, Volume 14, *Guide to Fighting Positions, Obstacles, and Revetments.*

3.2.1.2. **Long-Term Shelters.** Air bases often identify and use existing permanent facilities for shelters that will be occupied for periods longer than a few hours. However, temporary shelters (**Figure 3.1.**) such as TEMPER tents, Alaska Small Shelter Systems, COTS products, and others may be used when permanent facilities are not available. In some cases, temporary facilities are modified to support extended living and may even be hardened to protect against attack. Specific factors to consider for extended shelter occupation include space, structure, ventilation, water supply, health and sanitation, electrical power, and food. Each factor is discussed below. These factors are also vital to long-term shelters and facilities used during expedient beddown operations addressed in **Chapter 6**.

Figure 3.1. Temporary Shelters May Be Used for Extended Periods When Necessary.

3.2.1.2.1. **Space.** Physical space for human occupancy is the first shelter requirement. The approximate volume required for an adult is 2.3 cubic feet. While history has recorded cases of crowding for extended periods to this level, personnel will not voluntarily stay in these conditions. Many studies have been conducted to determine the minimum shelter space allocation standard. The US uses an area of 10 square feet (about the space an adult occupies when lying down) and 65 cubic feet of volume per person. **Table 3.1.** shows how this standard relates to other situations where personnel are or were confined. The US standard is spacious compared to other experiences; particularly wartime. Some experienced European nations recommend one-half meter (about 5.4 square feet) as a minimum. The recommended 10 square feet of usable area is a desirable goal but not always practical. Allotments reduced down to 5 square feet can be tolerated when there are no better alternatives.

Table 3.1. Space Allocation Conditions.

SITUATION	AREA PER PERSON (SF)	VOLUME PER PERSON (CF)
Crowded jail (two inmates in one-person cell)	19.2	145
Railroad coach (60 seated passengers)	12.0	96
100-person, 2-week shelter experiment, NRDL[1] 1959	12.0	117
U.S. shelter standard	10.0	65
30-person, 2-week shelter experiment, AIR[2], 1960	8.0	58
Civil war prison	8.0	40
Local bus filled to seating capacity	6.3	42
160-person, 2-day shelter experiment, Univ. of Georgia, 1966	6.0	60
West German 5-day shelter experiment	5.5	--
Swedish recommended shelter minimum	5.4	--
London WWII shelter sleeping 200 people	4.0	30
[1] US Naval Radiological Defense Laboratory, San Francisco CA [2] American Institute for Research, Pittsburgh PA		

3.2.1.2.2. **Structure.** Most long-term occupancy shelters are located in permanently constructed facilities. The building structure, or at least the shelter portion, must be able to withstand the physical effects of the disaster or threat weapons. Existing structures can be upgraded using expedient hardening techniques discussed later in paragraph **3.4.**

3.2.1.2.3. **Ventilation.** Longer term shelters require ventilation to maintain a minimum oxygen level, prevent an excessive buildup of carbon dioxide (CO_2), and control shelter temperature. Air quality and temperature control must be provided by ventilation with outside air. Normal building ventilation systems cannot be counted on because commercial electric power may not be available. Natural ventilation may be adequate in aboveground shelters if enough windows are opened. In basements, ventilation is improved if cooler air can be allowed to flow in through doorways or windows at one end while warm shelter air escapes up an elevator shaft or stairwell or to higher windows at the other end. Unfortunately, natural ventilation may often be insufficient to maintain a habitable environment in larger shelters during warm weather. The best solution is to provide an emergency generator (with fuel supply) sufficient to operate all or a portion of the building's ventilation system—or at least provide a number of pedestal fans for this purpose. Other options include using aerospace ground equipment (AGE) ground air conditioning units from the flightline or spare environmental control units (ECU). Both types of units can be ducted directly into the shelter or tied into the shelter's air distribution ducts. If entry of CBRN contamination is an issue, CBRN filters must be installed in the ventilation system.

3.2.1.2.3.1. Fresh air contains about 21 percent oxygen; when the oxygen content drops between 19.5 and 17.5 percent, the Occupational Safety and Health Administration (OSHA) considers a confined space to be oxygen depleted. Below 17.5 percent, workers are required to be on supplied air. Studies have shown that healthy young adults can survive without long-term effects at an oxygen level as low as 14 percent, but they cannot perform sustained vigorous activities. Fortunately, it takes only 0.4 cubic feet of fresh air per minute per person to maintain the oxygen level at 17.5 percent.

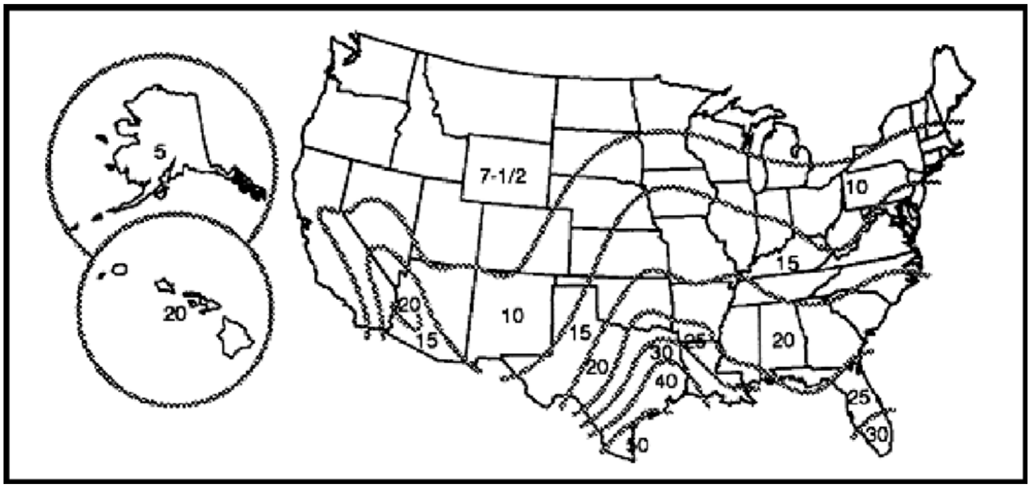
3.2.1.2.3.2. CO_2 concentration is a bigger problem. The results of prolonged exposure to higher levels of CO_2 have shown the desirability of keeping the level below 1 percent. The Federal Emergency Management Agency (FEMA) has established a goal of not more than 0.5 percent. This limit requires 3 cubic feet of fresh air per minute per person, which more than satisfies the oxygen requirement as well.

3.2.1.2.3.3. In addition to consuming oxygen and generating CO_2, shelter occupants produce an average of 500 British Thermal Units (BTU) per hour. Part of that heat is given off as “sensible” heat that can be measured by a thermometer. The other part is given off in water vapor as “latent” heat. During winter months, this may be very welcome heat. However, during summertime, proper ventilation is needed to rid a shelter of excess heat and moisture to prevent body temperatures from rising to dangerous levels. As long as the air temperature is well below skin temperature, the body can radiate heat to maintain normal temperature. At higher temperatures, the body must rely on evaporative cooling by perspiration. If the air is humid and air movement low, evaporative cooling loses its effectiveness, and body temperature will rise.

3.2.1.2.3.4. The most widely used measure of heat and moisture effects on the human body is “effective temperature” (ET). It combines the effects of air temperature, air moisture, and air movement to yield equal sensations of warmth or cold and approximately equal amounts of heat strain. The numerical value of ET is the reading on an ordinary thermometer when the air is completely saturated (100 percent relative humidity). At less than 100 percent, the thermometer reading would be higher than the equivalent effective temperature. For a relative humidity of more than 50 percent, a common summertime level, an effective temperature of 82 degrees would correspond to air temperatures in the mid-90s.

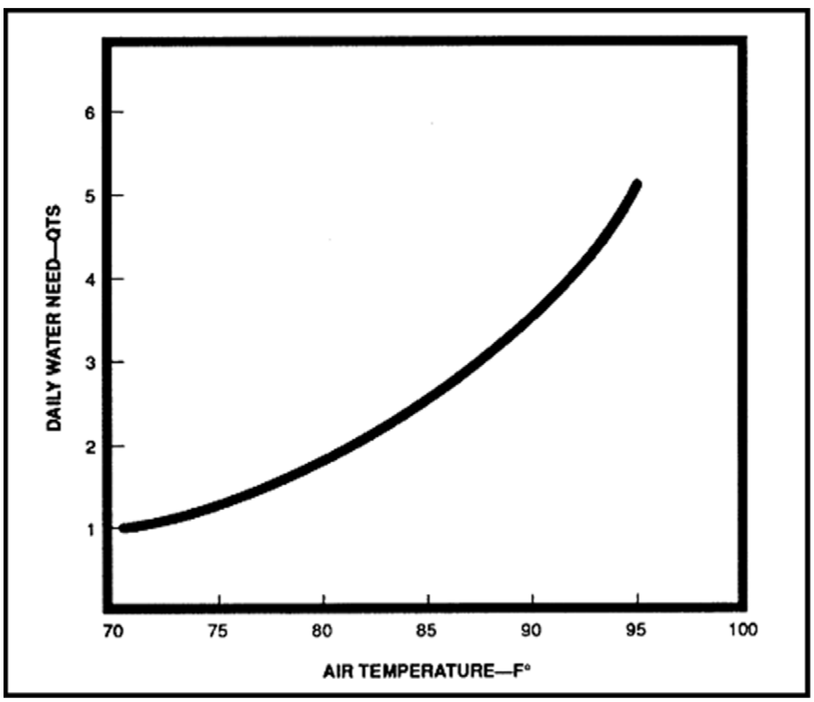
3.2.1.2.3.5. Using 82 degrees as the minimum effective temperature, the map in **Figure 3.2.** defines the required ventilation (in cubic feet per minute per person) in the different zones in the US. The ventilation provides 90 percent reliability of maintaining the effective temperature in the shelter at 82 degrees or less. As you can see, the required ventilation rates are all greater than the 3 cubic feet per minute per person needed to control the CO_2 buildup. Therefore, adequate ventilation to maintain effective temperature also provides sufficient oxygen and control of CO_2 buildup.

Figure 3.2. Required Ventilation to Control Temperature (Cubic Ft. Per Min. Per Person).



3.2.1.2.4. **Water Supply.** An assured water supply is important if the shelter is to be occupied for an extended period. During wintertime, or in an uncrowded shelter, 3.5 gallons per person will last for approximately 2 weeks; this may last only 3 days in hot weather. **Figure 3.3.** illustrates the relationship of required water versus shelter air temperature. Given an abundance of water, people can drink extra water to help compensate for deficiencies in temperature control, but do not count on normal water sources. Having sufficient quantities of water often creates a storage problem (as does disposal of liquid wastes). Plastic and metal trash cans, with plastic bags as liners, are suitable and readily available as are 1-gallon plastic jugs and 5-gallon plastic cans.

Figure 3.3. Minimum Water Required.



3.2.1.2.4.1. When water intake is restricted or negligible, the bodies of healthy people compensate by reducing the amount of urine excretion by about half, from about 3 pounds (pints) in adults to about 1-1/2 pounds. Unless people are required to perspire to lose body heat, about 1 quart of water suffices to maintain the water balance. If the shelter temperature is warm, however, the amount of water needed to avoid dehydration increases rapidly. This is another reason to be concerned about temperature control in shelters.

3.2.1.2.4.2. The consequences of dehydration vary widely among individuals, with the very young, very old, and ill being especially vulnerable. Pregnant women require more water than usual and must avoid dehydration to prevent injury to the unborn child. Generally there is nothing to be gained by stretching out inadequate water supplies to cover a presumed shelter stay. Health is best maintained by delaying any dehydration as long as possible. Water management should be aimed at ensuring adequate intake and preventing waste rather than at rationing the available supply, particularly since there is no way to determine a "fair share" for each person except by satisfying thirst.

3.2.1.2.4.3. Water for washing is an amenity and not a necessity for an extended shelter stay.

3.2.1.2.5. **Health and Sanitation.** Minimizing the spread of disease or infection requires constant attention to sanitation measures, cleanliness of toilet areas, careful handling of water and food, and establishment of an isolation area for personnel who are ill. The disposal of human waste is the highest priority sanitation need. The emergency standard is one commode per 50 people. Shelter areas will have few conventional commodes, if any, and flushing water must be limited. Toilet facilities can still be used, however. The contents of chemical toilets can be disposed of by dumping into the conventional toilets. If water is available, those toilets can be flushed occasionally. Otherwise, emptied water containers, plastic bags, or other containers must be used to store wastes. As a rough rule of thumb, waste storage capacity must be able to handle about 1/2 gallon of sewage per person per day.

3.2.1.2.5.1. Portable chemical toilets are the best substitute for the lack of conventional toilets. Makeshift commodes can be made by lining large cans with heavy-duty plastic bags and improvising a seat with a pair of boards or cutting a hole in plywood. Disinfectant (chlorine, bleach, etc.) should be poured in periodically to fight germs and odors. If human waste must be stored, plastic bags from chemical commodes can be tied off when nearly full and placed in large covered garbage cans. Double bag the waste to prevent spills if a bag tears.

3.2.1.2.5.2. Keeping toilet areas and toilets clean is a big part of preventive medicine. Unless the shelter space is part of a facility occupied in peacetime, janitorial and cleaning supplies, such as trash cans, brooms, and mops, are not usually available. Additional supplies of heavy-duty plastic bags are invaluable.

3.2.1.2.5.3. Bathing is not a necessity, but some water is needed to allow food handlers to wash their hands; this reduces the transmission of disease.

3.2.1.2.5.4. Perform good housekeeping practices as much as possible. Substantial amounts of litter and trash accumulate in a crowded shelter. This ranks high on a shelter "discomfort index."

3.2.1.2.6. **Electrical Power.** As eluded to earlier, emergency power is important for ventilation, but it is also needed to provide limited lighting in the shelter. Lighting levels need only be sufficient for personnel to navigate within the shelter and find exits, although sufficient lighting for reading helps morale. Excess lighting adds to the heat load, which is unwelcome in hot conditions.

3.2.1.2.7. **Food.** Providing food is not a CE responsibility, but the packaging and types of food consumed can affect water consumption, shelter heat load, and waste generation. CE planners should coordinate with shelter planners to address requirements affected by shelter food stocks. Food is near the end of the list of essential shelter needs. Healthy adults can survive without food for several weeks given adequate water and temperature conditions. This does not consider the emotional impact. People consider food a basic and will likely leave the shelter if it is not available. If shelter occupants are expected to participate in base recovery operations, they must eat. Foods high in protein or fat greatly increase the amount of drinking water required to eliminate wastes. A diet composed entirely of carbohydrates is also undesirable. Heating or cooking foods adversely affects temperature control, requires an assured heat source, and can constitute a hazard in a crowded shelter. Foods that require cooking or eating utensils or that produce garbage or trash offer sanitation problems. Perishable foods are not recommended and, if brought in, should be consumed first. The “best” foods are crackers and canned goods which are easy to transport, store, and prepare, as are whole-grain cereal products and dried fruits. Augmentation with food products that are mostly liquid is desirable. Glass containers present a problem and should be handled with care if they cannot be avoided. Shelter occupants should bring ready-to-eat food to supplement any shelter stocks.

3.2.1.3. **Collective Protection.** Collective protection is an important factor when determining personnel shelter requirements. Ideally, it provides a temperature-controlled, contamination-free environment to allow personnel relief from continuous wear of individual protective equipment (IPE). The basic concept for most facility collective protection solutions is to provide overpressure, filtration, and controlled entry and exit. Maintaining a higher internal air pressure than external pressure and filtering incoming air prevent contaminated external air from infiltrating the shelter. Other types of collective protection rely on the facility structure to provide short-term protection. They are not equipped with positive pressure air filtration systems or airlocks and use shelter-in-place techniques to limit or delay the entry of contamination. Collective protection supports two mission sustainment areas that quickly erode in a CBRN environment: personnel rest and relief (breaks and sleeping) and work relief (command and control, medical treatment, mission-oriented protective posture (MOPP) recovery time after maximum work effort). Each installation must assess collective protection requirements based upon the likely threats and mission requirements. Specific collective protection solutions may include a mixture of permanent, mobile or transportable, or expedient or temporary collective protection systems. Refer to AFMAN 10-2602 (until rescinded by AFMAN 10-2502, Series publication) for more detailed information on shelters with collective protection systems.

3.2.1.4. **Nuclear Protection.** The design and construction of shelters to resist the direct effects (versus a direct hit) of nuclear weapons are complex, costly, and beyond the scope of this publication. Considerable information is available on the construction, preparation, and operation of shelters to protect personnel from the direct effects of a nuclear blast and from radioactive fallout. Refer to AFMAN 10-2602 (until rescinded by AFMAN 10-2502 Series publications), AFTTP (I)

3-2.46, *Multiservice Tactics, Techniques, and Procedures for Nuclear, Biological, and Chemical (NBC) Protection*, and UFC 3-340 series publications.

3.2.2. **Equipment Shelters.** Similar to personnel shelters, equipment shelters used to protect vehicles and equipment vary in design and function—from temporary to permanent structures. **Figure 3.4.** shows equipment containers and vehicles inside a Rapid Deployment Bare Base Shelter System (Dome Shelter) at a forward deployed location. The covered design helps to protect equipment and vehicles from chemical and biological contamination in the event of an attack. Expedient equipment shelters can be erected using modular concrete panels, revetments, and other materials and designs. Although these designs typically do not offer overhead protection, they will provide some degree of blast, small arms, and indirect fire protection. There are many types of equipment shelters used during contingencies—some are manufactured and others are expediently constructed. See AFH 10-222, Volumes 2, 6, and 14, for more information concerning equipment shelters.

Figure 3.4. Sheltered Vehicles and Equipment.

3.2.3. **Aircraft Shelters.** Shelters used to protect helicopters, fixed-wing aircraft, and unmanned aerial vehicle (UAV) aircraft vary greatly and are based as much on when and where the shelters were built as on the type of protection provided (**Figure 3.5.** through **Figure 3.9.**). Some permanent aircraft shelters provide only minimal protection from the elements while others are hardened facilities that provide near total protection from enemy attack, including protection from the effects of CBRN weapons. Other aircraft shelters may provide limited ballistic protection or shield from small arms weapons fire and blast fragments. Although aircraft shelters built from steel revetment kits are still in widespread use, the amount of time and equipment required to airlift and erect these kits is considerable. In time, more advanced, resource-friendly barriers may replace the older steel revetment kits in many expeditionary environments.

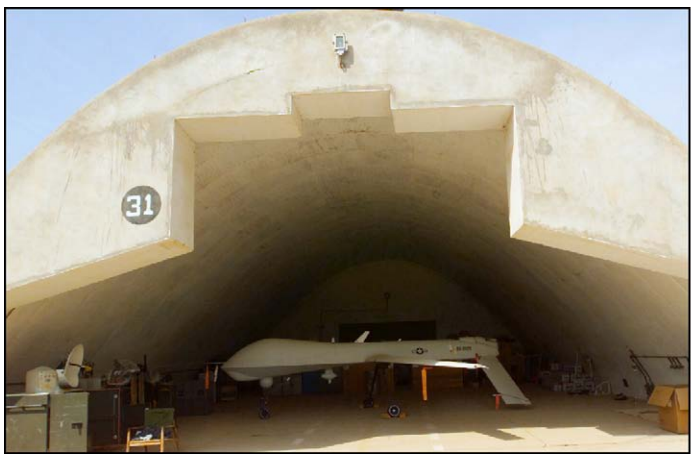
Figure 3.5. Engineers Build Aircraft Shelters from B-1 Steel Revetment Kits.

Figure 3.6. HESCO Barriers Provide Limited Shelter for Aircraft.

Figure 3.7. Airmen Push Aircraft Into Hardened Aircraft Shelter.

Figure 3.8. TAB VEE Permanent Aircraft Shelters Still in Widespread Use.

Figure 3.9. UAV Sits in a Bunker at a Forward Operating Location.



3.2.4. **Summary.** Personnel shelters protect people from the effects of weapons and disasters. Having "a place to jump when the bombs start falling" or when disaster strikes provides people with a sense of security. Expedient shelters are relatively easy and quick to construct and may be the only option at many installations. Aircraft and equipment shelters minimize damage to critical assets and help to preserve the mission. Whatever the reason for the shelter, good disaster and attack preparations help to ensure shelters are available if the need arises.

3.3. Redundancy. Like an attack, a disaster could easily knock out critical utility systems or facilities. Planning and preparations should include procedures to establish redundant or backup sources in case utilities are destroyed or rendered unusable. Installations should also consider redundancy when designing or redesigning utility systems. Redundant utility systems are addressed in **Chapter 5**, Isolation, Emergency Backup, and Protection of Utilities.

3.4. Hardening. Another key factor of CE preparations for disaster and attack is facility hardening. From a civil engineer perspective, hardening is the process of strengthening buildings and utility systems to resist destructive effects of weapons or natural forces. Hardening is used to prevent loss of critical resources and functions inside those facilities and to protect the utility systems supporting the critical assets and functions. Hardening may be permanently constructed into facilities either during initial construction or added later as supplemental hardening. Permanent hardening is accomplished during peacetime, because there is not enough time for detailed engineering designs or elaborate construction when an enemy or disaster threatens. More often, engineers are called on in an expeditionary environment to provide expedient hardening, such as rapidly erecting a sandbag wall or building protective barriers and soil berms. Preparations for hardening are addressed in the following paragraphs.

3.4.1. **Selection of Candidates for Hardening.** The responsibility for the selection of facilities and equipment that must be protected by hardening does not rest with the base civil engineer (BCE). The BCE is, however, responsible for ensuring that the hardening process is accomplished. Normally, items which are most essential to continuing the base mission receive priority for protection. Aircraft, command and control centers, personnel shelters, and communications centers are typical high-priority facilities that are good candidates for hardening.

3.4.2. **Hardening Design.** For permanent hardening, an engineer must perform a structural analysis to determine the hardening method. To perform this analysis, the threat, in terms of type of weapon (munitions), fuzing, size, angle of impact, etc., must be known. The engineer must also understand the function of the facility. For supplemental hardening or facility retrofits, this involves evaluating each structural component versus the expected weapon type and size. Because this analysis is very detailed, it is only conducted for permanent construction or peacetime retrofit of existing structures.

3.4.3. **Expedient Hardening Considerations and Factors.** There are many ways to upgrade the hardness of existing non-hardened facilities and to protect critical resources from the effects of conventional weapons. This section outlines basic factors to consider and techniques for expedient hardening of facilities (see **Table 3.2.**).

Table 3.2. Factors to Consider for Expedient Hardening.

Expedient Hardening Considerations
Threat (in terms of weapon effects).
Number of resources and facilities to be protected and the characteristics of each.
Type and dimensions of aircraft to be protected.
Layout of aircraft parking areas.
Time available for design and construction.
Materials available.
Expected duration of use.
Equipment and labor needed for construction.
Soil conditions (type, moisture, pH, etc).
Drainage (both surface and off roofs).
Terrain.
Weather.

3.4.3.1. **Threat.** Understanding threat weapons and their effects on facilities is the first step in selecting and designing hardening measures. The variety of weapons available for attacking Air

Force facilities is almost unlimited, ranging from small arms to heavy weapons delivered aerially. Weapon effects often occur in combination for greater lethality. The detonation of a general- purpose bomb is a good example of a one-two punch. The impact of high velocity fragments from the bomb casing can weaken a structure, making the blast wave immediately following detonation more effective in destroying the structure. Fragment and projectile penetration typically controls the design of the hardening method used. Additional information on weapons and their effects can be found in AFMAN 10-2602 (until rescinded by AFMAN 10-2502 Series publications), and UFC 3-340-01.

3.4.3.2. **Resources and Facilities to Be Protected.** Civil engineers should prepare a hardening analysis for each resource and facility to be upgraded. Each structural component should be evaluated against the effects of the probable threat weapons and the expected duration of use to determine design features. If aircraft are to be protected, consider the length, wingspan, and height of the aircraft. Also consider the layout of aircraft parking areas. If conducted in peacetime, these hardening analyses provide the basis for the installation's permanent and expedient hardening plans. Exhaustive field investigations and elaborate plans are not necessary, but adequate site investigations are important and help reduce the number of problems caused by immediate decisions based on a sense of urgency.

3.4.3.3. **Time.** Normally, the nearer an air base is to the potential battle area, the more vital the time element becomes. Time is saved by efficient use of manpower, heavy equipment, hand tools, materials, and other facilities available. Good planning, scheduling, and supervision are needed during construction. Develop task priorities and assign crews and equipment to specific work areas to minimize travel. Sequence operations so all equipment is kept busy.

3.4.3.4. **Materials.** Hardening materials act as either shielding (for protecting personnel or critical resources), serve as structural components (to hold the shielding in place), or perform both functions at the same time. Shielding provides protection against penetration of projectiles and fragments, nuclear and thermal radiation, and the effects of fire and chemical agents. When time is limited, materials must be conserved, particularly those shipped from the continental United States (CONUS). Local materials should be used whenever practicable. Some possible hardening materials are discussed in the following paragraphs.

3.4.3.4.1. **Soil.** Soil is generally the primary fill material for revetments and soil berms. Projectile and fragment penetration in soil is based on three considerations: for materials of the same density, the finer the grain the greater the penetration; penetration decreases with increase in density; and penetration increases with greater water content.

3.4.3.4.2. **Soil Cement.** Soil cement is used mostly for revetments which use sandbags in their construction. Soil cement can also be used in the construction of caps for earth revetments and to stabilize soil foundations under revetments. The standard ratios are one part cement to ten parts soil by weight or one part cement to six parts sand or gravel.

3.4.3.4.3. **Steel.** Many expedient types of steel may be available for shielding. Sheet piling, steel landing mats, and culvert sections can be used in a protective structure as one of several composite materials. The thickness of these materials is a key factor in determining the overall penetration resistance of the revetment. Steel plate, only 1/6 the thickness of concrete, affords equal protection against small and intermediate caliber projectiles. Steel is also more likely to deform a projectile as it penetrates and is much less likely to spall than concrete. Steel sheets can be used to confine soil in a soil revetment. However, material with perforations larger than 1/2 inch do not properly confine the soil material.

3.4.3.4.4. **Concrete.** Concrete provides a very permanent revetment medium. If used with reinforcing bars or mesh, concrete is quite resistant to fragmentation shells. Reinforcing helps the concrete stay intact even after excessive cracking caused by penetration. When a shell or bomb explodes, its fragments travel faster than the blast wave. If these fragments strike the exposed concrete surfaces of a protective position, they can weaken the concrete to such an extent that the blast wave destroys it. Fragment strikes on exposed concrete surfaces may also cause spalls or pop-offs, on the inside surface of the concrete wall. Traveling at high speeds, the pop-offs create a hazard to personnel and materials on the inside. When possible, at least one layer of sandbags, placed on their short ends, or 15 inches of soil should cover all exposed concrete surfaces. Concrete construction requires skilled personnel and specialized equipment. Unfortunately, Portland cement may not be readily available after a conflict begins.

3.4.3.4.5. **Rock.** In areas where rock is readily available, it can be an excellent hardening material. Fragment penetration into rock depends on the rock's physical properties and the number of joints, fractures, and other irregularities contained in the rock. Several layers of irregularly-shaped rock can change the angle of penetration. Hard rock can cause a projectile or fragment to flatten out or break up and stop penetration. Brick and masonry have the same protection characteristics and limitations as rock. Large rock is often used as a burster layer.

3.4.3.4.6. **Snow and Ice.** Although snow and ice have only limited applications, they may occasionally be the only readily available materials in some areas. They should be used for shielding only. Weather changes can cause protective structures made of snow and ice to wear away or even collapse.

3.4.3.4.7. **Dimensioned Wood Timbers.** Because of its low density and relatively low compressive strength, wood should generally be used only as structural support for survivability positions. Much greater thicknesses of wood than of soil are needed for protection from penetration. Timber is better used to construct retaining walls for earth or sandbag revetments or used to construct stand-offs. The timber may be hard or soft wood but should be free of knots or other imperfections that would affect its strength and resistance to penetration. Timber which is used against earth should be treated with tar or creosote to prevent decay.

3.4.3.4.8. **Plywood.** Multiple layers of plywood can be used as a very effective field expedient protective wall. The wall must be designed and constructed with sufficient braces and anchors to provide stability against blast. Most often plywood is used as a barrier to contain soil in a retaining wall or revetment.

3.4.3.4.9. **Logs.** In heavily forested areas, timbers may be cut from existing woodlands and used to make log revetments. Logs can be better used as the walls in a soil bin revetment.

3.4.3.4.10. **Corrugated Metal.** This material can be used to assemble revetment retaining walls and bulkheads. Since corrugated metal is not as rigid as landing mat and other steel material, it requires additional vertical and horizontal support to withstand the pressure of the earth fill.

3.4.3.4.11. **Boxes.** Many types of boxes available on a typical installation can be filled with earth and used to construct a revetment. Ammunition boxes filled with earth provide some protection as retaining walls and bulkheads if they are adequately reinforced with vertical supports. CONEX or similar type containers filled with dry earth make formidable protective walls.

3.4.3.4.12. **Combined Materials.** In most contingency situations, the availability of construction materials and skilled workers will likely be limited and will vary by installation. This might require a combination of expedient methods to insure that effective protection is supplied. In fact, if the materials are available, the combined use of materials normally results in a more effective revetment.

3.4.3.5. **Equipment and Labor.** Selection of the hardening method should be based on resources required, resources available, and other subjective factors. As in any design situation, more than one solution may be possible or close to optimal. Adequate protection may also require the use of more than one method. For example, bin revetments may be selected to protect the structure walls while sandbags and loose soil are used to cover the roof. A number of innovative concepts are possible for expedient hardening. **Table 3.3.** shows the equipment, labor, materials, and space required for the various methods. A quick screening of each of the methods can be performed using this table. For example, if space is very limited, soil berms are not usually an option. Also some methods such as sand grid forms require special materials.

Table 3.3. Design, Construction, and Special Considerations Matrix.

METHOD	EQUIPMENT	LABOR	MATERIALS	SPACE (TYPICAL)
Soil Berm	Backhoe/Loader Hand Shovel[1] Truck/Trailer[5]	Unskilled[2,3]	Soil[4]	>6 ft
Sandbags	Hand Shovel Truck/Trailer[5]	Unskilled[3]	Soil/Gravel Bags or other expedient container[6]	1-4 ft
Sand Grids	Backhoe/Loader Hand/Shovel[1] Truck/Trailer[5]	Unskilled[2,3]	Soil/Gravel Grid Forms	~3 ft
Modular Concrete Revetments	Crane/Forklift	Unskilled Skilled[2]	Precast Modular Units Straps and bolts for connections Sandbags[7]	4-8 ft
Bin Revetments	Backhoe/Loader Hand Shovel[1] Crane/Forklift Truck/Trailer[5]	Unskilled Skilled[2]	Soil/Gravel/Rock Rubble Container Straps & bolts for connections Sandbags[7]	2-10 ft

METHOD	EQUIPMENT	LABOR	MATERIALS	SPACE (TYPICAL)
Sacrificial Panels	Crane/Forklift	Unskilled Skilled[2] Engineering[8]	Varies[9] Hardware for connections	<1 ft

[1] Hand construction/shovel filling possible if heavy equipment unavailable.

[2] Skilled labor required for operation of heavy equipment.

[3] Engineering required for determination of allowable loads when placed overhead or against nonhardened walls (berms only).

[4] Requires facing to control erosion and blowing dust problems.

[5] For transport of fill material if not available at site.

[6] Acrylic fabric bags recommended for durability.

[7] Sandbags should be used to protect corners of revetment array.

[8] Engineering design required for thickness of panel, sizing of air space, and design of structural attachment.

[9] A variety of materials may be used, from plywood to asphalt to concrete to modern composites.

3.4.3.6. **Topography.** The topography of the area near the deployment site should be considered when determining the protective requirements for parked aircraft, other vital assets, and key facilities. High ground within a range of 3,500 meters (11,483 feet) that offers good observation for effective mortar or direct fire may destroy the effectiveness of revetments unless the air base defense force plans for effective counter-fire. Similarly, wooded areas, villages, or other sites permitting concealment close to parked aircraft give opportunities for guerrillas and terrorists to assemble. These factors indicate a need for active defense measures in addition to passive fortification.

3.4.3.7. **Terrain.** Slopes, drainage, vegetation, character of soil, likelihood of floods, and other conditions that may affect construction and layout should be studied.

3.4.3.8. **Effects of Soil Moisture.** Wet soil may be used for revetments if dry material cannot be obtained, but it is uneconomical since larger quantities are required to resist penetration. Wet soil must be approximately one-half again as thick as dry soil to resist penetration by a given type of ammunition. Thus, selecting dry soil for earth revetments and providing a waterproof cover for them conserves manpower and materials. Of the various soils, wet clay can be penetrated most easily and is the least effective revetment material. Dry sand has the most resistance to penetration and therefore is the most desirable soil for revetment purposes. Soils with high moisture content, if not well protected from the elements, give way to erosion in a relatively short period.

3.4.3.9. **Impact of Weather.** The local weather is an important factor in the development of hardened structures. Areas with high amounts of rainfall cause earth-filled revetments and sandbag structures to lose some of their effectiveness. Dampness also has an adverse effect on the durability of other materials that are used in the hardening process. Wood rots and steel rusts quickly under these conditions unless well covered with protective coatings.

3.4.4. **Selection of the Hardening Method.** Several hardening options may be suitable for a given situation. Soil berms provide the greatest level of protection for both single and multiple attacks, because of the large mass of earth that is typically used. Also, tests have shown that soil berms remain relatively intact through repeated attacks. Material blown from the face of the berm falls back onto the berm, and fragment and projectile penetration generally does not disturb stable berms. In general, any method that places a large mass of soil between the threat and the structure (or resource) provides good protection. Other methods include sandbags, sand grids, and bin revetments. These methods do not provide the level of multiple-attack protection provided by soil berms. They all depend on relatively vulnerable soil confining systems that tend to break down, allowing the soil to spill out on repeated attacks. Concrete modular revetments also provide good protection, although they do not provide the same level of protection afforded by a large mass of soil. Sacrificial panels have been shown to provide good protection levels since a significant amount of the destructive energy of the threat is dissipated in the breakup of the panel. However, sacrificial panels are better suited to semi-hardened structures that can withstand the impacts from the breakup of the panel and any fragments or projectiles that perforate the panels. Of course, as their name implies, sacrificial panels are not expected to provide multiple-attack protection.

3.4.4.1. **Soil Berms.** Soil berms are among the oldest and simplest methods of providing improved and expedient protection to existing structures, personnel, and other assets. They are traditional military field structures and have been used as breastworks throughout history. Berms are extremely effective in protecting against modern weapons, particularly when coupled with semi-hardened structures. Berms can be employed as freestanding structures, constructed against exterior walls of buildings, or placed against retaining walls (**Figure 3.10.** through **Figure 3.12.**).

Figure 3.10. Freestanding Berm.

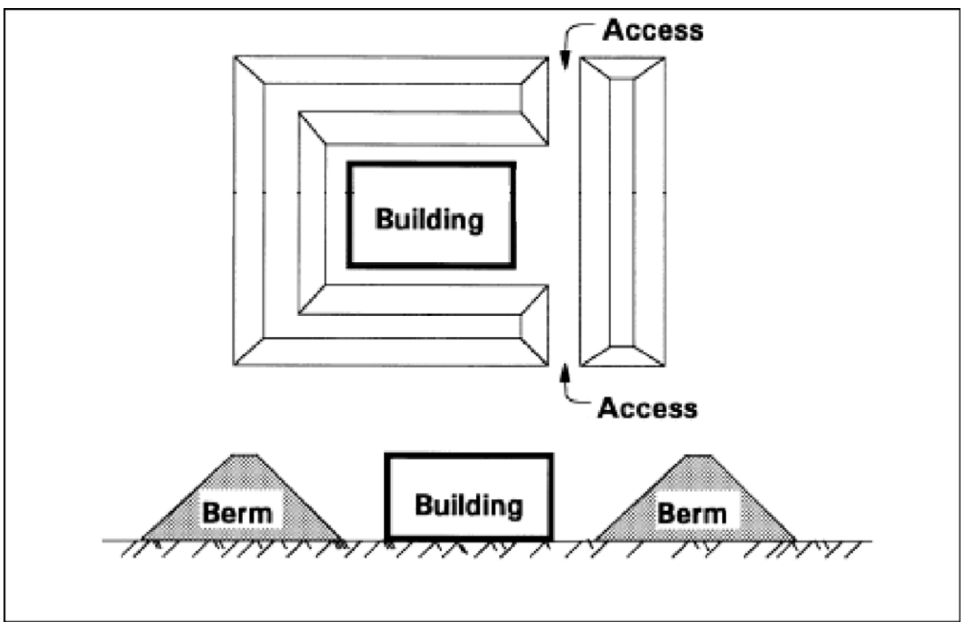


Figure 3.11. Bermed Wall.

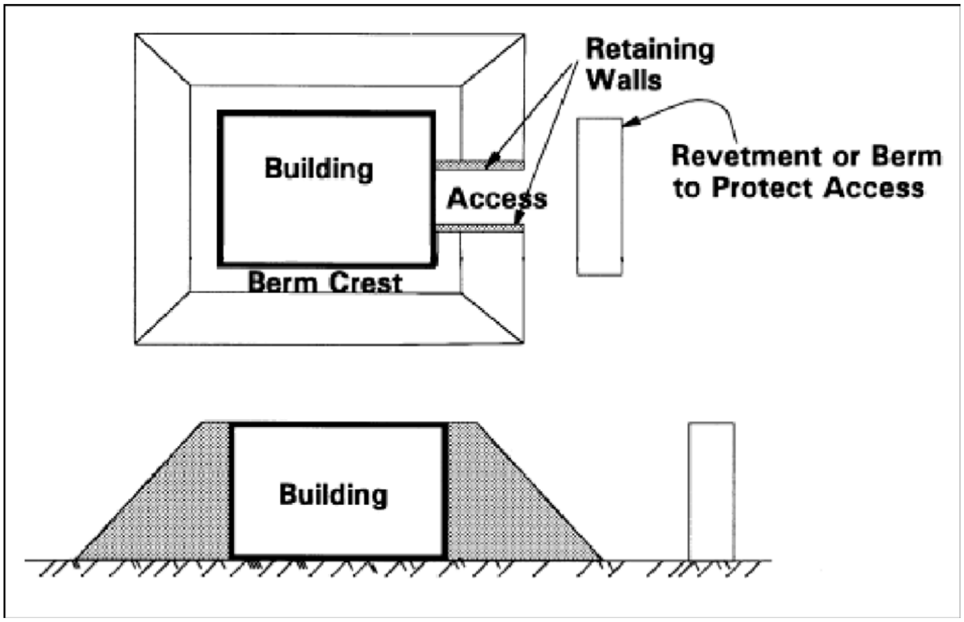
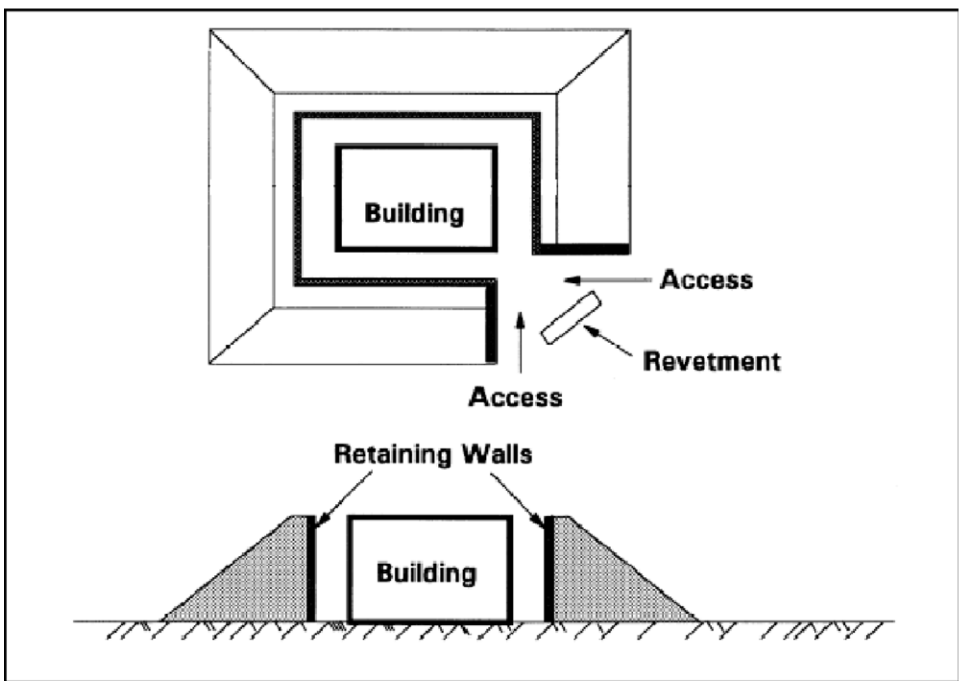


Figure 3.12. Bermed Retaining Wall.



3.4.4.1.1. **Threat Protection.** Berms provide protection against near-miss general purpose bombs; high-explosive artillery rounds; rockets; and ballistic penetration. Soil berms can also be designed to defeat the effects of shaped charges. As freestanding structures, berms can be used to deny a direct line of sight to protected assets or a vulnerable area such as a door opening. Freestanding berms offer little protection from air blast effects. This is because the blast wave quickly reforms after passage over the berm. Consequently, freestanding structures are not recommended for applications requiring significant reductions in air blast pressure. However, tests have shown that berms constructed against a structural wall can dramatically reduce the damage from fragment impact and air blast.

3.4.4.1.2. **Multiple-Attack Protection.** Freestanding soil berms and bermed walls provide good second or multiple-attack protection. This is principally due to the excellent protection against fragment penetration provided by soils and in part due to the geometry of the sloped face—material blown from the berm by the blast tends to fall back on the berm face.

3.4.4.1.3. **Limitations/Special Considerations.** The main disadvantage of berms is their large space requirements. Berming may not be a practical hardening option for structures sited in very rocky terrains or where grading equipment is not available. At air base facilities, berms sited near taxiways and runways may exacerbate problems related to blowing dust and debris. Erosion control measures are particularly important under these circumstances. Generally, semi-hardened structures that were originally designed to withstand loadings associated with weapon effects have ample capacity to support additional dead loads associated with berming. The capacity of conventional wall structures must be investigated to determine the need for additional support. Simple earth berms and bermed walls can be effectively used in some instances by incorporating them into landscaping and energy management schemes for permanent facilities. In areas with ample rain, berms require frequent maintenance, especially if the sides and crest are not waterproofed, sodded, or sandbagged.

3.4.4.1.4. **Manpower.** Preparing for an attack should be an installation-wide effort. Civil engineers will use their heavy equipment to move, place, and compact the soil. Unskilled labor from other units can complete tasks such as placing sod and sandbags and waterproofing and digging drainage channels.

3.4.4.2. **Sandbagging.** Sandbagging is a traditional method of providing effective protection to walls and overhead structures. Sandbags can also be used to construct freestanding walls, revetments, and wall structures for protection of otherwise exposed assets. Sandbag revetments are practical expedient field fortifications, particularly when heavy equipment or skilled labor is in short supply. **Figure 3.13.** depicts how sandbags might be used to upgrade an existing structure.

3.4.4.2.1. **Other Uses.** Sandbag structures can be used to protect vital resources from natural or man-made disasters. During a flood or hurricane, sandbag dikes can prevent important resources from being swept away or seriously damaged by high water. Sandbags could also be used in a man-made disaster, such as the rupture of a large fuel storage tank, to stop the spread of the highly flammable material. Civil engineers might use sandbags to contain the blast from a terrorist's bomb. Sandbags make effective temporary barriers to prevent access to critical installation areas during times of increased alert. They can also quickly replace protection lost through battle damage. A hole blasted in a permanent revetment could be temporarily filled with sandbags during a lull in the battle to provide protection during the next attack.

Figure 3.13. Fortifying Shelter with Sandbags.

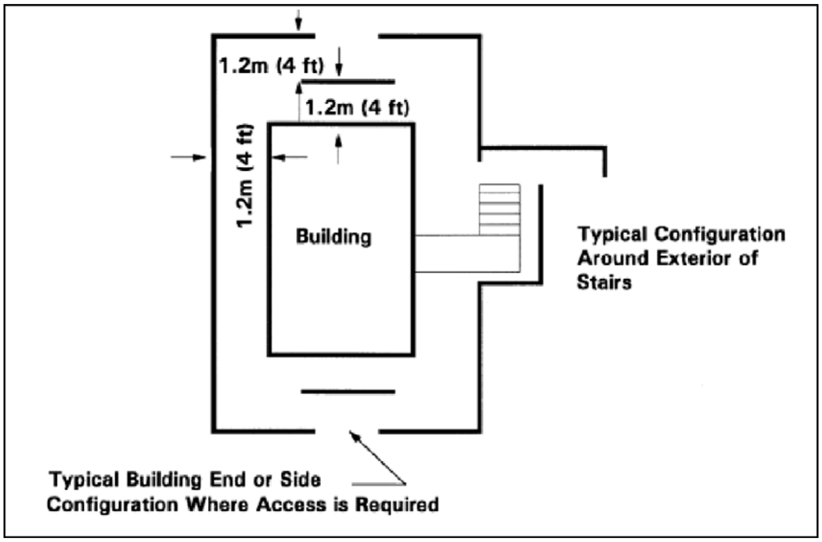
3.4.4.2.2. **Threat Protection.** Sandbags placed against walls and over roofs are successful in protecting against near-miss and direct-hit high-explosive artillery rounds and direct ballistic impacts. Placed against walls, sandbags provide protection similar to that obtained from berming with soil. A 16-inch layer of sandbags stacked against a 6-inch precast concrete wall provides good protection against a 155 mm high-explosive artillery round detonated at a standoff of 5 feet.

3.4.4.2.3. **Multiple-Attack Protection.** Sandbag berms, walls, and roof coverings provide multiple-attack protection to near-miss high-explosive threats similar to soil berms or soil covers. However, the sandbag material tends to deteriorate, spilling the soil contents. Protected walls or roofs become vulnerable to a second attack unless repairs are made.

3.4.4.2.4. **Limitations/Special Considerations.** The main limitation of sandbags, as compared with soil berms, is the time required to fill and place the bags. Older sandbags were susceptible to rot, but newer bags with acrylic fabric remain serviceable for over two years with no signs of deterioration under all climatic conditions.

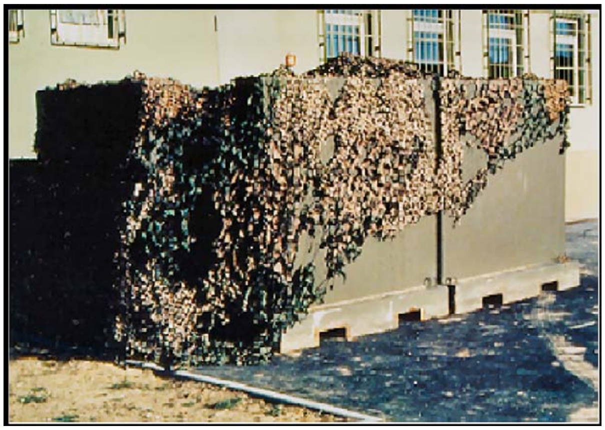
3.4.4.3. **Concrete Modular Revetments.** Permanent revetments with integral foundations are usually associated with hardness upgrades and new facilities. Prefabricated concrete modular revetment units provide an expedient method for hardening structures and protecting exposed assets. **Figure 3.14.** shows a typical configuration for placing modular revetments to protect a building or key resource. The major distinguishing feature of modular revetments, when compared to other hardening measures, is their portability. Revetments can be bermed with soil to improve protection.

Figure 3.14. Configuration for Protecting a Building With Concrete Modular Revetments.



3.4.4.3.1. **Uses.** Concrete modular revetments provide versatile, low-cost, relocatable, maintenance-free and long-lasting protection for critical equipment and facilities (**Figure 3.15.**). They can be placed in aircraft parking areas, around buildings and equipment, and on and off paved surfaces. They can protect assets such as AGE, liquid oxygen storage tanks, WRM assets, and generators. They can be used to deny line-of-sight to doors and other vulnerable openings.

Figure 3.15. Concrete Modular Revetment Protects Key Equipment.



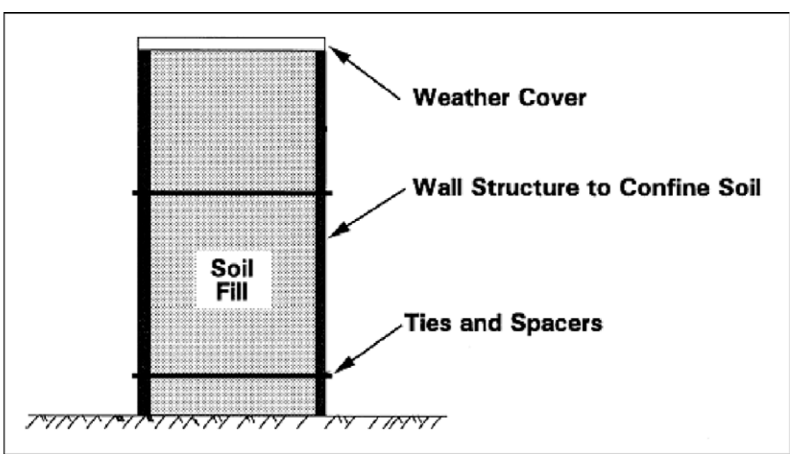
3.4.4.3.2. **Threat Protection.** Concrete revetments can provide protection against fragments and air blast from near-miss general-purpose bombs and other lesser threats such as high-explosive artillery rounds, rockets, mortars, and small arms. An unbermed revetment provides good first strike protection but can suffer significant front face cratering and backface spall from fragment impacts. Bermed revetments improve protection for the revetment against fragment damage. Portable concrete revetment panels (6 inches thick) resist small arms fire but will not protect against a direct hit by a 122 mm rocket or larger weapon.

3.4.4.3.3. **Multiple-Attack Protection.** Unbermed concrete revetments in practical wall thicknesses of 0.2 to 0.3 meters (approximately 7.9 inches to 11.8 inches), provide limited to moderate second attack protection from near-miss general-purpose bombs due to their susceptibility to fragment damage and movement. Bermed revetments provide excellent second attack protection. Panel displacements that create gaps between revetment units reduce the effectiveness of the revetment against second attack. This deficiency can be minimized by providing connectors between the panels.

3.4.4.3.4. **Limitations/Special Considerations.** Concrete revetments are limited by the resources necessary to fabricate and deploy them. Because it takes a lot of time to make them, their use as an expedient measure requires that they be prefabricated in peacetime before a disaster threatens or during an extended buildup phase before hostilities begin. Cranes and forklifts are required to position them. Modular, prefabricated revetments must be placed on a relatively smooth base (graded and compacted). Bermed concrete revetments have fairly large space requirements and other limitations associated with soil berms or bermed walls. The geometry of the aircraft revetment does not allow for turns and corners in the layout of an array of revetments. The base of Bitburg revetments has corners mitered at 45 degrees that allow for such turns and corners, but these corners are vulnerable to fragment penetration because the wall thicknesses of the two revetments just meet and do not lap. These corners should be protected with sandbags when time permits. The Bitburg revetment can be used to protect assets less than 6 feet in height.

3.4.4.4. **Bin Revetments.** Bin revetments refer to hardening methods used to create vertical walls of soil, gravel, or rock rubble. **Figure 3.16.** shows the features of a generic bin revetment. Such systems are employed in the same way as soil berms, but combine the protective qualities of soil structures with efficient use of space. The thickness of the geologic medium is the primary means of providing protection. The wall structure consists of panels to confine the soil or rock plus a structure to hold the panels in place. Spacers hold the walls apart at specified distances while ties keep the walls from separating under the soil load. In some bins, these functions are performed by the structure itself. A weather cover keeps the soil fill dry.

Figure 3.16. Double Wall Bin Revetment.



3.4.4.4.1. **Types of Bin Revetments.** There are many variations and life spans to soil bins. Some are permanent while others have only a limited life. Two types of soil bins are B-1 steel bins and HESCO barrier revetments (**Figure 3.17.** and **Figure 3.18.**).

3.4.4.4.2. **Threat Protection.** Bin revetments provide essentially the same protection as other earth walls. They can also be used to deny line-of-sight to doors and other vulnerable openings. Two of the more important factors in determining the total effectiveness of a revetment system are the height of the revetment compared to the resource it is protecting and the configuration of the revetment around the resource.

Figure 3.17. Engineers Erecting Steel Bin Revetment Kits.

Figure 3.18. Engineers Fill HESCO Barrier Revetment With Soil.

3.4.4.4.3. **Multiple-Attack Protection.** Multiple-attack protection is tied to the durability and resistance of the structural system containing the geologic material. Once fragment damage destroys the confining system, little second attack protection is provided since the bin revetment is reduced to rubble and acts only as a small breastwork. Bin revetments using steel or reinforced concrete confining systems provide good second attack protection.

3.4.4.4.4. **Limitation/Special Considerations.** Soil bin revetments generally require significant construction resources. If built of expedient materials, they tend to be temporary measures. Constructed of reinforced concrete or masonry, they are usually part of permanent upgrades or new facility construction.

3.4.4.5. **Sand Grids.** Sand grids were originally developed as a soil-confining system for use in roadway construction over loose soils. Testing has demonstrated that sand grids are also an effective and versatile method of providing expedient hardening. Sand grids are essentially soil structures and are similar to soil berms and sandbags in their use. The principal advantages of using sand grids over soil berms are ease of construction, reduced space requirements, and fewer erosion problems. Sand grids are prefabricated plastic forms shaped like cells of a honeycomb (**Figure 3.19.**) and filled with granular material such as sand, gravel, or other soil (**Figure 3.20.**). The sand grid form is available in a standard configuration or a newer, notched configuration. The notched configuration allows for development of a lapped joint between layers that prevents leakage of the fill material. Currently available sand grids are 38 inches wide in place. Sand grids are durable and will not rot.

3.4.4.5.1. **Threat Protection.** Sand grids can provide efficient and effective protection against near-miss general-purpose bombs, high-explosive artillery rounds, shoulder-launched rockets, and machine gun fire. Sand grids are very effective in protecting semi-hardened walls from near-miss general-purpose bomb fragments and air blast.

Figure 3.19. Sand Grid Form.

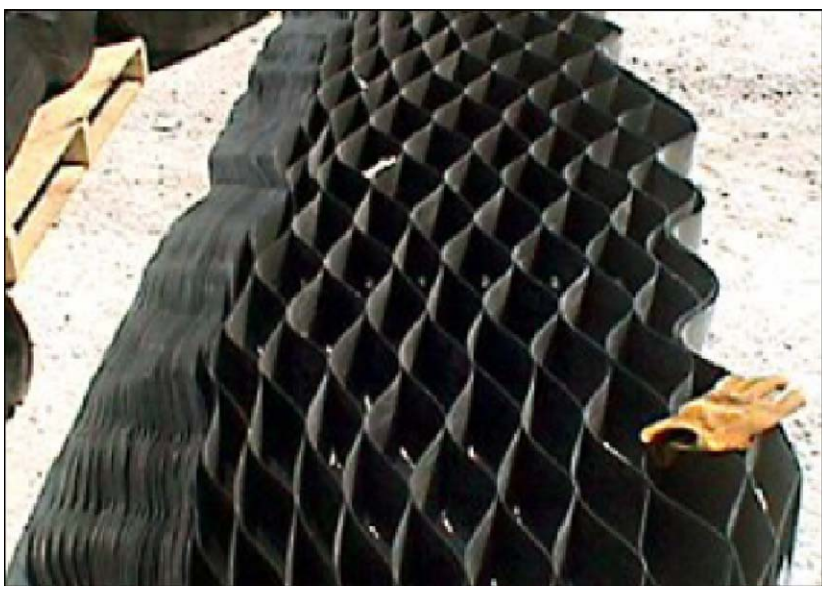


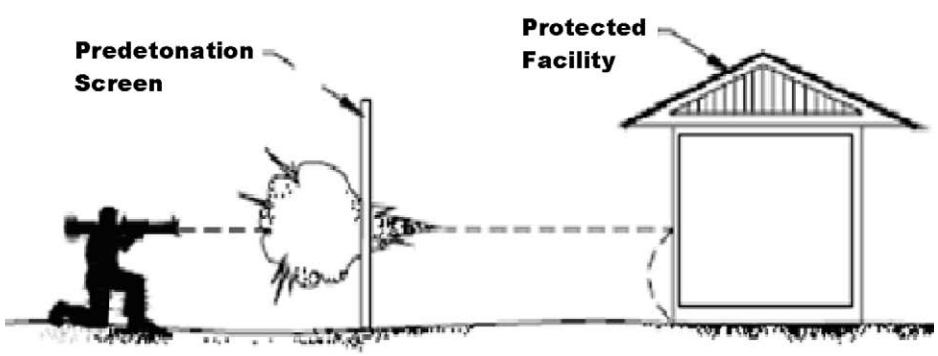
Figure 3.20. Gravel-Filled Sand Grid.

3.4.4.5.2. **Multiple-Attack Protection.** Sand grid revetments provide limited second attack protection from near-miss general-purpose bombs. In other applications against less severe threats, such as near-miss high-explosive artillery rounds, sand grid revetments provide excellent second attack protection. As overhead protection, sand grids provide limited second attack protection against direct-hit mortar and high-explosive artillery but can be repaired with loose soil or sand bags.

3.4.4.5.3. **Limitations/Special Considerations.** Perforations in the face of the sand grid cause spilling of fill material from damaged cells. The fill material used in unnotched sand grids is susceptible to washing by rains unless a sheet material (fabric or plastic) is placed between layers. The notched grid is not susceptible to rain damage. The maximum free-standing height for use as a protective structure against conventional weapons is about 8 feet. The grid also requires significant amounts of fill.

3.4.4.6. **Predetonation Screens.** Predetonation screens are erected in front of a facility or fighting position to detonate an incoming antitank weapon at a standoff distance (**Figure 3.21.**). In doing so, screens may supplement the protection inherent in the protected structure or position and reduce structure damage. The screen can be constructed of wood, fencing, etc. It is usually constructed between 10 to 40 feet from the structures it is intended to protect. Although pre-detonation screens may could damage the fuse on the weapon, causing it to dud, structures being protected must still be capable of defeating the kinetic energy of the fired round. For additional information on constructing and siting pre-detonation screens, refer to UFC 4-020-03FA, *Security Engineering: Final Design*.

Figure 3.21. Predetonation Screen.



3.4.4.7. **Unconventional Hardening.** In extreme, time-critical situations, none of the previously discussed hardening methods may be suitable, and hardening by unconventional means may be considered. For example, under threat of a terrorist attack or similar emergency, pseudo revetments can be set up using dump trucks, buses, bulldozers, or other heavy equipment to act as a shield for high-value or mission-critical base assets. Obviously, one must weigh the risk involved versus the possible destruction of the equipment used as a shield. The point is: do not overlook any technique simply because it is not one of the "standard" hardening methods.

3.4.5. **Summary.** As you can see, expedient hardening includes standard and non-standard hardening techniques. Improvisation is often required to compensate for the lack of traditional construction materials or specialized equipment. Use expedient methods to take advantage of available local materials and terrain features. AFH 10-222, Volume 14, and the *Joint Forward Operations Base (JFOB) Force Protection Handbook*, provide methods to select and construct expedient hardening measures. These methods are suitable for expeditionary operations and are effective against a wide range of air base threats. Most methods require only a simple analysis and plan. Unit personnel with minimal training can accomplish expedient hardening. Recognize that the most effective hardening measures may not be best to employ under every situation. Consider factors such as the estimated construction time, manpower and equipment availability, life-span requirement, and availability of materials. Implement specific actions based on these considerations and the decision of the senior Air Force commander. For more information on specific hardening criteria and procedures, refer to the references in **Table 3.4.**

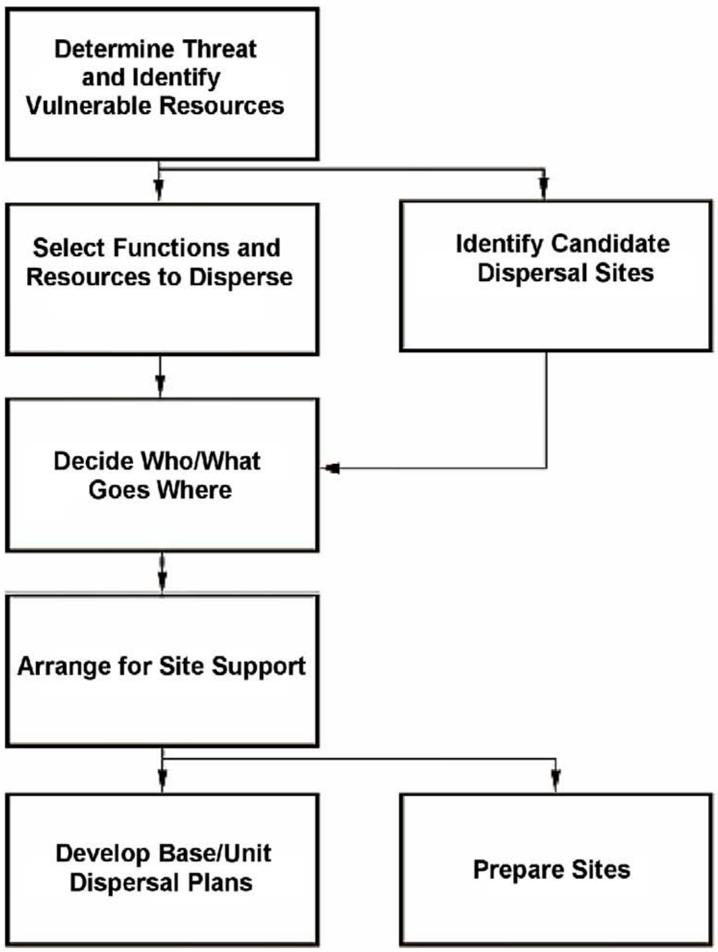
Table 3.4. Hardening References.

Other Facility Hardening References
AFH 10-222, Volume 3, *Guide to Civil Engineer Force Protection.*
AFH 10-222, Volume 14, *Guide to Fighting Positions, Obstacles, and Revetments.*
AFMAN 10-2602, *Nuclear, Biological, Chemical, and Conventional (NBCC) Defense Operations and Standards.*
UFC 4-010-01, DOD *Minimum Antiterrorism Standards for Buildings*.
Joint Forward Operations Base (JFOB) Force Protection Handbook (to be replaced by UFC 4-027-01, *Design of Deployed Operational Bases to Mitigate Terrorist Attacks).*

3.5. Dispersal. Dispersal is the separation or relocation of resources, preferably away from a threat or pending disaster, for the purpose of increasing survivability. Dispersal has a role at CONUS, overseas, permanent, and bare bases. Dispersal can be incorporated into everyday installation operations through intelligent facility siting. Usually, however, dispersal is viewed as an expedient measure to protect important installation resources from a pending disaster or wartime threat by temporarily relocating them. Include dispersal plans in the CEMP 10-2, In-Garrison Expeditionary Site Plans (IGESP), and Expeditionary Site Plans (ESP).

3.5.1. **Planning and Preparing for Dispersal.** Effective temporary dispersal depends upon the circumstance dictating dispersal and the location where resources are dispersed. For example, dispersing personnel and equipment into a wooded area prior to a hurricane could cause greater injury and damage from falling branches and trees than if the resources remained in the open. However, the same action prior to a hostile attack could save lives and protect equipment by removing them from likely target areas and providing concealment from enemy forces. As discussed in this volume, seven steps are involved in planning and preparing for resource dispersal. Those steps are outlined in **Figure 3.22.** and discussed below. Because dispersal is an installation-wide effort, all units should provide inputs to each step.

Figure 3.22. Dispersal Planning and Preparation Flowchart.



3.5.1.1. **Determine the Threats and Identify Vulnerable Resources.** As used here, a threat can be a man-made or natural disaster as well as an enemy attack. Each installation must decide what threats it faces and which resources are vulnerable for each threat.

3.5.1.2. **Identify What Resources and Functions Should Be Dispersed.** Usually, these are the high-value or critical mission and support assets that are not protected by other measures. Each unit should identify key resources to disperse for each threat and outline the priority in which they should be dispersed. The major consideration is usually how important a resource is towards continuing or reestablishing the base mission or recovery effort. Personnel should be high on the list if there are not shelters for everyone. No two bases have exactly the same requirements; therefore, each base should carefully evaluate needs and assign dispersal priorities.

3.5.1.3. **Select Candidate Dispersal Sites.** Dispersal sites that are to be used during hostile attacks should be located away from the high-threat areas of the installation and provide concealment and protection from attacking forces. Look for multiple dispersal sites to increase resource survivability. Select sites on base, or convenient to it, with at least two access routes. Choose sites that provide good natural cover and concealment, and avoid open areas. Pick sites which need the least amount of advance preparation. Sites with in-place facilities, utilities, and communications are ideal if they are not easily identified as targets in their own right. Avoid recommending sites where radio contact with the base cannot be established. Ideally, each site should have pavement for parking vehicles or the soil should be capable of supporting fully loaded, wheeled vehicles during wet weather. Adequate security is needed for sites with mission-critical or high-value items. Some examples of areas to consider as possible dispersal locations are discussed in the following paragraphs

3.5.1.3.1. **Aircraft Hangars.** Under certain conditions, such as a hurricane evacuation or flying unit deployment, base aircraft are relocated to other installations. At such times, you may be able to use these facilities for dispersal and protection of some equipment. If hangar doors are opened electrically, be sure there are alternative procedures to open them during power outages. Keep in mind that hangars may be a target during wartime.

3.5.1.3.2. **Munitions Storage Areas.** Some installations have abandoned or unused munitions storage facilities that are ideal dispersal points for resources. These structures are usually hardened and provide substantial protection from the destructive effects of a major disaster. Special arrangements may have to be made if hardened structures interfere with radio communications. In peacetime, munitions bunkers can shield vehicles and equipment from the effects of high winds if the vehicles and equipment are placed close enough.

3.5.1.3.3. **Base Housing.** When hostilities are expected in overseas areas, military dependents will be relocated stateside, time permitting. Vacant base housing units can then be used as dispersal areas for personnel as well as beddown facilities for incoming forces.

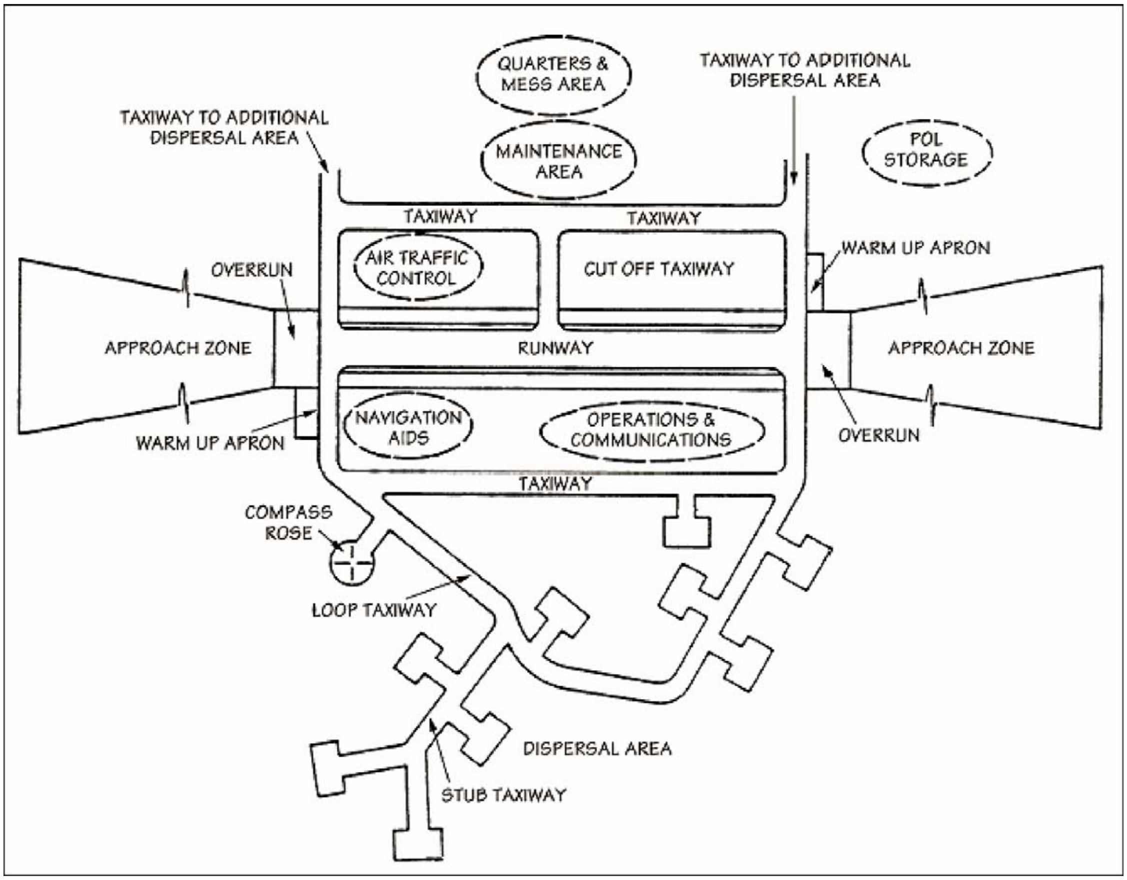
3.5.1.3.4. **Off-Base Warehouses and Storage Facilities.** Depending on the location, civilian warehouses or other storage facilities near the installation may be rented as temporary dispersal locations during an emergency. Railheads and port facilities in the vicinity of the installation make good dispersal facilities, but they may also be targets.

3.5.1.3.5. **Recreation Halls/Gymnasiums.** Large base structures such as recreation halls and gymnasiums could be used during emergencies as temporary dispersal points or emergency shelters for personnel. Facilities of this type should be evaluated carefully to ensure that they provide adequate protection from the anticipated threat.

3.5.1.4. **Dispersed Base Layout and Pattern.** **Figure 3.23.** shows a conceptual base layout and dispersal pattern. Base planners should consider these concepts when siting facilities or selecting dispersal sites.

3.5.1.4.1. **Aircraft.** When aircraft are not sheltered or revetted, random dispersal of parked aircraft increases their survivability during an attack. When attacked by aircraft dropping general purpose bombs, the survivability rate increases from two to four times when aircraft usually parked at 50-foot separations are dispersed to irregular parking with minimum separations of 300 feet. An aircraft dispersal plan should consider operational requirements, maintenance, installation security, existing parking areas, and the availability of real estate for additional aircraft parking.

Figure 3.23. Dispersed Base Layout.



3.5.1.4.2. **Generators.** Base power generating plants should be located in a minimum of two separate areas. Where there are several individual generators at each location, they should be positioned with adequate separation or revetting between each unit to provide maximum survivability.

3.5.1.4.3. **Munitions.** Accidental or deliberate detonation of stored munitions is reduced by maximum separation between explosives and other resources. Explosives should be dispersed into small compatible groups. Ammunition should not be located near an installation perimeter where exposed ammunition could easily be damaged by small arms fire. Consider splitting key storage or other munitions operations into sub-operations.

3.5.1.4.4. **Petroleum, Oils, Lubricants (POL).** Fuel should not be stored on the perimeter of an area where it could easily be damaged by small arms.

3.5.1.4.5. **Vehicles and Heavy Equipment.** Motor vehicles should not be pooled. Parking motor vehicles under or beside trees, next to earthen embankments, or behind buildings (**Figure 3.24.**) provides partial concealment as well as dispersal. The “harder” the structure—the better, but not if that structure is likely to be targeted by the enemy.

Figure 3.24. Dispersing Key Equipment Behind Buildings.

3.5.1.5. **Decide Who and What Goes to Each Dispersal Site.** When deciding where to disperse specific assets or functions, consider factors such as resource priority, distance to dispersal sites, how hard a resource is to move, and how much advance warning time is likely. Split capabilities and do not cluster vital assets. Do not concentrate personnel with the same specialty in one spot. Likewise, do not put all equipment, vehicles, and response teams of the same type in one place. If possible, keep dispersed personnel within easy walking distance of their equipment; this improves the success of the dispersal. Airfield damage repair (ADR) equipment and materials should be dispersed to at least three separate sites. When selecting dispersed shelters for damage assessment response teams (DARTs), ensure each team is able to maintain communications with the DCC either by land line or radio. Maintain team integrity of DARTs; however, do not place more than one team in the same dispersed location. This action provides a degree of redundancy in the event one or more of the shelters is hit. If there is a choice of shelters for the DARTs, choose shelters that are closest to the DCC. This eases the reassembly of the teams and subsequent flow of information to the teams from the DCC. Try not to overload a dispersal site.

3.5.1.6. **Arrange for Support Needed at Each Site.** Selected services, facilities, utilities, and communications may be required at dispersal sites under certain circumstances. However, planners should attempt to minimize the amount of centralized support required at each site; none is the ideal. Units and individuals should provide their own support whenever possible. Each person can carry his or her own sleeping bag, food, water, and cold weather gear. Work details can be formed from each dispersed unit to provide services such as obtaining water, digging latrines, erecting tents, removing refuse, and operating the contamination control area (CCA). Identify and consider resources normally available at the site or in the nearby area. Provide only limited support in the short term—enough for survival. Increase support as the duration of the dispersal increases. Each installation must determine its own priorities for providing this support. As a minimum, consider the following items and provide for them in dispersal plans.

3.5.1.6.1. **Shelters or Tents.** Personnel can sleep in or under vehicles for a day or two if required. Facilities may be required to shelter personnel from the elements, especially if personnel must disperse frequently or for extended periods. Units may transport and erect their own tents, if available.

3.5.1.6.2. **Sleeping Bags, Blankets, and Cots.** Individuals should carry their own sleeping bags; blankets can substitute for sleeping bags. If not already issued when the dispersal order is given, make arrangements to have these items pulled from unit mobility gear storage area, or base supply, and delivered to the dispersal site. This especially applies when dispersing during cold weather or for long durations. Cots are a nice-to-have item for frequent or long-term dispersals.

3.5.1.6.3. **Food.** Individuals should carry enough Meals, Ready to Eat (MREs) to last a couple of days; if necessary, units can carry more MREs for longer periods. Explore food service options with the services squadron if dispersing for more than seven days.

3.5.1.6.4. **Water.** Individuals should disperse with full canteens or bottled water. Water must be available at the dispersal sites or arrangements made to deliver it after two days. Treating a nearby water source is an option if equipment is available.

3.5.1.6.5. **Electrical Power.** Arrange for generator power and limited distribution for the few dispersed functions that may need power.

3.5.1.6.6. **Fuel Storage and Dispensing (Vehicle and Heating Fuels).** If the dispersal site is not near the installation, some capability to refuel vehicles and provide heating fuels may be necessary. A small refueling truck from base supply is one option. That same truck could also be used to provide fuel to expedient storage and dispensing points at more than one dispersal site. Bladders, and even 55-gallon drums, can be used to store or transport fuel. Even at dispersal sites, fuels must be stored away from shelters and other resources to minimize the explosive hazard.

3.5.1.6.7. **Sanitation (Latrines and Refuse Collection).** Each site must provide a way to collect and dispose of human and solid waste to prevent a public health problem. Expedient latrines are sufficient for human waste. Generally, a refuse pit periodically covered with a layer of soil is sufficient for solid waste.

3.5.1.6.8. **Vehicle Maintenance.** If necessary, request that the transportation squadron provide a maintenance capability at the dispersal site, or place a mobile maintenance truck on standby. Do not forget to make spare parts available for key equipment. If maintenance and repair procedures are unique, consider taking maintenance technical orders for special equipment.

3.5.1.6.9. **Communications With Dispersed Forces.** Skilled personnel, critical equipment, and valuable materials are not normally dispersed to an area and left to operate on their own. To effectively use these forces, command personnel must maintain communications with dispersal sites. Dispersed forces must be kept informed of conditions at the base and kept ready to respond. If a dispersal site is permanently established, consider installing a land line telephone or making cellular phones available to stay in contact with the base. At sites where a telephone connection is not feasible or when telephones are inoperative, a radio network can be used. Other communications measures that may be employed include runners, signal flags, and signal lights. Any communication method used is appropriate so long as the message received is the same as the one sent. If signals are used, their meanings must be prearranged and simple. If necessary, use intermediate locations to relay messages; another dispersal site that is closer to the main base could serve this function. When making plans, the base must decide who maintains contact with the dispersed forces: the installation control center (ICC), the emergency operations center (EOC), or unit control centers (UCC) for their own personnel. For multiple on-base sites, UCCs can generally perform a better job. At off-base sites with multiple organizations, the ICC or the EOC may elect to maintain communications and provide direction.

3.5.1.6.10. **Transportation.** Decisions must be made as to how personnel, vehicles, and equipment will be moved. This can be a unit responsibility, a consolidated base effort, or a combination. For extended dispersals prior to hostilities, units may use their own vehicles to transport personnel and equipment as required. Base shuttles may be set up to run scheduled routes for long-term dispersals.

3.5.1.6.11. **Contamination Control Area (CCA) Operations.** In a CBRN environment, dispersal sites should be in toxic-free areas if possible. To process personnel, vehicles, and equipment into and out of the dispersal site, a contamination control area and a vehicle/equipment decontamination station must be set up, manned, and operated. The responsibility for these tasks can be assigned to one unit permanently, to all units on a rotation, or to CCA teams formed by detailing individuals from the different units at the site. For around-the-clock operations, at least two—preferably three—CCA teams are required. Decide who will set up the CCA and who will supervise the CCA teams. See AFMAN 32-4005, *Personnel Protection and Attack Actions,* (until rescinded by AFMAN 10-2502 Series publications) for tips on CCA set up. Plans should specify who will obtain, store, and maintain CCA equipment and materials.

3.5.1.6.12. **Security.** At on-base sites, units should expect to provide security for their own assets. This does not mean the assets have to be guarded on a full-time basis; each installation and situation is different. Civil engineers should work out details with the security forces. When off base at overseas locations, additional security is required. Depending upon the location, the civilian countryside surrounding an overseas air base may be relatively peaceful or extremely hostile. Even during peacetime dispersals, security remains an important consideration. Resources available from base security forces, US Army units, or host nation security forces determine the level of protection available to dispersed assets. Civil engineers and other units at the dispersal site may be called upon to assist the security forces.

3.5.1.7. **Develop the Base and Unit Dispersal Plans.** The base plan provides the big picture, such as what units disperse and where. The unit dispersal plans identify what specific resources and which personnel disperse and how dispersal is accomplished.

3.5.1.7.1. **Base Dispersal.** The base dispersal plan should detail which units disperse, where each goes, under what conditions dispersal will be necessary, the priority of the resources, who provides what support, and the command and control structure. When more than one unit is dispersed to the same location, the plan may outline which part of the site each unit occupies. However, do not expect this level of detail very often. The plan should clearly outline the command and control structure, especially for off-base sites, to control the initial chaos and to direct site operations during extended stays. It is reasonable to expect that the senior ranking person will be in charge. The plan could also designate a lead unit and the senior person of that unit to be in charge. Civil engineers should be prepared to offer recommendations to the senior leader with regard to “facility” siting, utilities, sanitation, hardening, and CCA operations. Do not discuss locations of off-base wartime dispersal sites. Keeping them a secret may be impossible, but do not draw attention to them. Have enough alternate sites established so you can keep an enemy guessing where the actual dispersal site is located. When dispersal plans are exercised, alternate deployments between each site to avoid tipping off which site is favored among all locations. If dispersal plans are to another installation or location far from the home base, convoys or other mass transportation efforts will have to be planned.

3.5.1.7.2. **Unit Dispersal.** The unit plan provides the specifics. It should identify personnel, equipment, and vehicles to disperse, in what priority order, and to what location. Specify who moves which vehicles and equipment items, and designate where repair materials will be located. The methods of dispersal are generally determined by the distance to the dispersal site. Powered equipment may be driven to dispersal sites on base; other equipment may be transported by truck or similar vehicle, or personnel may physically carry smaller pieces of equipment and materials. To the greatest extent possible, disperse resources by teams.

3.5.1.7.2.1. Create dispersal checklists and load plans. The checklists should include items such as obtaining food, water, sleeping bags, chemical warfare ensembles, tents, camouflage netting, hand tools, shovels, picks, sandbags, and extra consumables (oil, grease, hydraulic fluid, air filters, etc.) and servicing vehicles (fuel, engine oil, air in tires, jacks, spare tires, etc.). The load plans should identify what items are to be loaded on each vehicle. Load plans minimize confusion and ensure the most important assets are moved first.

3.5.1.7.2.2. If possible, inspect designated dispersal sites in advance. Determine what site improvements are required before and after dispersal. Decide what support items should be taken and estimate how much.

3.5.1.7.2.3. Perform operational checks and service equipment before dispersal. To save time later, load vehicles with repair materials likely needed early on during base recovery.

3.5.1.7.2.4. When preparing for enemy attack, disperse at night, if possible. This concealment is especially important in the desert where dust from moving vehicles can reveal activity and your position. Be sure to cover vehicle tracks to and from a dispersal area.

3.5.1.7.2.5. When dispersed, use natural and man-made features to hide assets. Park vehicles close to buildings and in shadows. Do not position assets in open areas or in straight lines where a single bomb or strafing run can destroy many assets. Attempt to position priority vehicles where they are easily accessible to avoid moving other assets to get to them. Position assets to allow the observation of personnel and equipment on either side of them.

3.5.1.8. **Enhancing Dispersal Sites.** This is the last step. With proper site selection and limited site support, advance preparations can be eliminated or minimized. However, units can make good use of their time after dispersal by improving such things as shelters, facility hardening, and fighting positions at their dispersal sites (**Figure 3.25.**).

Figure 3.25. Airmen Use Sandbags to Enhance Shelter Survivability.

3.5.2. **Hasty Planning and Preparations.** Ideally, dispersal planning is accomplished during the leisure of peacetime, but not every contingency can be foreseen. If the unit only has time for hasty planning, the common sense steps outlined above still apply. Just do not labor over the options. Quickly decide which of your resources are most important to protect and go with the most obvious. From personal knowledge of the installation and the surrounding area, determine which sites are best for dispersal. Decide how to move the resources and who will do it. Determine what communication methods will be used to keep all unit personnel informed, and ensure all personnel understand how this is to be accomplished when dispatched. Ideally, each vehicle group traveling between the installation and a dispersal site should have at least one working radio.

3.5.3. **CONUS CE Dispersal Guidance.** The primary purpose of dispersal in CONUS is to escape the destruction of natural disasters and to get personnel and priority assets out of harms way. Some installations may support a survival, recovery, and reconstitution (SRR) plan which calls for dispersal.

3.5.3.1. **On-Base Dispersal.** When establishing CONUS on-base dispersal sites, resources should be identified for pre-positioning at the locations to save time during dispersal. Materials that do not have a critical shelf life, such as sand, gravel, and other building items, are good candidates for pre-positioned dispersal. A remote fuel storage facility at the dispersal location ensures that dispersal force vehicles can continue to operate if main fuel storage facilities are damaged or destroyed. If personnel are relocated to the dispersal site for an extended period of time, utilities, billeting, and food service will be required.

3.5.3.2. **Dispersal to Other Military Installations.** If the civil engineer unit is required to disperse resources to another installation during an emergency, numerous details must be considered. Transportation arrangements are a primary concern. When reasonable distances are involved, a truck convoy may constitute the best method. Qualified personnel should supervise the loading and movement of the convoy. Seemingly insignificant details overlooked during transportation planning have a tendency to become large problems during convoy movements. During disasters, as in war, transportation routes tend to become overloaded with military and civilian traffic. Sound convoy procedures should be followed. Close coordination with the receiving installation is essential. The BCE should appoint an experienced person to coordinate billeting and food service support upon arrival at the receiving installation. Communications capabilities should also be assessed to ensure that contact can be maintained with the dispersing force throughout the movement and subsequent stay at the dispersal site.

3.5.3.3. **Dispersal to Civilian Locations.** If a situation arises where this type of dispersal becomes necessary under peacetime conditions, the BCE must ensure that close coordination is established with local property owners and civilian government officials. Approval of the property owner must be obtained, and civil engineer personnel must carefully document any property damage that occurs as a result of the dispersal. This documentation greatly facilitates the handling of any claims for reimbursement following the dispersal. If civilian dispersal locations are a reasonable alternative for a CONUS BCE during a peacetime emergency, consider negotiating prior use or rental agreements with civilian property owners or local community officials. Dispersal to civilian locations should only be done after careful consideration of on-base and other military base alternatives.

3.5.3.4. **Dispersal During Survival, Recovery, and Reconstitution (SRR) Plan Implementation.** The SRR plan is intended to improve survival and enhance recovery and reconstitution operations for CONUS air force installations under threat of nuclear attack. Not all CONUS civil engineer units have responsibilities under an SRR plan. For those installations that do, the BCE and staff should carefully review the local SRR plan to determine specific actions required during implementation. The general SRR concept of operations during various attack phases follows.

3.5.3.4.1. **Attack Preparation Period.** If responsibilities have been previously identified, civil engineer forces may be deployed to dispersal installations to support beddown of other dispersed forces. Additionally, the BCE should send key personnel and equipment to safe locations away from likely target areas so that they are available for recovery operations at their home installation or at a regroup installation following the attack.

3.5.3.4.2. **Attack Response Period.** Assuming they are not under direct attack, the activities of the dispersed force during this time are concentrated on keeping critical facilities and utilities in operation, supporting the deployed force, and maintaining the capability to support the attack recovery mission. Civil engineer personnel may be required to operate emergency electrical generators, isolate utilities, and provide other emergency engineer services.

3.5.3.4.3. **Attack Recovery Period.** During this phase, dispersed civil engineer resources can be most valuable. These assets may be the only military resources capable of restoring remaining installations to an operational status. Reconstitution bases will be designated, and the dispersed forces will likely be called upon to make any expedient repairs required to accept and beddown forces deployed or recovering to those installations. The type of work expected from dispersed forces at this time could range from debris clearance and airfield damage repairs to construction of a tent city.

3.5.3.4.4. **Civil Resource Requirements.** Emergency contractual support and materials will be required from local sources for rehabilitation of damaged installations or conversion of civilian airstrips for military use. For installations with an SRR responsibility, civil engineer resource requirements should be identified and local sources listed for each dispersal or reconstitution base contemplated for SRR operations. It should be assumed that during wartime conditions these resources would be available through emergency requisition.

3.5.4. **Overseas CE Dispersal Guidance.** An overseas civil engineer uses dispersal as a means of resource protection for many of the same reasons as a CONUS BCE. In addition, the overseas civil engineer should consider dispersal as a means of protecting resources from CBRNE attacks. Forces at an overseas air base might be dispersed to a remote location on base, to a collocated operating base (COB), or to a civilian location.

3.5.4.1. **On-Base Dispersal Locations.** Overseas civil engineers, like their CONUS counterparts, should select locations on the main base which provide optimum protection against any foreseeable disaster. An area of difference is protection against CBRNE attacks. The overseas air base is more vulnerable to a CBRNE attack than a CONUS location; therefore, emphasis should be given to selecting multiple dispersal sites removed from the likely target areas of the installation. Dispersal locations removed from prime air base target areas (such as runways, command and control centers, POL facilities, and munitions storage areas) contribute to the preservation of resources during an attack. Once these sites have been identified, develop physical protection methods for each location as further resource protection. Fire Emergency Services (FES) should be located in close proximity to the operational infrastructure and should be given special consideration for dispersal locations, concealment, and physical protection.

3.5.4.2. **COB Dispersal Locations.** A COB is an allied installation that can be used to beddown augmenting forces. Close coordination with the host installation agencies is a primary requirement during any dispersal to a COB. An important aspect of dispersal to a COB is the cultural, procedural, and language differences that civil engineer personnel must overcome.

3.5.4.3. **Dispersal to Civilian Locations.** Dispersal to a civilian location in an overseas environment is much more complicated than it would be in a CONUS area. The laws of each country differ, and there may be no existing status-of-forces agreements for obtaining rights to use local property as a dispersal site. Again, the base must evaluate needs and determine if off-base dispersal sites would serve a useful purpose. If these sites are determined to be necessary, discuss the possibility of negotiated agreements with the base legal staff, your MAJCOM, and representatives of the host government. Negotiations with foreign property owners are best left to members of the host government.

3.5.5. **Summary.** Temporary dispersal is a relatively inexpensive and expedient method to protect important installation assets from the effects of disasters and enemy attack, but some advance warning is required to mobilize personnel and assets. The value of wartime dispersal can be improved by employing supplemental protection and hardening measures. For information on specific dispersal criteria and procedures, refer to the reference documents in **Table 3.5.**

Table 3.5. Dispersal References.

Other Dispersal References
AFPAM 10-219, Volume 3, *Postattack and Postdisaster Procedures.*
AFPAM 10-219, Volume 5, *Bare Base Conceptual Planning Guide.*
AFH 10-222, Volume 1, *Guide to Bare Base Development.*
AFH 10-222, Volume 3, *Guide to Civil Engineer Force Protection.*
AFMAN 10-2602, *Nuclear, Biological, Chemical, and Conventional (NBCC) Defense Operations and Standards.*
UFC 3-260-01, *Airfield and Heliport Planning and Design.*
UFC 3-340-01, *Design and Analysis of Hardened Structures to Conventional Weapons Effects.*
UFC 4-010-01, DOD *Minimum Antiterrorism Standards for Buildings*.
Joint Forward Operations Base (JFOB) Force Protection Handbook (to be replaced by UFC 4-027-01, *Design of Deployed Operational Bases to Mitigate Terrorist Attacks).*

3.6. Antiterrorism Measures. Antiterrorism measures help ensure adequate protection of personnel and assets critical to air base operations. Although, the installation Force Protection Working Group (FPWG) or Antiterrorism Officer (ATO) identifies appropriate force protection and antiterrorism requirements, civil engineers also play an important role in the planning, design, and development of antiterrorism and force protection measures. For more specific actions to increase a facility's physical and passive protection against terrorist activities, see AFI 10-245, *Air Force Antiterrorism (AT) Standards*, and the reference documents listed in **Table 3.6.**

Table 3.6. Antiterrorism References.

Other Antiterrorism References
AFPAM 10-219, Volume 3, *Postattack and Postdisaster Procedures.*
AFH 10-222, Volume 3, *Guide to Civil Engineer Force Protection.*
AFH 10-222, Volume 14, *Guide to Fighting Positions, Obstacles, and Revetments.*
UFC 4-010-01, *DOD Minimum Antiterrorism Standards for Buildings.*
UFC 4-021-01, *Design and O&M: Mass Notification Systems.*
UFC 4-022-01, *Entry Control Facilities/Access Control Points.*
Joint Forward Operations Base (JFOB) Force Protection Handbook (1 May 2008) (to be replaced by UFC 4-027-01, *Design of Deployed Operational Bases to Mitigate Terrorist Attacks).*

3.7. CBRN Passive Defensive Measures. If an adversary succeeds in launching a CBRN attack and active defense measures fail to eliminate the delivery vehicle and/or weapons, passive defense will be essential. Civil engineers play a prominent role in CBRN passive defense. Passive defensive measures are designed to improve the capability of personnel to survive and sustain operations in CBRN environments and are organized into four capability areas: *sense*, *shape*, *shield*, and *sustain.*

3.7.1. **Sense.** Sense activities provide commanders with up-to-date information on CBRN threats by detecting, identifying, and qualifying/quantifying hazards. Obtaining this information requires accurate assessments in a number of areas to include sampling, detection, and identification. CBRN detection, sampling, and identification are multifaceted and multifunctional operations and include CBRN point and standoff detection systems; medical, food, and water surveillance; and attack preparation and Post Attack Reconnaissance (PAR) for unexploded explosive ordnance by unit and installation PAR teams. Point detection systems continue to improve and incorporate rapid identification capabilities. Epidemiological surveillance conducted by public health and medical personnel also contributes to detecting biological weapons exposure, low-level chemical agent exposure (below current instrument detection levels), and radiation exposure. Airmen also serve as a key component of the sensing architecture. They should be trained to sense indications of impending or actual CBRN attacks, report those indications, and take the immediate and prudent actions necessary to protect themselves and mission resources.

3.7.2. **Shape.** Shaping is the characterization of CBRN hazards to accurately describe the current and future operational picture to the commander. Passive defense activities that allow a commander to shape the operational environment include CBRN effects predictions, meteorological condition assessments, gaining situational awareness and predicting future events, establishing protected beddown locations to mitigate CBRN effects, and identifying health risks to ensure a fit and healthy fighting force. Intelligence, civil engineering, and weather experts provide predictions on the nature of the threat. For meteorological condition assessments, weather experts supply information on terrain, weather conditions, and other meteorological data, while CE readiness CBRN experts provide accurate predictions about the type of agent, release point, and the plume (footprint of the contaminated area).

3.7.3. **Shield.** Shielding includes protecting forces from harmful effects and hazards of CBRN threats. Shielding may be accomplished through activities to prevent, mitigate, and minimize CBRN exposure effects (including the administration of vaccines and prophylaxis) or through contamination avoidance to prevent or reduce exposures. Passive defense activities which allow a commander to shield warfighting forces include disease and casualty prevention, contamination avoidance, contamination control, and protective countermeasures. Disease and casualty prevention includes steps taken to prevent casualties before attack and to minimize casualties after a CBRN attack. Contamination avoidance includes actions taken to minimize the impact of CBRN attacks by eliminating exposure to contamination. While operating in a CBRN environment, contamination control prevents secondary transfer of disease and chemical, biological or radiological material and/or re-aerosolization of an agent. Contamination control includes avoiding, reducing, removing, or rendering harmless the hazards from CBRN contamination.

3.7.4. **Sustain.** Sustainment activities enable the commander to sustain operations or facilitate the return to operational capability as soon as possible. These activities include identifying hazardous areas through PAR, notifying personnel, and decontaminating and managing casualties, as needed. Decontamination and health risk assessments are important first steps toward a return to operational capability. Effective decontamination operations help sustain or enhance the flow of operations by preventing or minimizing performance degradation, casualties, or loss of material (**Figure 3.26.**).

Figure 3.26. Effective Decontamination Prevents Casualties.

3.7.5. **Other Passive Defensive Measures.** Installation CBRN defense actions should focus on attack detection and warning, protection, and mitigation of specific threats and threat weapon systems. Although not all inclusive, **Table 3.7.** list a few examples of passive defensive measures that installations may take. See Air Force Doctrine Document (AFDD) 2-1.8, *Counter-Chemical, Biological, Radiological, and Nuclear Operations*, and AFMAN 10-2602 (until rescinded by AFMAN 10-2502 Series publications) for more information on CBRN passive defensive measures.

Table 3.7. Typical Installation CBRN Passive Defensive Measures.

CBRN Passive Defensive Measures and Specific Actions
Review threat levels, warning signals, and alarm conditions:
Provide visual aids and current information to each unit control centers, the base population, and all assigned, attached, coalition, and host-nation forces. Develop multilingual visual aids and public address systems announcements. Include warning procedures for geographically separated units, non-combatants, and enemy prisoners of war.
Verify the operation and coverage of the installation warning system:
Verify the actual times required to notify the air base population under each warning method (base siren, public address system, radio net, and telephone). Verify the warning system is able to provide warning and notification to 100 percent of the air base population within 10 minutes.
Implement the air base zones or sector plan to support the movement of contaminated assets (people and equipment) between zones or sectors:
Identify critical attack recovery teams (explosive ordinance disposal (EOD), airfield and building damage assessment, CBRN reconnaissance, and firefighter) and sector or zone crossing procedures to facilitate quick movement in support of recovery operations. UCCs must ensure that personnel moving from contaminated zones or sectors to uncontaminated zones or sectors do not inadvertently reduce MOPP when split-MOPP operations are executed.
Review the status of planned and in-progress medical pretreatments.
Develop and implement an air base Ground Sector and CBRN zone plan:
Practice likely attack recovery scenarios with command and control elements. Ensure unit control centers understand their responsibility to maintain control of their personnel when they enter or exit contaminated areas. Provide zone or sector information or maps to each unit control center and all assigned, attached, coalition, and host-nation command and control centers.
If the previous alarm condition was Alarm Red or Black, re-evaluate the status of protective actions:

CBRN Passive Defensive Measures and Specific Actions
Replenish material expended during contamination control or decontamination operations. Redistribute material, such as IPE and nerve agent antidotes, to support priority missions or units with high usage rates. Take action to replace casualties. Review previously reported damage. Verify damage, contamination, and UXO reports were received and action is complete or under way to resolve the situation. Initiate action to collect and dispose of contaminated waste, unclaimed weapons and ammunition, and UXO that is declared safe for movement to holding areas. Prepare a written record that identifies the location of previously contaminated areas, unrecovered human remains, contaminated waste burial sites, missile and bomb craters, and unrecovered UXO.
Review the probable CBRN attack threat scenarios and actions with Security Forces, CE Readiness and Emergency Management, and intelligence personnel at each shift change.
Activate CBRN specialized teams:
Assign personnel where needed to bring teams up to 100 percent of required manning for 24-hour operations. Direct responsible units to verify team material is serviceable and operators are proficient. Conduct team drills and training to meet local proficiency standards.
Maintain watch for clandestine attack indications
Periodically remind personnel to remain observant for signs of a clandestine or suspicious activity. Provide specific information on threats, if available. Increase protection for food and water supplies. Direct units to store a 24-hour supply of Meals, Ready to Eat (MREs) in their unit area. If attacks have occurred, consider the need to use uncontaminated MREs or packaged foods and bottled water until food service supplies are checked for contamination.
Develop or implement the air base CCA plan:
Identify primary and alternate CCA on-base locations. CCA must be able to process the required percentage of the air base population over a 24-hour period.

3.8. Base Evacuation. Evacuation of personnel and key resources is often accomplished to prevent injury and minimize damage and destruction. Limited area evacuations are usually conducted for reasons such as accidents, criminal activity, terrorist attacks, and other localized incidents. However, base evacuations are large-scale relocations typically implemented for natural disasters and non-combatant evacuation operations (NEO) prior to an enemy attack. Since specific CE execution tasks for base evacuations are different for each installation, mission, situation, and location, follow instructions in the base CEMP 10-2 and CE CRP. In addition to coordinating on-base evacuation plans, general CE preparations for base evacuations include the following:

3.8.1. **Natural Disasters.** Develop unit procedures to disseminate and execute base evacuation orders and information. Also develop unit evacuation plans to include vehicle load plans.

3.8.2. **Non-Combatant Evacuation (NEO) Prior to Enemy Attack.** Develop facility use and site plans to beddown incoming non-combatant evacuees.

Chapter 4

COMMUNICATIONS SYSTEMS

4.1. Introduction. Managing and controlling information effectively are paramount in any coordinated activity—this is especially true during military and disaster response operations. Command and control centers are virtually worthless without good communications. A key part of civil engineer preparations for disaster and attack includes working with the communications squadron to ensure key communication nodes are in place and operational. These nodes include: primary and secondary installation warning systems (e.g., Giant Voice and Telephone Alerting Systems); primary and secondary crash networks; and communications nodes for the primary and alternate Installation Control Center (ICC), Emergency Operations Center (EOC), CE Damage Control Center (DCC), Base Defense Operations Center (BDOC), Fire Alarm Communications Center (FACC), and the Emergency Communications Center (consolidated dispatch) when implemented. Civil engineers also accomplish other command and control preparations such as setting up the DCC and EOC facilities and establishing manual procedures for collecting information on damage to facilities, utilities, and pavements when disruptions in installation communications and computer systems occur.

4.2. Communications Systems. Communications systems are a primary means of command and control. They are used in every aspect of C2, including planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission. Although the discussion in this section focuses on communications systems that are used in the EOC and DCC, several of the communications methods addressed here could apply to any unit control center (UCC).

4.2.1. **Emergency Operations Center (EOC).** The EOC is the C2 support element that directs, monitors, and supports the installation's actions before, during, and after an incident, attack, or disaster. The EOC updates the ICC with ongoing incident status and seeks support through the ICC when on-scene requirements surpass the installation's inherent capability. Each method of communication listed below fulfills a unique requirement, and each has its own limitations. There is no specific standard, but a well-equipped EOC will have the following:

4.2.1.1. **Telephones.** Preferably one multi-line unit is provided at each work station. Prepare a list with phone numbers of key personnel and frequently called organizations. Include counterparts for joint operations and local communities (i.e., local EOC). Remember that non-secure telephones can be monitored, and lines can be easily cut.

4.2.1.2. **Intra-Base Radios.** Radios should be capable of communicating on all frequencies associated with disaster and wartime response. These frequencies include emergency management, FES, EOD, CE, security forces, vehicle operations/dispatch, etc. Equip the radios with speakers and headsets. The headsets help reduce the noise level in the EOC while the speakers permit everyone to listen when required. Older radio systems may have only one frequency. Those radios are easily jammed and monitored. When a lot of personnel need to use one frequency, your own personnel tend to jam each other. These problems can be reduced by using the secure, multi-frequency Scope Shield II radios.

4.2.1.3. **Tactical Radios.** These radios are required to communicate with the mobile emergency operations center.

4.2.1.4. **Hot Lines.** These provide a direct line to the ICC and UCC. Hot lines are useful between functional representatives in the EOC and their UCCs. While a little slower and subject to busy signals, telephones can do this job.

4.2.1.5. **Installation Public Address System.** Access to a public address system, such as Giant Voice, gives the EOC a method to pass time-sensitive threat warning conditions to the base population, but it is one-way communication only.

4.2.1.6. **FAX Capability.** FAX machines are an increasingly useful method of quickly transmitting information. While one machine in a control center is sufficient, identify a backup machine or one that can be relocated to the EOC.

4.2.1.7. **Cellular Phones.** These phones significantly expand the communication options in the US. This area continues to improve, both in the US and overseas. They are especially useful in disaster situations.

4.2.1.8. **Field Telephones.** When nothing else is available, field phones can be a blessing. However, you must run wires between the phones, and that takes time. You will also need to protect the wires from accidental breaks especially near vehicle traffic routes. Not many installations have these phones on-hand, because other communication methods are convenient and readily available.

4.2.1.9. **Computers.** Computers facilitate the quick transfer of data and other information between the EOC, ICC, and unit control centers, significantly reducing the time and errors involved versus passing information by telephone or radio. Computers typically replace visible status charts, store additional status and damage assessment information, and eliminate the need for paper copies of damage assessment reports. Computers should be pre-loaded with installation maps, status charts, plans, checklists, etc. Maps can be loaded so the user can zoom into any location for additional detail, which is especially useful with accurately mapped utility systems. The Guardian Installation Protection Program is introducing linked computers which connect the IC to the EOC wirelessly, allowing digital photos and other real-time data from the scene to be provided to the EOC. However, wireless communications and some other uses can present firewall problems which must be worked out in advance with your local communications squadron.

4.2.1.9.1. Four conditions should be satisfied before you rely on computers in or between control centers: each key person in any control center should have easy access to a computer, the computers should be networked so the status information can be shared, the server should be protected from damage, and the computers must have secure power. You cannot afford to lose the information or lose access to it.

4.2.1.9.2. Be sure to safeguard classified checklists, plans, and other materials stored in individual computers or transferred over a network.

4.2.2. **CE Damage Control Center (DCC).** Normally manned by CE specialists from infrastructure support, heavy repair, facility maintenance, and other engineering fields, the DCC controls and communicates CE response activities, coordinates those activities with other base organizations, and arranges support from others as needed. Communications equipment within the DCC facility normally includes telephones, hot lines, radios, and other communication devices.

4.3. Installation Notification and Warning System (INWS). The INWS is a combination of methods using audible and visual signals, verbal messages, and electronic communication. Communication modes include sirens, horns, radio tone alerting, mass notification systems, unaided voice systems, public and broadcast address systems, local area network messaging, telephone alert conferencing, pagers, television, radio, flags, signs, and other electronic or mechanical methods. The design of these warning systems is usually a collaboration between CE and communications squadrons, and the systems are required to be redundant, hardened, or splinter-protected and operate using both commercial and emergency power. Existing networks should also be incorporated into this system. Other features of the INWS are listed in **Table 4.1.**

Table 4.1. INWS Features.

Installation Notification and Warning System
Provide installation-wide coverage of outdoor areas, indoor facilities, housing, and separated sites.
Reach off-base facilities that are controlled or owned by the installation to ensure coverage for personnel working or billeted in those areas.
Incorporate DOD-required Mass Notification System (MNS) into the indoor coverage.
Incorporate systematic and coordinated standard to support the Air Force Incident Management System (AFIMS).
Provide mechanisms for vertical and horizontal coordination, communications, and information sharing in response to threats or incidents.

4.3.1. **Mass Notification System (MNS).** Implementation of an effective mass notification system requires the coordinated efforts of engineering, communications, and security personnel. Coordination with communications personnel is needed because every mass notification system will require the use of base communication systems. Each installation should prepare an implementation plan that establishes a comprehensive approach to mass notification that is acceptable to security, communications, and engineering personnel. Elements of an implementation plan include a needs assessment, requirements definition, alternatives evaluation, system selection, and implementation schedule. Mass notification systems include *individual building systems*, *giant voice system*, and *telephone alerting system*.

4.3.1.1. **Individual Building Systems.** These systems consist of the Autonomous Control Unit and Notification Appliance Network.

4.3.1.1.1. **Autonomous Control Unit.** The autonomous control unit is used to monitor and control the notification appliance network and provide consoles for local operation. Using a console, personnel can initiate, in a building, the delivery of pre-recorded voice messages, provide live voice messages and instructions, and initiate visual strobe and (optional) textual message notification. The autonomous control unit will temporarily deactivate audible fire alarm appliances while delivering voice messages to ensure the messages are intelligible. If an installation-wide control system for mass notification is provided on the installation, the autonomous control unit also communicates with the central control unit of the installation-wide system to provide status information and receive commands and messages.

4.3.1.1.2. **Notification Appliance Network.** The notification appliance network consists of audio speakers located to provide intelligible instructions in and around the building. Strobes may also be provided to alert hearing-impaired occupants.

4.3.1.2. **Giant Voice System.** The Giant Voice System (**Figure 4.1.**), also known as Big Voice, is typically installed as an installation-wide system to provide a siren signal and pre-recorded and live voice messages. It is most useful for providing mass notification for personnel in outdoor areas, expeditionary structures, and temporary buildings. It is generally not suitable for mass notification to personnel in permanent structures because the voice messages are generally unintelligible. If an installation-wide control system for mass notification is provided on the installation, an interface to the Giant Voice system may improve the functionality of both systems.

Figure 4.1. Engineers Install Giant Voice System at Deployed Location.

4.3.1.3. **Telephone Alerting System.** Telephone alerting systems are independent systems that may be used to provide mass notification to buildings and facilities. These systems are useful for buildings in which notification to all building occupants may not be appropriate (e.g., child development centers, hospital patient areas, brigs). They also might be appropriate for small facilities and military family housing where mass notification is not required by UFC 4-010-01. Use of telephone alerting systems, however, should be considered carefully before installing in most buildings and facilities requiring mass notification because there are many limitations in delivering notification messages by telephone.

4.3.2. **INWS Summary.** Every Air Force installation is required to have a rapid and effective system to disseminate emergency information quickly, but every installation does not have an installation notification and warning system with all the elements and methods described in this section. Nevertheless, any system, procedures, or combination thereof that provides required mass notification capability may be acceptable. Refer to AFI 10-2501 and UFC 4-021-01 for details on notification and warning standards.

4.4. Other Command and Control Preparations. In addition to helping with EOC communications and the installation's mass notification and warning system, civil engineers have the added tasks of setting up and managing the installation primary EOC, mobile emergency operations center (MEOC), and CE unit control center and completing other C2 preparations. These other command and control preparations involve setting up facilities, organizing control center teams; putting communications equipment and procedures in place; publishing base alert conditions and alarm signals; establishing control center operating procedures; developing unit procedures for recall, authentication codes, and passwords; and making provisions for continuity of operations. The composition of the EOC and the functional relationships with the installation control center and unit control centers are addressed in AFI 10-2501.

4.4.1. **EOC Facility.** Ideally the EOC should be located adjacent to or collocated with the installation control center; however, some EOCs are located in separate facilities and still operate effectively. In a high-threat area, the EOC should be semi-hardened or at least splinter protected to improve its survivability. Be sure to provide backup electrical power or a connection for quick hookup of an emergency generator. On the inside, arrange work stations so emergency support function (ESF) personnel have easy access to view maps, situation status information, and the Common Operating Picture and can communicate easily with each other and the EOC director (**Figure 4.2.**).

Figure 4.2. Typical ESF Work Station Arrangement.

4.4.1.1. **Maps.** Typical maps that should be provided are listed in **Table 4.2.** The airfield pavements map is most often used in wartime to plot damage and repairs to the airfield pavements.

Table 4.2. Map Types and Scale.

Map Type	Scale
On-Base Crash Grid Map	1:4800 or 1:2400 (suggested)
Off-Base Grid Map	1:250,000 (approximately)
Area CBRN Map	1:250,000 (approximately)
Base CBRN Map	1:50,000 (or smaller)
Airfield Pavements Map	1:1200 (suggested)

4.4.1.2. **Incident Status Displays.** In addition to maps, readily visible status displays (usually electronic or status boards) help the EOC staff keep track of the condition of the installation, unit status, and the recovery efforts. Suggested incident status displays include those listed in **Table 4.3.**

Table 4.3. Incident Status Displays.

Incident Status Information/Data
Alert Condition/Defense Condition/Air Raid Status
NUDET (Nuclear Detonation) Board
MOPP Analysis
Chemical Downwind Message Status
Shelter Status
Unit Status, Including Manpower
Facility/Utility System Damage Status
Casualty Status
Generator Status
Aircraft Arresting Systems Status

4.4.2. **CE Damage Control Center.** The best place for the CE Damage Control Center (DCC) is within walking distance of the CE shops. This makes communications easier when phones or radios are not available. Install a backup power source. As with the EOC, appropriate maps of the facility and airfield should be readily available for coordinating and plotting response activities (**Figure 4.3.**). See AFPAM 10-219, Volume 1, for staffing recommendations.

Figure 4.3. Civil Engineer DCC Facility.

4.4.2.1. **OPLANs and Support Plans.** Keep at least one copy in the DCC of every operations plan (OPLAN), support plan, or base plan that CE supports. There should be multiple copies of the CE Contingency Response Plan. **Table 4.4.** lists three examples of plans that should be maintained in the DCC when needed.

Table 4.4. Support Plans and Their Purpose.

Plan Type	Purpose
Comprehensive Emergency Management Plan (CEMP) 10-2	Provides comprehensive guidance for emergency response to physical threats resulting from major accidents, natural disasters, conventional attacks, terrorist attacks, and CBRN attacks.
CE Contingency Response Plan (CRP) with all annexes and checklists.	This plan is the civil engineer's detailed guide for using and controlling the engineer forces in a disaster or contingency at an installation. This plan should provide CE-specific guidance for supporting implementation of CEMP 10-2 and other base-level plans.
HAZMAT Emergency Planning and Response Plan	Outlines how the base responds to a spill of hazardous materials other than nuclear and explosives. Base Civil Engineer is responsible for the HAZMAT Plan; however, it requires the active support of many base organizations.

4.4.2.2. **Maps.** Nothing is as useful as a good map to help maintain a “picture” of the crisis and your response. Place maps in frames and cover with Plexiglas so the maps can be easily marked up and cleaned off. Light the maps, but do it so glare is not a problem. Use these maps:

4.4.2.2.1. On-base crash grid map (1:4800 scale - 1” = 400′)

4.4.2.2.2. Off-base crash grid map.

4.4.2.2.3. Airfield pavements or takeoff and landing (TOL) surfaces map (1:1200 scale - 1” = 100′) with runway/taxiway station marking systems annotated.

4.4.2.2.4. Master plan tabs (G-tabs) - utility systems. The suggested scale is 1” = 400′. If necessary at big bases, use 1” = 600′ or 1” = 800′. (If they exist, keep a set of the smaller scale (1:1200 - 1” = 100′ or 1:600 - 1” = 50′) tabs for each utility. These are usually too large to mount on the wall.)

4.4.2.2.5. Use geospatial site-mapping information, services, and overlays, when available.

4.4.2.3. **Status Charts.** Maintain visible status charts (**Table 4.5.**) to help control the CE responses to a crisis. Display these charts and any others that you may find helpful. **Attachment 2** contains some ideas for status chart formats.

Table 4.5. DCC Status Charts.

Sample Status Charts	
Personnel status—key personnel/team and shift assignments/accountability by Air Force Specialty (AFS)/casualty status.	Alert condition/defense condition/air raid warning condition/threat condition/natural disaster threat condition/MOPP condition.
Aircraft arresting system status.	Utility systems status.
Generator status.	ADR status.
Vehicle status.	CE radio call signs and frequencies.
Special purpose equipment status.	Priority facility damage/recovery status.
Critical supplies and spares status.	Critical infrastructure status.

4.4.2.4. **Communications.** Provide good communications equipment for the DCC staff. As with the EOC, install telephones, intra-base radios, and FAX capability. Use cellular phones when possible, and consider field telephones. Radios in the DCC should be equipped with both speakers and headsets. The DCC should be connected with the functions, units, and teams listed in **Table 4.6.** Try to establish two independent methods. Practical connections are offered, but any method you choose is okay.

4.4.2.4.1. **Call Signs.** Set up call signs for CE shops or teams. At home station, use codes you normally use in peacetime. This reduces confusion. At deployment locations, find out the local CE frequencies and call signs. When starting from scratch, consider functional call signs, such as Electrical-1, 2, 3; Structures-1, 2, 3; Pavements-1, 2, 3, or with humorous but descriptive names such as Sparky-1, 2, 3; Hammer-1, 2, 3; Dirtboy-1, 2, 3.

4.4.2.4.2. **Unit Recall.** Develop procedures to recall members of the CE unit to duty stations during non-duty periods. The most common method is the telephone pyramid recall, but runners can be used. Keep recall and assembly instructions simple, and train unit personnel in advance on where to report and with what. Have procedures to recall the entire unit and just the military. Review those procedures for possible adjustment when a Prime BEEF team deploys. When normal telephone communications are not available, preplanned and tested alternate procedures must be ready for use.

Table 4.6. DCC Communication Methods.

Function	Sample Communication Methods
Installation Control Center	Telephone / FAX / Runners
EOC and alternate EOC	Hot line / Telephone / Radio / FAX / Cellular Phone / Runners / Field Phone
Alternate DCC (if there is one)	Hotline / Telephone / Radio / FAX / Cellular Phone / Runners / Field Phone
CE Response and Repair Teams	Radio / Cellular Phone / Runners
CE Shelters	Telephone / Radio / Cellular Phone / Field Phone / Runners
Fire Alarm Control Center (FACC)	Telephone / Radio / Hot Line
Base Defense Operations Center (BDOC) and Alternate BDOC	Telephone / Radio
Hospital	Telephone
Other Installation units	Telephone

4.4.2.5. **Other Items to Have On Hand.** There are a number of other items which are useful to have on hand in the DCC. Some of them are:

4.4.2.5.1. AFPAM 10-219 series publications.

4.4.2.5.2. AFH 10-222 series handbooks.

4.4.2.5.3. MOS (minimum operating strip) selection templates (at bases subject to an enemy attack).

4.4.2.5.4. T.O. 35E2-4-1, *Repair Quality Criteria System for Rapid Runway Repair* (at bases subject to an enemy attack).

4.4.2.5.5. Local area telephone directory with yellow pages.

4.4.2.6. **Computers.** Computers can also be put to good use in the DCC. The thoughts on using computers in the EOC also apply to the DCC.

4.4.3. **Alternate Communications Procedures.** Plan and practice Comm-out/radio silence procedures. In a crisis, count on losing communications with someone or some organization. Also, there may be situations where you want to impose radio silence. In either case, develop alternate methods to pass information. If you lose a base station, a vehicle with a radio can be positioned nearby or just the radio with a battery can be used. Most likely you must use other radios in between your destination to relay the messages. Runners are also effective, but slower.

4.4.3.1. Arrange for runners. Runners are a reliable way to pass lengthy, detailed data, but they are also the slowest form of communication. While not an absolute rule, it is a good idea to identify these personnel in advance. Show runners where they must go and how to get there, because some will have a poor knowledge of the installation and a poor sense of direction.

4.4.3.2. Arrange for visual signals such as flags and flares. These methods can quickly send simple alert signals to personnel within visual range when radios are not available.

4.4.3.3. Map the radio dead spots on and around the installation. Check with the operations personnel in base communications. They may already have this information. Mark this information on control center maps.

4.4.4. **Continuity of Operations.** Provide for continuity of command and control. Organize the second shift for the control center. Set up an alternate control center during wartime operations. There are many ways to do this. Two such possibilities are:

4.4.4.1. Do nothing until the control center is damaged. Then consolidate or collocate the lost control center function with another control center where communication equipment is available. (The off-duty shift would be recalled to pick up control, and another relief shift would be formed.) Crowding would be a major issue.

4.4.4.2. Set up a separate facility with minimum equipment before the first enemy attack. This facility can be unmanned until activated by the off-duty shift. To speed resumption of control, consider staffing the facility with a minimum crew who keep a duplicate set of status charts. This requires a good communications link with the primary control center and procedures to keep the alternate facility staff informed. Telephones are important. Radios are essential. A FAX capability and computer link would be helpful.

4.4.5. **Force Protection Conditions (FPCONs).** An FPCON is a security posture declared by the commander in consideration of a variety of threat factors (**Table 4.7.**). US facilities, because of their symbolic value or relative isolation, can be attractive terrorist targets. This is also true for military and civilian personnel because of their grade, assignment, or symbolic value. Based on available information about local terrorist activity, installation commanders determine whether or not there is a terrorist threat to installation facilities or personnel, and, if so, select and declare the appropriate FPCON. AFI 10-245 describes force protection conditions and measures.

Table 4.7. Force Protection Conditions (FPCONs).

Condition	Application	Considerations
FPCON NORMAL	Applies when a general global threat of possible terrorist activity exists.	Warrants a routine security posture.
FPCON ALPHA	Applies when there is an increased general threat of possible terrorist activity against personnel or facilities, the nature and extent of which are unpredictable and circumstances do not justify full implementation of FPCON BRAVO measures.	ALPHA measures must be capable of being maintained indefinitely. However, it may be necessary to implement certain measures from higher FPCONs resulting from intelligence received or as a deterrent.
FPCON BRAVO	Applies when an increased or more predictable threat of terrorist activity exists.	BRAVO measures must be capable of being maintained for weeks without causing undue hardship, affecting operational capability, and aggravating relations with local authorities.

Condition	Application	Considerations
FPCON CHARLIE	Applies when an incident occurs or intelligence is received indicating some form of terrorist action or targeting against personnel or facilities is likely.	Implementation of CHARLIE measures for more than a short period probably will create hardship and affect the activities of the unit and its personnel.
FPCON DELTA	Applies in the immediate area where a terrorist attack has occurred or when intelligence has been received that terrorist action against a specific location or person is imminent.	Normally, this FPCON is declared as a localized condition.

4.4.6. **Emergency Notification and Alarm Signals.** Emergency notification and alarm signals warn base personnel and units of an attack or impending disaster. The more advance warning given, the greater the probability that advance actions can reduce damage and injury. Everyone on base should know the meaning of each signal. Signals may be passed by sirens, horns, flags, telephone, intra-base and tactical radios, stationary and mobile public address systems, whistles, person-to-person, television, radio, etc. The methods used depend on the nature and immediacy of the crisis, location of personnel to be notified, and alerting systems available. Signals may be repeated as often as necessary to make sure that the entire base population responds. The Air Force has standard emergency notification and alarm signals which are described in two visual aids: AFVA 10-2510, *U.S. Air Force Emergency Notification Signals*, and AFVA 10-2511, *USAF Standardized Attack Warning Signals for NBCC Medium and High Threat Areas,* as shown in AFMAN 10-2602 (until rescinded by AFMAN 10-2502 Series publications). Additional signals may be used to meet the peculiar needs of any command or installation. Installations in overseas areas use the signals prescribed by the unified theater commander.

4.5. Summary. Sound command and control preparations facilitate coordination, communications, and cooperation between agencies and personnel during an emergency. They also improve base response, recovery, and mission sustainment. For more specific information on CE preparations related to command, control, and communications, review the references listed in **Table 4.8.**

Table 4.8. C2 and Communications Preparations References.

C2 and Communications Preparation References
AFI 10-245, *Air Force Antiterrorism (AT) Standards.*
AFI 10-2501, *Air Force Emergency Management (EM) Program Planning and Operations.*
AFPAM 10-219, Volume 1, *Contingency and Disaster Planning.*
UFC 4-021-01, *Design and O&M: Mass Notification Systems.*
UFC 4-010-01, *DOD Minimum Antiterrorism Standards for Buildings.*
Joint Forward Operations Base (JFOB) Force Protection Handbook (to be replaced by UFC 4-027-01, *Design of Deployed Operational Bases to Mitigate Terrorist Attacks).*

Chapter 5

ISOLATION, BACKUP, AND PROTECTION OF UTILITIES

5.1. Introduction. The loss of utility service has immediate impacts on the operations of an air base. Some losses cause only annoyance or inconvenience, but others quickly degrade mission performance. The significance of those impacts varies with the utility that has been disrupted, the nature and extent of the disruption, and the importance of the affected activities to the mission. As “owner” of the base utility systems, civil engineers can minimize utility service disruption and resulting mission impacts with good disaster attack planning and preparations. As a minimum, civil engineers should ensure that procedures and resources are in place to isolate all or portions of the base utility systems, provide utility backup to mission-critical activities, and protect key components of the utility systems from damage. For situations when only limited utility service can be provided, the base must also develop demand reduction procedures. Protecting important base utility services is not a CE-only responsibility. Many preparations require installation-wide inputs and preplanned responses. This chapter presents recommendations for developing system isolation; emergency backup; and physical protection measures in each of seven utility systems: electrical, water, heating, gas, liquid fuels, sanitary sewage, and airfield lighting. The importance of installation-wide demand reduction procedures is also highlighted.

5.2. Learning the Systems. The first step in disaster or attack preparation of a utility system is to learn all you can about that system: its sources, configuration, vulnerabilities, operating details, recurring problems, spare parts, and other basic utility data. If possible, use Expeditionary Site Mapping to aid in identifying and locating critical equipment or resources. When searching for utility information, a good data source is the Base Comprehensive Plan. This plan is a combination of component plans, studies, and maps that document a wide range of information that is essential to decision-makers when planning and managing an installation’s physical assets in support of the mission. The Infrastructure Component Plan and tabs E and G are part of the Base Comprehensive Plan and are good sources of information for successful planning of isolation procedures and other utility system preparations. **Attachment 4** is a comprehensive plan map that lists the titles of all associated tabs.

5.2.1. **Basic Utility Data.** This paragraph outlines, in general terms, the information you should collect for all utility systems on your installation. You can find suggestions for utility-specific information in paragraph **5.5.** through **5.11.** Include systems information in the utilities annex (N) of your CE Contingency Response Plan. For most installations, data collection is an easy task because information should already be available. Good shop foremen have this information on hand, because they use it in their day-to-day activities. Civil engineers need to gather this information and put it in one place, because “the person with the needed information” may not always be available.

5.2.1.1. **Source/Treatment Facility.** Describe the sources/treatment facilities for each base utility. Identify the location and capacity of each source. Explain any operating restrictions. If furnished from off base, show the point(s) of receipt or discharge and include the point of contact, normal and emergency telephone numbers, and address.

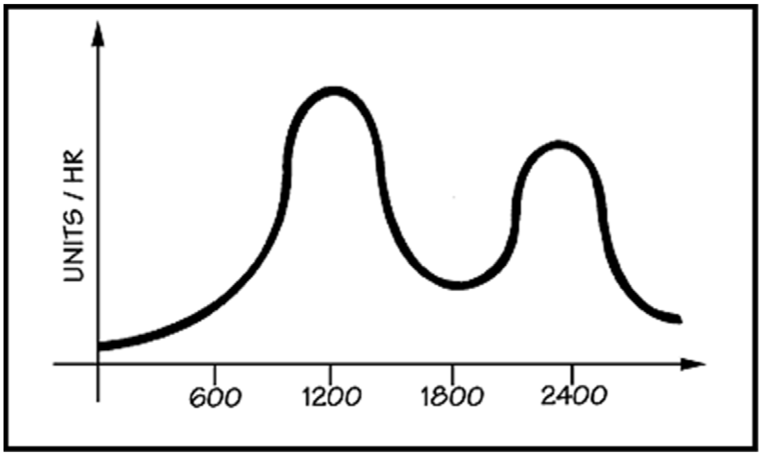
5.2.1.2. **On-Base Production and Storage.** If the commodity is consumed and the base has the capability to produce it, state daily production capacity both in total quantity and as a percentage of average daily base consumption. If the commodity is stored, state the base's storage capacity both in total units and as a percentage of average daily consumption.

5.2.1.3. **Layout and Configuration of Distribution System.** Describe key system components such as pumps, transformers, and lift stations. Identify items which are interchangeable. Explain the layout of the distribution systems and the normal configuration of valves or switches.

5.2.1.4. **Operation of the System.** If not apparent by the preceding information, describe how the system operates. Explain adjustments needed for pre-identified special situations.

5.2.1.5. **Consumption or Discharge.** Record maximum, minimum, and average daily consumption (or discharge), and show daily variation in demand. This is easily done using graphs such as shown in **Figure 5.1.**

Figure 5.1. Typical Demand (or Discharge).



5.2.1.6. **Recurring Problems.** Every utility system will occasionally have problems, but some systems experience recurring problems with regularity. Identify and document such problems so your base can prepare for them and minimize their impacts.

5.2.1.7. **Backup Capabilities.** Describe alternate methods which the base, not just CE, can employ to deliver full or limited utility service to users.

5.2.1.8. **Hazards.** Briefly describe any hazards to personnel that would result from damage to the distribution, production, or storage facilities associated with a utility system.

5.2.2. **Repair Considerations.** While collecting basic system information, it also makes sense to gather information on repair capabilities such as type, location, and quantity of repair materials and replacement items. Address the issue of what spares should be maintained for critical components and identify which components within the system (transformers, circuit breakers, and switches) are interchangeable. Spare equipment lists should be checked against system requirements and a record made of the condition and location of all spares. This same information is needed for generating plants and mobile generators. An annual review is particularly critical for those items stored as special levels.

5.3. Assessing Vulnerabilities. To determine what preparations deserve priority attention, identify which utility system components are most at risk from the likely threats. Obviously underground elements of utility systems are inherently more survivable. CE shop personnel possess the knowledge and experience to assess system vulnerabilities and to develop additional protective measures. To perform an assessment, try the red team-blue team approach. Divide personnel responsible for operating and maintaining a particular utility into two groups. One group plays the role of aggressor, saboteur, terrorist, natural disaster, or accident. The other group develops countermeasures and repairs to defeat or minimize the measures proposed by the former. Have the two groups switch roles during follow-on sessions. Since the utility systems serving an installation are usually complex, time is well spent in this iterative gaming process. In addition to identifying vulnerable system components, a well conducted exercise can develop feasible options for system isolation, backup, additional hardening, as well as spares pre-positioning and repair procedures. Include the results of the assessment in the utilities annex (N) to your CE Contingency Response Plan. Request help from your security forces. They can identify specific enemy ground threats and avenues of attack.

5.4. Determining Critical Requirements. You need another step to complete the data gathering and assessment phase of disaster and attack preparations. You must determine hard core utility requirements—for individual users and the base. CE leads this effort, but all installation units and the installation leadership should be players. Three tasks are required: identify the critical users, determine the minimum requirements for each critical user, and calculate the minimum critical base-wide requirement.

5.4.1. What is a critical utility requirement? Each installation has different answers to that question. If you need a description, try this one: if the loss of utility service to a facility prevents aircraft from flying or being repaired, degrades command and control of the installation's forces, or jeopardizes life-saving activities such as hospital operating rooms or CBRN shelters—that function/facility has a critical requirement. Loss of service that causes only inconvenience is not a mission-critical impact. Neither is a loss that forces work-arounds that are easily performed; for example, going next door for drinking water or to use the latrine. Air conditioning in quarters or in a dorm is very nice, but it is a convenience. However, air conditioning for temperature-sensitive air traffic control or communications equipment is probably critical.

5.4.2. An installation can sort critical from non-critical utility requirements in at least two ways or can use a combination of the two.

5.4.2.1. Start with the facility priority list. If it accurately reflects mission priorities, you can use that list to identify facilities which contribute most to mission priorities. Either measure consumption or have the occupants provide requirements for each building. Taking those inputs at face value, calculate the total critical requirements for the installation. This approach involves the least time and fewest number of personnel, but it may overstate requirements since the user inputs are not challenged.

5.4.2.2. A second way is more precise but also more time-consuming. Have installation units identify their mission-critical facilities, list specific utility requirements for each room which contains a critical function, and state what function is to be performed. For example, "We need 120/208V, 50 amps of power plus room lighting and air conditioning in room 12 of building 1142, so we can calibrate the F-15 internal navigation system with our test stand." Units should also defend their requirements in terms of mission impact. They should specify what work-around solutions they must implement if they lose a utility. They should state the impact of working in that alternative situation by explaining how the flying mission will be affected and how long it will take before loss of service starts to critically affect the mission. This need not be a quantitative defense as much as a common sense one. To help units do this, civil engineers should make facility drawings available so the units can annotate their needs on the drawings. CE should evaluate and challenge potentially unreasonable or excessive requirements. Negotiate questionable requirements with the users. If you still have problems with their inputs, develop alternatives. Present the user requirements and your alternatives to the installation leadership for approval. Then consolidate all critical requirements for the installation.

5.4.3. Sorting critical from non-critical requirements can be challenging, because no unit thinks of themselves as “non-critical.” Almost every unit can show how they directly support the mission and therefore are critical, but it is unrealistic to treat every unit—or even every section in the key units—as mission critical. This is where the installation leadership is essential. They can better see the “big picture” and can decide what activities really are mission critical. Civil engineers can then work with the units to refine the detailed requirements and total the installation's critical requirements. If you have the storage space in CE, keep a copy of every unit's requirements and marked up facility drawings. This makes it easier to periodically validate and update requirements.

5.5. Electrical System Preparations. The installation electrical system is one of the most complex utility systems serving an installation, and its loss has an immediate impact on the installation mission. This discussion of the electrical system covers four areas: system information to collect and document in the CE Contingency Response Plan, system isolation preparations, emergency backup preparations, and physical protective measures.

5.5.1. **System Information.** Good data collection must precede disaster and attack preparations. This paragraph provides guidance on specific data to obtain about the installation electrical system. This is the minimum information needed. Collect and document any additional information you need to adequately describe your system. Tab G-4 of the Base Comprehensive Plan generally contains much of the basic data for on-base systems. The infrastructure support element chief should ensure that system information is maintained in at least two separate locations. This includes schematics of substation equipment and layout, name plate data, technical orders, manufacturer’s literature on equipment, switch configurations, and other pertinent information.

5.5.1.1. **Government-Owned Substation.** With an off-base source, begin at the point of receipt—the main substation/switch station. Give a general description that includes the location, number and size of supply feeders, voltages, and transformer capacities; state whether or not the capacity is limited by the conductors, transformers, or other feature. If there is more than one source, provide this same information for each receiving point.

5.5.1.2. **Non-Government Substation.** At many installations, the substation, although physically located on base, belongs to the supplier. Gather the same basic information on substation/switch station capabilities as outlined for a government-owned substation. No matter whether the power supplier is a commercial source, public utility, or national power corporation, it is important to know the point of contact and record that information in the CE Contingency Response Plan.

5.5.1.3. **Generating Plants.** Fixed generating plants (**Figure 5.2.**), to include mobile, continuous duty plants of 100 kW or greater capacity, should be inventoried and basic data recorded. As a minimum, include the following data:

5.5.1.3.1. Location.

5.5.1.3.2. Total rated plant capacity (in kW).

5.5.1.3.3. Firm plant capacity (in kW).

5.5.1.3.4. Capacity of each generator (in kW).

5.5.1.3.5. Make and model.

5.5.1.3.6. Type fuel required and amount stored on site (gallons).

5.5.1.3.7. Daily fuel consumption (in gallons) during continuous use and the time interval (in days or hours) before resupply is required.

5.5.1.4. **Distribution System.** Record the location, capacity, and type of cable, transformers, switch gear, etc., for each of the primary feeders and secondary (less than 600V) circuits. Identify the normal position of switches. Explain backfeed capabilities. Be sure to mark line voltages on the drawings. While not common, some installations have two or more separate primary distribution voltages. This can minimize back feed capabilities.

Figure 5.2. Power Plant Generator.

5.5.1.5. **Backup/Emergency Generators.** Generator units are accounted for as either Real Property Installed Equipment (RPIE), Equipment Authorization Inventory Data (EAID), or War Reserve Materiel (WRM). To maximize your capability and flexibility to provide electrical power during a contingency, keep a current inventory of all RPIE, EAID, and WRM units. Record, as a minimum, the following data for each generator:

5.5.1.5.1. Type of generator and capacity (in kW).

5.5.1.5.2. Run time when fully fueled (24 hours, 7 days, 14 days).

5.5.1.5.3. Location.

5.5.1.5.4. Facility and activity for which authorized.

5.5.1.5.5. Type of fuel and quantity available on site.

5.5.1.5.6. Whether it is part of an uninterruptible power system (UPS), has an auto start capability, or is manually controlled.

5.5.1.5.7. Connection details (plug, split-bolt, etc.) and load transfer method at the facility where the unit is likely to be used.

5.5.1.6. **Vulnerability Assessment.** As important as the electrical system is to the installation mission, it can be quite vulnerable, especially an older system. Aboveground components, such as transformer stations, substations, overhead circuits, and off-base transmission lines, are especially vulnerable. Identify any elements or portions of the system which have recurring problems. These locations have a greater chance for causing problems. Some installations have prime power generating plants collocated with the main substation which receives power from an off-base source. This arrangement makes an attractive and vulnerable target.

5.5.1.7. **Critical Facility Requirements.** Make a list of critical facilities and activities. Plot the location of these critical facilities on the tab G-4 layout of the Base Comprehensive Plan. Use this layout to preplan emergency switching and isolation procedures. Identify the specific power requirements for each key facility: voltage, load, frequency, quality of power for special equipment, etc. Remember, it is unlikely that all requirements within a facility are critical.

5.5.2. **System Isolation and Emergency Switching.** There are many reasons to isolate portions of the electrical system or to reroute power. An installation needs capabilities to rapidly isolate damage to the system and restore power to intact facilities in the area of the damage; create alternate paths to backfeed critical loads; and shut off power to all or portions of the system to protect it, personnel, and installation facilities from damage.

5.5.2.1. Utility system isolation is not an uncommon CE activity. Given warning prior to an attack or disaster, preparations and procedures can often be completed to protect system components and to sustain service to critical activities. Some activities must have power during or immediately after the active phase of an attack or natural disaster. An installation should consider the following actions:

5.5.2.1.1. Transferring essential loads to emergency/backup generators prior to the onset of the hazardous phase.

5.5.2.1.2. Sectionalizing the system (to the maximum extent possible) prior to the impending threat.

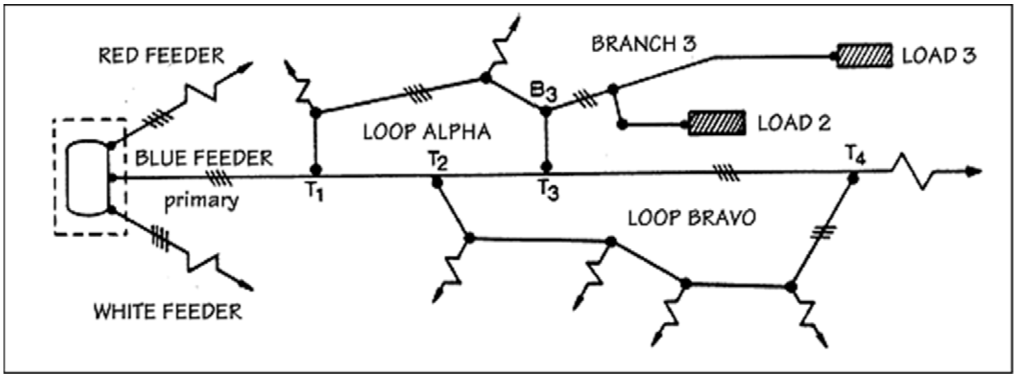
5.5.2.1.3. Shutting power OFF to minimize damage during the active phase of an attack or disaster. Generally this action is useful only where you have overhead distribution lines. Besides protecting personnel, this action protects system components from damage due to uncontrolled phase-to-phase or phase-to-ground shorts. One problem with cutting off power is that personnel cannot use their televisions or radios to get emergency instructions. Whether to shut off power and where to do it is an installation leadership decision. Civil engineers should offer recommendations.

5.5.2.2. Civil engineers should develop isolation procedures that specify which circuits to isolate, where to do it, and in what sequence. Always stress safe electrical practices when opening and closing switches and breakers, even in war—this protects system components and technicians. Document isolation and switching procedures in operating instructions (OI) and include those OIs in the CE Contingency Response Plan. Prepare supporting/execution checklists for shops and DCC. OIs and checklists should outline the sequence of actions and identify individual and coordinated tasks. If conditions permit, give users a warning that power is to be cut off. This gives them time to implement backup procedures.

5.5.2.3. To facilitate communications between repair crews and the DCC, it is helpful to use a code to identify primary feeders and their associated loops. One technique is to use a combination of colors, letters, and numbers to identify system parts. For example, given an installation that has three primary feeders with several loops on each feeder (**Figure 5.3.**), a branch circuit on one of the loops might be identified as Blue Alpha Three. Further, assuming Load 2 is essential, power may be maintained to that load by opening breakers at T1, thus isolating and protecting all of Loop

Alpha, except the segment from T3 to B3. Similarly, Branch 3 can be isolated by opening B3 without affecting service to Loop Alpha. Circuit coding on a map is good, but it is even better when circuit components are marked the same way in the field. Most installations already have a coding system and have implemented it by marking poles, transformers, etc. All personnel, not just supervisors, should know the code.

Figure 5.3. Example of Distribution System Parts.



5.5.2.4. System modifications can increase isolation and backfeed flexibility. Possibilities for isolating circuits and backfeeding key facilities are limited only by the layout of the system and the funds available. Analyze the existing electrical system, and identify points where switching capability can be added. If any threat warrants the cost of the modification, do it. Such modifications should be planned with system backup capabilities in mind.

5.5.3. **Redundant or Backup Electrical Systems.** Because electrical service is vulnerable to disruption, installations should have redundant service and backup equipment in place. For electrical systems, that generally means generators and the procedures to keep them operating. Installations should be prepared to operate backup equipment for extended periods after a disaster or attack.

5.5.3.1. Ideally, mission-critical activities should have backup electrical power and automatic switchgear, but not all such activities get generators—usually due to limited funding. There are a few common-sense steps to getting backup generators in the right places.

5.5.3.1.1. Identify all critical activities requiring backup power and list them in priority order. Logically, this will be the installation facility priority list or a variation of it. This list also establishes the priority for placing mobile/EAID or WRM generators and for replacing non-operating permanently installed/RPIE generators.

5.5.3.1.2. Determine the generator size required for each critical load. Decide whether to consolidate loads on a single generator or collocate generators serving critical loads in a geographic area. Decide if load transfer must be done automatically or can be done manually.

5.5.3.1.3. Follow the procedures in AFI 32-1063, *Electric Power Systems,* to get the generators authorized and delivered.

5.5.3.1.4. Develop an operating agreement with each user that covers generator start-up, load transfer, servicing, and equipment maintenance responsibilities. A standard one-page agreement is sufficient. Provide written generator start-up and load transfer procedures to the user. This can be added to the back of the operating agreement. Then train the user's generator operators.

5.5.3.1.5. In the operating agreements, include procedures for servicing the generators. Most important is the need to periodically refuel operating generators. The agreements should specify who is to monitor the fuel level, when they are to call for resupply, and who is to deliver fuel. For most power plants, CE handles these responsibilities.

5.5.3.1.6. Add quick connect/disconnect and double throw switchgear to facilities which house critical activities. This enables civil engineers to rapidly connect mobile generators and restore power to key facilities. This switchgear provides a second backup capability for facilities which have permanently installed backup power. For key facilities with a relatively large non-critical load, consider rewiring the facility to provide dedicated circuits for the critical loads. Those critical loads can then be supported from the quick connect/disconnect switchgear. This is important to minimize the sizes and cost of the backup generators.

5.5.3.2. Installations that conduct large-scale tests of mission performance under commercial power-out conditions commonly report the conditions below as major limiting factors (LIMFAC):

5.5.3.2.1. Limited availability of spare mobile/EAID units. Historically there have not been enough generators on installations to satisfy all critical requirements. Obtaining authorization for a backup generator requires a very strong justification.

5.5.3.2.2. Problems in transporting EAID units. This problem can be minimized by putting wheels and a towbar on EAID and WRM generators. If that is not possible or cost-effective, develop local procedures to use forklifts and vehicles to move generators.

5.5.3.2.3. Problems with disconnect and reconnect points. This problem is the easiest and cheapest to fix of the factors listed here. As mentioned earlier, add weatherproof junction boxes with switching devices to key facilities and make certain the junction boxes readily accept the cable leads from the generator.

5.5.3.2.4. Failure to refuel backup units when they are operating. Establish local procedures for refueling and servicing operating units. The system user should be heavily involved.

5.5.3.2.5. Limited manning in the power production shop. This is a tough problem, and there are no good solutions. If you can, cross train other CE specialties or vehicle mechanics to help. **Attachment 3** contains a historical list of effects on base activities caused by unplanned power outages. While some of the effects and terminology listed in the attachment may be dated (i.e., microfiche readers, word processors, typewriters, JP-4 fuel, teletype, etc.), they can still serve as a source of ideas to plan efficient manpower utilization and counter-measures to offset the effects of power outages on today’s operations. Consider those factors in your preparations.

5.5.4. **Physical Protection.** The best physical protection is to build the system underground during original construction. Second best option is to place it underground as the installation upgrades or replaces electrical systems or components for other reasons. In lieu of permanent protection, use expedient hardening techniques for aboveground elements. Measures such as earth berms and revetments can be used to protect power plants, substations, transformers, switch stations, generators, etc. Develop operating instructions which detail what is to be protected, how that will be accomplished, where the resources are located to do the task, and who will do the work.

5.6. Water System Preparations. In the CONUS, Air Force policy is to use public or private local utility systems as the primary source of potable water, where such service is available. For this reason, only a few CONUS installations have water treatment plants in operation. Some installations have well fields which supplement purchased water, while some isolated CONUS installations depend on wells as the primary source. At overseas locations, Air Force installations operate treatment plants where commercial sources are unavailable or below acceptable water quantity or quality.

5.6.1. **System Information.** No matter how an installation gets its water, basic system information is still required. The installation water system layout with some details can be found in tab G-1 of the Base Comprehensive Plan. Be sure to include the information in Annex N of the CE Contingency Response Plan. An example of how basic data for a potable water system can be presented is highlighted in **Attachment 5**. As with the electrical system, the infrastructure support element chief should have much of this information already available. Maintain the details on system components in at least two locations.

5.6.1.1. **Purchased Water.** Purchased water is usually introduced into the installation distribution system without further treatment. The configuration of receiving points varies at each installation. As a minimum, it consists of a metered receiving valve connected directly to the installation's main distribution line. Some installations may require pumps to boost the pressure to distribute water. Purchased water may also be fed from the metering point to a storage reservoir. A capability is sometimes provided at the point of receipt to introduce additional chlorine or fluorine. For purchased water, record at least the following information:

5.6.1.1.1. Capacity and minimum guaranteed quantity from source.

5.6.1.1.2. Pipe sizes and pressures.

5.6.1.1.3. Schematic of receiving point.

5.6.1.1.4. Pump data.

5.6.1.1.5. Description of chemical addition equipment.

5.6.1.1.6. Daily chemical requirements and stocks normally on hand.

5.6.1.1.7. Location, condition, and numbers of spares.

5.6.1.2. **Base Wells.** Identify and record the following information for on-base wells.

5.6.1.2.1. Location, depth, and capacity of wells plus pipe sizes and materials.

5.6.1.2.2. Well pump, control panel, and well point data.

5.6.1.2.3. Backup electrical power or other backup features.

5.6.1.2.4. Requirement, condition, and location of spares.

5.6.1.3. **Other Installation Sources.** A few installations have other sources like rivers, lakes, and reservoirs. Collect the information outlined above. Be sure to record the quantity of water available from those sources. That quantity can vary by season and during periods of drought.

5.6.1.4. **Water Treatment.** Frequently, when raw water is drawn from deep wells (**Figure 5.4.**), the only treatment required is disinfection. Where shallow well or surface supply sources are used, more extensive treatment is required—such as depicted in **Figure 5.5.** The physical size and type of a treatment plant depend on the production requirement and the characteristics of the raw water source. Capture the information provided below for water treatment plants.

5.6.1.4.1. Plant capacity.

5.6.1.4.2. Flow diagram through the plant. Include a process schematic which indicates backwash and bypass piping.

5.6.1.4.3. Data on motors, pumps, controls, valves, and other components (either indicate on schematic or as insets).

5.6.1.4.4. Main power supply to plant and backup power.

5.6.1.4.5. Daily requirement for chemicals used in the treatment process—requirements vary with raw water characteristics. Also list normal on-hand stock levels. **Note:** For contingency planning, follow MAJCOM stocking guidance. In the absence of such guidance, consider stocking a 15-day supply in CONUS and a 30-45 day supply for overseas. Base the number of days on how long it takes to typically get the product in hand. Allow for disrupted supply and transportation in a contingency. If disinfectant is provided in pressurized cylinders, consider a 100 percent backup of dry powder disinfectant for contingency operations

Figure 5.4. Deep Well Water Supply.

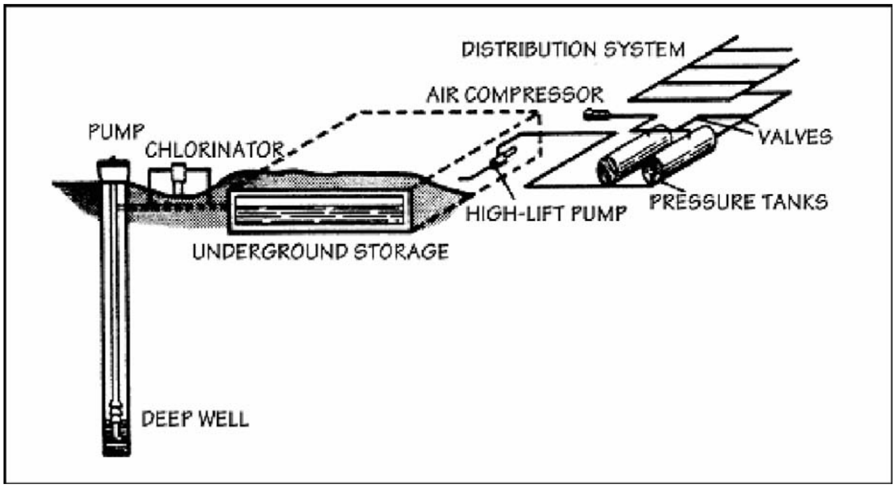
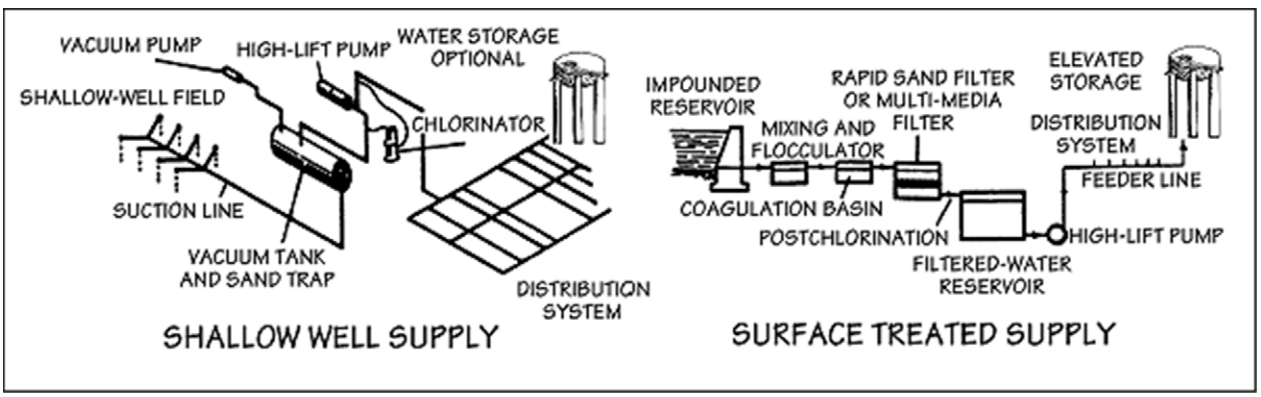


Figure 5.5. Water Supply Sources.



5.6.1.5. **Distribution System.** Once rendered potable, water is introduced into the distribution system. Well designed distribution systems are laid out in loops (**Figure 5.6.**) to provide continuous flow to any point in the system from at least two directions. This provides redundancy with a minimum of dead ends. The system normally consists of the elements in **Table 5.1.** As a minimum, record the information below for water distribution system elements.

5.6.1.5.1. Location of water lines, including pipe sizes/materials and normal operating pressures.

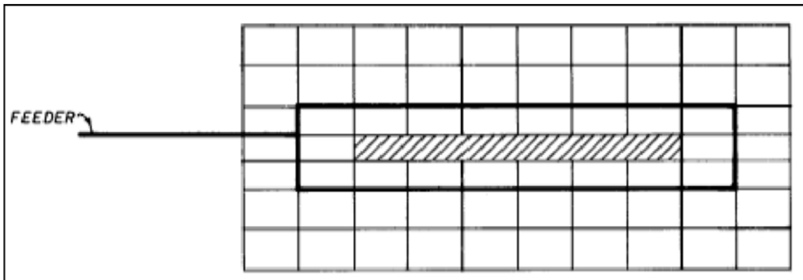
5.6.1.5.2. Location, capacity, and type of storage reservoirs and tanks.

5.6.1.5.3. Location and data on motors, pumps, controls, valves, and other components.

5.6.1.5.4. Backup electrical power or other backup features for pumps and control circuits.

5.6.1.5.5. Requirement, condition, and location of spares.

Figure 5.6. Typical Water Distribution System Pattern.



WATER DISTRIBUTION SYSTEM PATTERN

(Gridiron pattern with looped feeder--Area of highest demand is cross-hatched)

Table 5.1. Elements of Water Distribution System.

Water Distribution Elements	
Element	**Purpose**
Distribution Mains	Pipelines that carry water from the source to the users.
Arterial Mains	Distribution mains of large diameter which are interconnected with smaller distribution mains to form a complete grid system.
Service Connections	Piping that provides water to individual facilities.
Storage Reservoirs	Structures to store water which is used in periods where demand outstrips supply; also used to maintain pressure in the distribution system.
Booster Pumping Stations	As needed within the system to maintain pressure or supply areas of higher elevation.
Valves	Used to control flow, regulate pressure, and isolate water lines for repair.
Meters	Installed as required within the system. Meters gather consumption data and are also used for billing purposes to reimbursable customers (banks, AAFES, etc.). Meters are not a priority for repairing or replacing in contingencies.

Element	Purpose
Backflow Preventers	Devices which protect potable water from contamination.
Fire Hydrants	Firefighting.

5.6.1.6. **Backup Sources.** Describe any backup sources of water and treatment systems readily available to the installation. Also cover the installation's over-the-road hauling capabilities. Identify the location of equipment and points of contact.

5.6.1.7. **Vulnerability Assessment.** Water treatment facilities and underground distribution lines are not especially vulnerable to enemy attack or natural disasters, but be sure to annotate system maps pinpointing segments which are above grade and consider their vulnerability. As seen repeatedly in the Great Midwest Flood along the Mississippi River in 1993, water treatment plants located in low areas are vulnerable. Many were forced out of service because they could not keep the flood waters out of the treatment structures. While other targets are more attractive, water treatment plants and storage tanks can be peacetime or wartime targets for terrorists using chemical or biological contaminants. Water mains are normally carried across ravines and streams or drainage ditches either on the underside of road bridges or by structures erected only for the purpose of carrying the water main. Such features are especially vulnerable during floods, but that may not be a big problem if there are no critical users on the other side. At older installations, look for long, dead-end runs. These may have once served large complexes which have since been demolished, but the mains are still in service to supply a single facility. Such segments comprise a vulnerable component of the system that must be taken into account in the planning of isolation procedures.

5.6.1.8. **Critical Facility Requirements.** Plot the location of facilities or activities which require water to perform mission-critical tasks. For each location, list the specific water requirements: volume of water, total quantity, pressure, water quality, when needed, etc. Record fire protection requirements in Annex N of the CE Contingency Response Plan. Program for construction of additional storage capacity if the fire protection requirements exceed existing potable storage capacity.

5.6.2. **System Isolation.** Isolation enables an installation to provide continued service while valving off redundant paths to avoid excessive loss of pressure and storage capacity if the system is interdicted. Firefighting operations depend on an operational water distribution system. Since the system is normally buried and not particularly vulnerable, plan to leave the system pressurized for contingencies.

5.6.2.1. Develop isolation procedures that specify which distribution lines to isolate, which valves to open or close, in what preferred sequence, and by whom. As a minimum, identify primary and alternate lines to critical users. Incorporate procedures in OIs and develop checklists from them. Be sure your procedures call for immediate notification to the fire protection chief. If possible, also warn key users. This can be done through the installation control center or emergency operations center (EOC). Don't get too excessive with isolation plans—keep it simple. If necessary, cut off water near the storage tanks to avoid a major loss of water. Then quickly narrow the affected area. With current drawings, basic engineering judgment will suffice to direct on-the-spot response.

5.6.2.2. Set up a coding scheme to distinguish between the many similar features of an installation water system. As with the electrical system, you can use a scheme of color codes, letters, and numbers to enable crews to identify and isolate segments of the system rapidly in a variety of circumstances.

5.6.2.3. Locate and exercise valves periodically to make sure they work and can be easily found. Mark valve locations at the site and annotate system maps. Include detailed descriptions about where to find each valve in case the in-field markings are lost. This is especially important where there are two or more valves located next to each other. The shop chief should ensure new personnel know where the valves are located.

5.6.3. **Redundant or Backup Water Systems.** If you cannot distribute potable water through the water system, the installation must look at hauling water. In Desert Storm, bottled water was used initially. This dropped off as bare base treatment and distribution capabilities picked up. Hauling water in bulk tanks is also a good solution. With a moderate-size fleet, you may be able to haul enough water to satisfy more than human consumption needs. For individual consumption, the installation should set up water distribution points. While such points do not have to be at fixed locations, it is advisable to pre-identify likely points which can best serve the installation population. Good drainage is a must at every distribution point. Construct distribution points in advance or expediently if you have to. Hauling water can involve more than just civil engineers. Base transportation can be involved. Without water tank trucks or trailers, you may need to fabricate tanks which can be placed on the bed of any vehicle which can handle the load. Examples include dump trucks, low boys, flat bed trailers, and 12-ton trucks.

5.6.4. **Physical Protection.** Where topography permits, water treatment plants should not be located in areas subject to flooding. Treatment plants can be protected by constructing permanent dikes in advance or by expediently building sandbag dikes as a flood threatens. If expedient measures are to be taken, be sure to develop operating instructions which tell what is to be done, where, by whom, and with what resources. It is also a good idea to create guidelines as to when the preparations should be started and completed.

5.6.5. **Non-Potable Systems.** Non-potable systems are used for firefighting and, on occasion, irrigation systems. They may either use the potable system as a source or derive their supply from sources which could be made potable but are not treated. Deluge systems are found along the hangar line and at installations with industrial complexes (aircraft maintenance depots; testing, research and development facilities). Systems used primarily for irrigation generally support recreational facilities (golf courses, parks, and sports fields). These systems are mentioned to ensure that these supplies are inventoried for emergency purposes. In the case of deluge systems, pumping facilities equipped with backup power are designed into the system. Irrigation sources normally depend on electric power for pumping. In a power-out situation, that water is only available to firefighting equipment which has suction lift capability. All non-potable systems must be positively separated from potable systems by backflow prevention devices. This means you cannot easily inject that water into the installation distribution system even if you need it.

5.6.6. **Independent Systems.** Remotely located facilities, such as ready alert crew quarters and ammunition storage facility offices, are sometimes provided with potable water from independent systems. In most cases, only a generator is needed to ensure an uninterrupted supply of potable water. In extreme cases, potable water must be supplied over-the-road by tankers.

5.7. Central Heating System Preparations. A few Air Force installations have central heating plants (**Figure 5.7.**), and some of those have more than one plant. Steam or hot water is produced at a plant and is circulated throughout the distribution system to points of use. At those points of use, the steam or hot water gives up heat which is normally used to provide hot water and warm air. As steam gives up energy, its temperature and pressure are reduced until it condenses to water. A majority of this water, called condensate, is returned to the plant in condensate return lines for reconversion to steam in the boilers. The difference between the amount of water leaving the plant as steam and that returning to the plant as condensate is made up at the plant from water which is treated before being fed into a boiler. The process is known as industrial water treatment and the product is called make-up water. Hot water systems also have return lines.

Figure 5.7. Central Heating System.

5.7.1. **System Information.** Much information on the base central heating systems can be found on the G-5 tab of the Base Comprehensive Plan.

5.7.1.1. **Heating Plant Data.** The G-5 tab should depict the location of heating plants and their associated exterior lines. Identify each plant, its lines, manholes, laterals, facilities served, and return system separately. When recording data for each plant and its distribution/return lines, use a coding system to distinguish the different elements of the systems. For a plant, record the following data:

5.7.1.1.1. Identification of each boiler—trade name, year built, year installed, type (water tube or fire tube), and size in total heat output (MBTU/hr).

5.7.1.1.2. Classification—high pressure (above 15 psig) or high temperature hot water (HTHW) (above 160 psig or 350^{o}F).

5.7.1.1.3. Type fuel and storage quantity.

5.7.1.1.4. Number of operating days possible with amount of fuel typically stored on base during winter.

5.7.1.1.5. Dual fuel capability (if applicable).

5.7.1.1.6. Make-up water data—treatment process description, chemicals required for treatment and amount consumed, and normal stock levels.

5.7.1.1.7. The ratio of make-up water production capability to make-up water requirement.

5.7.1.1.8. Location, condition, and number of spares.

5.7.1.2. **Distribution System Data.** For each system, identify and code loops, laterals, manholes, valves, and traps. Identify points where service may be cut off and system return integrity preserved. Mark above and below ground portions of the system. Show the sizes and operating pressures of the lines. Record identical data for condensate returns or HTHW returns.

5.7.1.3. **Redundant or Backup Heating Sources.** Identify any backup capabilities you may have or can get in the local area. Traditionally, there is very little backup capability on an Air Force installation. If so designed, some incinerators are equipped with heat recovery systems and can serve as emergency sources for limited hot water when primary systems are out of service. The full utility of such opportunities can be achieved only when such capabilities are pre-identified.

5.7.1.4. **Vulnerability Assessment.** Central heating systems are closed-loop systems designed to operate on a minimum of make-up water. Thus, they are vulnerable to attack and sabotage. Fortunately, most of the distribution and condensate lines are buried, thereby making them relatively "hard" and not as susceptible to damage from falling or flying debris. The Achilles heels of these systems are their dependence on return lines to the plant and the addition of treated hot water. When system losses, either by leakage or interdiction, coupled with normal blow down and blow off, exceed make-up treatment capability, the operator will be forced to introduce untreated feed water (which will quickly destroy the boilers) or must shut the boilers down.

5.7.1.5. **Critical Facility Requirements.** Plot the key facilities served by each plant. Look for and identify means to provide alternative paths to serve priority requirements in the event the primary service path is interrupted. Most steam and HTHW systems contain few alternatives for emergency backfeed.

5.7.2. **System Isolation.** Develop procedures to isolate service to likely target areas. The objective should be to isolate damage while preserving the capability to continue operations to the maximum at near-standard pressures and temperatures. Two factors should be considered when deciding to shut a system down. First, steam and HTHW systems are slow and cumbersome to bring on line from a cold start. Once taken out of service, either as a deliberate precautionary measure or as a result of hostile action or accidental occurrence, they cannot be brought back into full service for hours or even days. Second, the potential of either system to contribute to secondary damage when interdicted is minor by comparison to electricity and gas. Thus the decision to shut down either type of system as a precautionary action prior to attack or natural disaster must be weighed against the predictable effects of a long-term outage. However, orderly and emergency shutdown procedures should be developed to protect the heating plant boilers if the distribution/return system is damaged.

5.7.3. **Physical Protection.** Protection should be built in the original construction. Because these central heating plants are usually so large, expedient measures are not likely to be effective. Each installation must decide what protection is warranted and possible. If supplemental protection is not feasible, installation units should develop procedures to operate without this utility.

5.8. Gas System Preparations. The gas system may be important for heating and hot water, but its loss does not usually have an immediate mission impact unless there is a fire hazard due to damaged lines. Nevertheless, CE should be prepared to isolate and back up this system.

5.8.1. **Engineering Facts.** Gas distribution systems are routinely buried. Portions of the system may be extended above grade to manifold, valve, adjust pressure, and provide service.

5.8.1.1. Gas is supplied in the three pressure ranges listed in **Table 5.2.**

Table 5.2. Gas Pressure Ranges.

Pressure Ranges	
High Pressure (Greater than 50 psi)	This pressure range is not found in base distribution systems, but it may exist (up to 1200 psi) in transmission pipelines that cross Air Force property.
Medium Pressure (12 to 50 psi)	The maximum distribution design pressure for military installations is 50 psi.
Low Pressure (Less than 12 psi)	Gas is normally distributed at a pressure from 3 to 8 ounces per square inch.

5.8.1.2. The lowest pressures are at the points of service and consumption. Where gas enters a building, it is normally regulated to a pressure of about 4 ounces per square inch. Leakage in a system varies with the operating pressure on a system, not with the amount of gas transported or distributed. The maintenance of a proper operating pressure is a critical feature for gas distribution. All gas appliances (heaters, burners, stoves, pilot lights, etc.) are adjusted for a specific pressure range. Although this range is fairly broad, the hazards of natural gas operations increase when system pressures vary significantly from the adjusted pressure. If the pressure drops below 50 percent of its adjusted value, the gas in appliances may not light properly or yield enough heat and may cause flashback. If appliances are adjusted to accommodate a new low pressure, care must be taken when the pressure is again increased to readjust the appliances. At pressures more than 50 percent above adjustment, carbon deposits, incomplete combustion, or flames blowing off the burners can result.

5.8.1.3. For natural gas, the lower limit of flammability is approximately 4.6 percent in a mixture with air, while the upper limit is about 13.9 percent. Neither gas nor air alone is explosive, but the mixture of the two is explosive within these upper and lower limits of flammability. The limits themselves are approximate because the composition of natural gas is not constant. Its heating value varies between 475 and 1,180 BTU/cubic foot.

5.8.1.4. Because most natural gases are odorless, producers introduce unpleasant odors into the gas so that its presence is readily detected in the atmosphere. In the unlikely event that delivered gas is odorless, installations should negotiate the inclusion of odor as part of their contract with the supplier. As a last resort, install a device, usually on the low pressure side of the pressure regulator, to introduce an artificial odor. A variety of approved odors are in use—usually chemically inert mercaptans or sulfides with odors described as rotten, sour, putrid, meaty, metallic, and sulfurous.

5.8.1.5. Only components designed and certified for gas service may be used in gas distribution systems. Though many are similar in outside appearance to like items used in water and sewer service, items not designed and certified for use in gas systems may not be used.

5.8.2. **System Information.** Much of the gas distribution system data can be found on the G-5 tab of the Base Comprehensive Plan along with the central heating system information.

5.8.2.1. **Sources.** Installations with natural gas service may have one or more sources, depending upon the degree to which the surrounding area has been developed. Each point of receipt has a combination of pipes, pressure regulators, meters, and valves. Gather the information listed below (as a minimum).

5.8.2.1.1. Amount of gas the supplier can provide.

5.8.2.1.2. Name and phone number of supplier's point of contact.

5.8.2.1.3. Location, description, and schematic of the receiving point.

5.8.2.1.4. Pipe sizes/materials and normal operating pressures.

5.8.2.2. **Distribution System.** Gas system maps must contain as much data as possible on the gas system and the relationship of the gas system to other buried utilities and fixed reference points. The following information should be recorded on the map and amplified in Annex N of the CE Contingency Response Plan.

5.8.2.2.1. Location, size, and kind of each main line and service line, as well as clearance from adjacent utilities (e.g., steam lines, sewers, ducts, manholes, water mains, etc.).

5.8.2.2.2. Size, type, make and location of each valve in the system, together with the location of manholes and high- and low-pressure points. Also record the designated code assigned for each valve and district regulator operation.

5.8.2.2.3. Operating pressures, line sizes, materials, and joint types.

5.8.2.2.4. Amount, location, and condition of the gas distribution spares. (It may not be necessary to maintain a high-cost, in-house inventory of spares to support a gas distribution system. Where commercial or public systems are present to provide service to installations, the entity providing the service can often be depended upon as a ready source of major spare parts. Individual installations need to pre-stock an inventory of emergency repair and smaller replacement parts, such as patches, clamps, and plugs for medium- and low-pressure applications, and focus the majority of the inventory investment in low-pressure plugs, caps, connectors, valves, regulators, petcocks, sealants, tubing, etc.)

5.8.2.3. **Independent Systems.** Liquefied petroleum gas (LPG) and liquefied natural gas (LNG) are the two common fuels sold in bulk for individual systems. The distinction between the two lies mainly in their BTU output per unit of measure (normally in BTU/lb). Individual systems normally serve only one facility and are in common use where (1) no gas service to an installation is provided, or (2) the facility requiring gas service is remotely located from the central system. Service is provided from a high-pressure tank where the gas is held in the liquid state. The gas leaves the tank via a valve and pressure regulator where it is piped to the point of use at low pressure. Be sure to collect the following information:

5.8.2.3.1. Location of independent systems, type of gas, and size of tank.

5.8.2.3.2. How long a full tank can support the facility.

5.8.2.3.3. Which systems are used to back up critical facility requirements.

5.8.2.4. **Transmission Pipelines.** Transmission pipelines cross some Air Force property. While it doesn't happen often, such pipelines have ruptured or leaked. Be sure you have a point of contact who can quickly stop the flow of gas if such problems arise.

5.8.2.5. **Critical Facility Requirements.** If gas service is needed for a critical function, it is more prudent to place a backup tank on site than to keep the gas system operating, particularly if the threat is an enemy attack.

5.8.3. **System Isolation.** There are a number of scenarios where you need to be able to isolate a portion or all of the gas system, especially to contain the risk of fire and secondary explosions inherent to all gas systems. Most often isolation only needs to affect a small area. Develop isolation procedures. Make sure shop personnel know where the valves are. Locate and mark the valves in the field and on the system maps. Describe where the valves are in case the field markers are lost. As with most utility systems, a coding system to identify portions of the gas system can be helpful. The only reasonable isolation procedure for individual gas systems is to turn the supply off at the tank.

5.8.3.1. It is fairly simple to cut off gas service to an entire system or to any portion of the system which is valved separately. In contrast, restoration of service to a segment of the system is both labor intensive and time-consuming. For example, each individual facility must be valved off at its service point prior to reintroducing pressure to the segment. Once the service main is pressurized, each facility must be brought on line separately by first securing all appliances within the facility. Finally, each appliance within a facility is individually put back into service by relighting and adjusting the pilot or checking electric/electronic pilots for proper operation.

5.8.3.2. Where hostile action is the imminent threat, the correct procedure is to shut off a central gas distribution system at the main source. Time permitting, all valves in the system should be placed in the “OFF” position. This is best accomplished by working from the farthest point in the system toward the main source, cutting off service at each facility. This procedure isolates all segments of the system, from appliance to main source, and ensures that a residual pressure remains in the system. It also limits the amount of gas available to form a flammable mixture to the gas remaining between any two closed valves. Consider the man-hours required to restore service before deciding to shut down or completely isolate the system for a threat which is not potentially explosive or incendiary. Those man-hours may be needed for other recovery operations.

5.8.4. **Redundant or Backup Gas Service.** Where gas service is critical to mission accomplishment and the central system is not dependable in a contingency, an individual LNG or LPG system is an effective alternate source. As individual systems are resupplied by container on a full-for-empty basis, storage is invariably aboveground.

5.8.5. **Physical Protection.** Being buried, the gas system is well protected. There is little else you can reasonably do to protect the system. You can, however, berm tanks positioned at facilities with critical gas requirements.

5.9. Liquid Fuel System Preparations. This may be the most important utility on the installation—certainly on an installation with a flying mission. It is also unique among utilities in that civil engineers “own” and maintain it, but supply operates it.

5.9.1. **System Information.** Tab G-7 of the Base Comprehensive Plan lays out the installation liquid fuels systems. Between that tab and the information in the CE Contingency Response Plan, you should have the following information on storage, distribution, and vulnerability.

5.9.1.1. **Storage and Distribution.** Bulk fuel products are normally provided to an installation either by rail, barge or pipeline. The fuel is typically stored in a tank farm close to the point of receipt (**Figure 5.8.**). If the tanks are some distance from the flight line, where the majority of the fuel is usually dispensed, an underground pipeline system is often used to transport fuel to smaller tanks commonly called ready tanks. From the ready tanks, fuel is pumped to a hydrant system. It may also be moved by refueling vehicles to aircraft, motor vehicles, and other users. The hazard presented by the different fuel products varies significantly. Data concerning tank contents and transport line contents should be kept current. The base fuels officer must advise the BCE whenever changes are made. The following liquid fuels system information should be recorded:

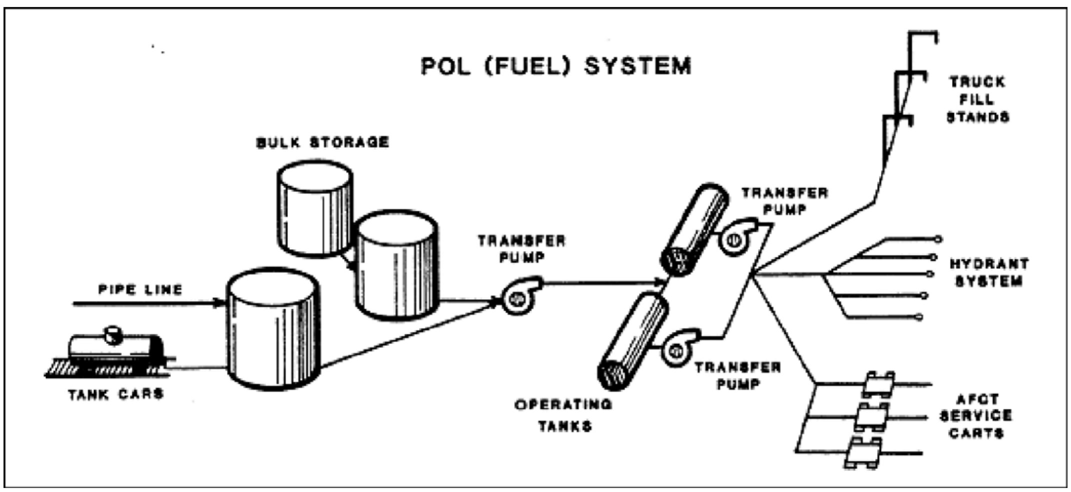
5.9.1.1.1. Location, description, and schematic of the receiving points, pump stations, and hydrant systems.

5.9.1.1.2. Pipe sizes/materials and normal operating pressures.

5.9.1.1.3. Capacity and type of storage tanks.

5.9.1.1.4. Requirement, condition, and location of spares.

Figure 5.8. Typical POL System.



5.9.1.2. **Vulnerability Assessment.** POL systems are a lucrative enemy target; they have a powerful potential for originating and sustaining secondary damage from a variety of natural and man-caused disasters. Because of the importance of this system, most of the components are underground or are hardened at installations in PACAF and USAFE. Power to run the system is a potentially vulnerable element.

5.9.2. **System Isolation.** Develop procedures so CE liquid fuels maintenance or base supply's fuels management personnel respond and cut off the flow of product to prevent or contain secondary damage should the system be damaged. In this case, a redundant response is okay. As with other systems, valves should be marked in the field and on the system maps, and each shop person should touch every valve to learn where they are. A system coding is helpful to identify the different parts of the system.

5.9.3. **Redundant or Backup Liquid Fuel Procedures.** If damage to the pipelines or pump houses is too great, base supply will use refuelers to move fuel from the bulk storage area. Civil engineers may need to give priority to maintaining and repairing haul routes.

5.10. Sanitary Sewage Collection and Disposal System Preparations. System failures in the sanitary sewage system create a public health hazard more than a direct mission impact. Even so, there are smart preparations which civil engineers should make. Sewage collection and treatment systems (**Figure 5.9.**) are designed for minimum operation and maintenance cost. Therefore, the majority of the system is designed to flow by gravity.

Figure 5.9. Sewage Treatment System.

5.10.1. **Engineering Data.** To permit proper operation of gravity sewers, flow velocities in the pipe must be maintained at greater than 2 feet/second and less than 8 feet/second. The amount to be transported determines the size of pipe. The pipe size, in combination with terrain slope, determines the number and location of pumping stations (called lift stations in practice).

5.10.1.1. Lift stations are installed where the collected wastes no longer flow with sufficient velocity to avoid settling of solids and stagnant conditions. Lift stations may serve only to raise the hydraulic grade line to a high enough elevation where gravity continues the flow, or they may inject wastewater into pressurized pipelines, called force mains. Force mains are comparatively large pipelines (12” or greater) which transport wastewater across relatively long runs where the natural grade is not steep enough to provide the necessary velocity.

5.10.1.2. Lift stations are conventionally two-stage devices. Incoming wastewater flows to a wet well where the level is monitored by a float switch. The float switch is set to activate at a predetermined level to control a pump in the dry well which then picks up the wastewater and lifts it into the following stage of the sewer. At the discharge end of the system, a lift station is used to pump the wastewater either to a sewage treatment plant or to a regional collection system. All lift stations must be provided with a source of alternate or backup power. Installations with operational

Energy Monitoring and Control Systems (EMCS) may have a remote sensing capability installed to monitor continuous performance at lift stations. Keeping lift stations in operation during a contingency should be the priority objective. Stoppages and resulting overflow from the system present the greatest hazard from a sanitary collection system. Overflows usually occur from two main causes: (1) power failure or damage at lift stations, or (2) debris being either blown or washed into the system.

5.10.2. **System Information.** Data on the sanitary sewage collection and disposal system should be recorded in Annex N of the CE Contingency Response Plan.

5.10.2.1. **Collection System.** Data to be gathered, in addition to that contained on a properly drawn tab G-2, is not extensive. Focus on lift and other pumping stations. As with other utility systems, select a coding and identification procedure (adapted to the local situation) which lends itself to rapid, accurate reporting of damage and dispatch of repair crews. The data elements below should be recorded concerning the system.

5.10.2.1.1. Gravity Flow Lines. It is only necessary to ensure that the location of individual building sewers is marked on the map. Note direction of flow and size of lines where greater than 4” diameter. Record size, direction of flow, and manhole locations for lateral, branch, trunk, main, and interceptor sewers.

5.10.2.1.2. Force Mains. Record size and direction of flow. Also record type of construction, design pressure, and quantity.

5.10.2.1.3. Lift Stations. Record data on motors, pumps, and power requirement. Record data on backup power (whether manual or auto start). Estimate minimum elapsed time from loss of power to overflow. Estimate times for this condition based on diurnal flow pattern. Record this data for each lift station.

5.10.2.2. **Treatment Plants.** Treatment plants are relatively “hard” structures and are not lucrative targets. They are able to withstand the destructive forces common to natural or man-caused disasters with little effect on their continued operation. In normal practice, a lift station at the receiving point provides sufficient energy to the hydraulic grade to provide flow through the plant to the receiving body of water or land disposal area. If the process is more complex, in-plant booster pumping may be required. This pumping and its associated power are the vital points in the plant for which spares and alternatives may be required in the contingency planning process. As a final resort, when plant holding and equalization tanks are insufficient to contain the flow from the system, plants are routinely designed with bypass capability which allows discharge of untreated effluent directly into a receiving body of water or land application area. Information concerning holding capacity and bypass discharge alternatives for a treatment plant must be summarized in Annex N. A decision to exercise one or more of these options can then be made intelligently in a contingency.

5.10.2.3. **Regional Connections.** Where regional connections to sewage collection and treatment systems exist, it has been Air Force policy to effect direct connection as an alternative to maintaining on-base treatment plants. These connection points consist of a metering device combined with a pumping station capable of injecting installation effluent into the regional system. Along with the meter, these facilities deserve the same planning considerations as on-base lift stations. They are normally located at, or in the vicinity of areas where treatment plants formerly existed. Therefore, failure or interdiction of these facilities can result in the release of untreated sewage to the topographic storm water and natural drainage pattern for the local area.

5.10.3. **Critical Requirements.** The "priority facility" approach is not appropriate in attack preparations for sanitary sewage systems. Examine your installation map for areas subject to flooding by sewage when lines, force mains, or lift stations are interdicted. Look for and identify alternate paths or means by which sewage can be routed around probable ponding points or away from populated areas. Keep escaping sewage away from potable water systems and sources, and keep a positive pressure in the potable water system at all times.

5.10.4. **System Isolation and Backup.** There are no effective isolation or backup procedures with sanitary sewer systems. Civil engineers should develop procedures to mitigate the health hazards when it is necessary to divert raw sewage. Super chlorination is one example.

5.11. Airfield Lighting System. Obviously airfield lighting is a mission-critical support element of air operations (**Figure 5.10.**). System information, operational and backup procedures, and repair considerations should be prepared in advance and included in the CE Contingency Response Plan.

Figure 5.10. Lighted Runway.

5.11.1. **System Information.** Much of the information should be available in the Infrastructure Component Plan and the E-10 tab of the Base Comprehensive Plan. Recommend you gather the following information:

5.11.1.1. **Supply.** Specify the location of the airfield regulators and, for each location, list the number, type, and manufacturer of each regulator. Also provide a description or schematic showing which elements of the system are controlled by each regulator.

5.11.1.2. **Distribution System.** Show the location of the distribution cables (E-10 tab) and control cables. Specify the lamp types and voltage.

5.11.1.3. **Backup Sources.** Show all locations where lights can be controlled. Identify where backup systems, such as bean bag lights (**Figure 5.11.**) and batteries, are located and how many there are. Briefly describe and locate backup power sources and state the hours of on-site fuel available. Identify minimum generator size (kW) needed.

Figure 5.11. Bean Bag Light.

5.11.1.4. **Vulnerability Assessment.** The aboveground elements are most at risk of damage. Identify those components (usually the regulator buildings and backup generators) and decide how best to protect them.

5.11.2. **Redundant or Backup Airfield Lighting Procedures.** Develop procedures for changing settings if the air traffic control tower loses primary control. Develop procedures for quickly placing backup lights if required.

5.11.3. **Physical Protection.** Specify how vulnerable system elements are to be protected. Give brief details on when to do the work and who is to do it.

5.11.4. **Repair Considerations.** List location, type, and number of spare controllers as well as extra cable, lights, lenses, bulbs, etc.

5.12. Demand Reduction. While it doesn't happen often, there can be circumstances when an installation needs to quickly reduce consumption of a utility. Ideally an installation would be able to throw a switch, turn a valve, or send a computer command to make this happen, but few installations are set up to easily isolate service in this way. Consequently, installations need plans to reduce consumption in predetermined increments without impacting mission-critical functions.

5.12.1. Demand reduction can be achieved through voluntary efforts by users or by cutting circuits or isolating lines. Voluntary reductions require a committed installation-wide effort and a system for rapid notification. No unit should be immune. Even mission priority functions have non-priority activities which can be suspended. For many units, the temporary loss of utility service is annoying or maybe even a major inconvenience, but most users can develop workable procedures to overcome the disruption. For example, if a unit needs power for a computer or small tools, they can move them. Civil engineers can help occupants in critical facilities by running separate circuits or lines to just the critical areas of the building. Then building occupants can cut off all circuits except for the key circuit. Voluntary reductions are the least intrusive to the mission, but tend to be ignored when new personnel—not involved in making the original plans—arrive on base. Notification and compliance throughout base housing presents a special challenge. When notified of a problem, especially water, occupants tend to fill containers and tubs so they don't run out, which only worsens the problem.

5.12.2. When voluntary reductions don't work or time is critical, civil engineers can use system isolation to force reductions. To minimize mission impact, users need to identify key functions. Then the circuits or distribution lines which feed those functions can be the last to be isolated. Some installations have identified key circuits and rerouted lines to tie critical functions into those circuits. Unless time does not permit, the installation commander should approve involuntary cuts. Give as much notification to units as possible. Give an after-the-fact explanation and estimated time when service will be restored, when necessary.

5.12.3. Develop a demand reduction plan in 10 percent increments. Identify specific actions which users must take for each increment; for example, turning off lights, lowering the thermostat during the heating seasons and raising it during air conditioning times, minimizing flushing of toilets, curtailing equipment washing, and curtailing functions. The plan should also detail CE actions for each increment: which circuits to cut, valves to turn, in what sequence, etc.

5.13. Summary. The objective of utility isolation, backup, and physical protection is to provide continued utility service to mission-critical users and to minimize damage to the installation's utility systems through proper advance preparations. Prepare your operating instructions and execution checklists. Document the procedures in the CE Contingency Response Plan so there is always a place to turn should the unit need information on the systems. Finally, use the checklists and practice the procedures periodically so each person in his or her respective utility shop can effectively respond to the unexpected. For more specific information on utility isolation, backup, and physical protection, see reference documents listed in **Table 5.3.**

Table 5.3. Utility Isolation, Backup, and Physical Protection References.

Utility Isolation, Backup, and Physical Protection References
AFI 10-2501, *Air Force Emergency Management (EM) Program Planning and Operations.*
AFI 32-7062, *Air Force Comprehensive Planning.*
AFPAM 10-219, Volume 1, *Contingency and Disaster Planning.*
AFPAM 10-219, Volume 3, *Postattack and Postdisaster Procedures.*
Joint Forward Operations Base (JFOB) Force Protection Handbook (to be replaced by UFC 4-027-01, *Design of Deployed Operational Bases to Mitigate Terrorist Attacks).*

Chapter 6

BEDDOWN OPERATIONS

6.1. Introduction. A significant amount of planning and preparation must take place in order to adequately beddown incoming forces or disaster victims. For civil engineers, beddown usually means providing facilities and utility service to military units. An Air Force forces beddown can generally be divided into three elements—aircraft, personnel, and infrastructure support. Aircraft support provides for maintenance shops, hangars, squadron operations, munitions storage, fuel storage, and other facilities that directly support the flying mission. Personnel support provides for housing, feeding facilities, latrines, showers, administrative offices, and other indirect support facilities. Infrastructure support provides the utility systems, waste disposal, roads, and communications that serve the beddown site. Beddown locations range from main bases with adequate existing facilities to bare bases with no facilities other than runways, taxiways, and aircraft parking aprons. Beddown activities are not limited to military deployments. Military engineers have built extensive tent cities to house refugees and relief personnel for many decades, and will no doubt be called on again to provide shelter for relief workers or personnel left homeless by hurricanes and other disasters (**Figure 6.1.**).

Figure 6.1. Beddown of FEMA Personnel in New Orleans During Hurricane Katrina.

6.2. Beddown Concepts. The unpredictable nature of Air Force deployments dictates that civil engineers be able to provide beddown support for differing situations. Because limited time is usually a factor, advance preparations must be made or expedient methods must be employed—in some instances, both approaches can be used.

6.2.1. **Engineer's Role.** Beddown support may be provided by in-place or deployed engineers or a combination of both. Civil engineers erect, modify, or construct many of the facilities that Air Force units need at deployment locations, plus engineers teach other deployed units how to erect their own portable shelters such as TEMPER tents. Engineers also set up and operate the utility systems that serve the aircraft and personnel support facilities. Ideally, beddowns that support OPLANs are preplanned by the gaining major command (MAJCOM) or a subordinate unit and documented in the OPLAN, In-Garrison Expeditionary Support Plan (IGESP), or a joint support plan (JSP). Expect the level of detail and quality in those plans to vary. For short-notice deployments and disaster recovery support, there may be no time for advance planning. Civil engineers will be faced with making an existing plan work or developing a new plan on the spot. Whether a plan exists or not, on-site civil engineers must provide beddown details. They must be able to develop requirements; sort out beddown priorities to get the critical efforts started quickly—sometimes before all details are known; and then site, lay out, and erect or modify the facilities and utility systems.

6.2.2. **Advanced Echelon (ADVON) Team.** Hopefully civil engineers are included in any ADVON team sent to a non-Air Force installation to prepare for the arrival of the main deployment force. ADVON engineers should start developing beddown details, gain a sense of the commander's priorities, and locate vehicles and supplies. They should begin site layout and may even begin erecting shelters and providing limited utility support before the main force begins to arrive. Sound beddown planning requires user input. ADVON civil engineers should solicit requirements and functional relationships from other ADVON members.

6.2.3. **Beddown Timing and Responsibilities.** Not all beddown facilities need to be ready for occupancy before deploying forces start arriving. Because forces flow into an installation over a number of days, work can be sequenced to correspond with their arrival. The flow of forces into an installation is determined using a force module concept as depicted in **Figure 6.2.** below. This concept is further explained in AFI 10-401, *Air Force Operations Planning and Execution,* and AFMAN 10-219, Volume 6, *Planning and Design of Expeditionary Airbases*. Engineers usually deploy early, but are rarely among the first arrivals. Consequently, civil engineers are immediately in a catch-up mode of activity. As other units flow in, they should erect their own portable shelters. Of course, CE must show them where shelters should be erected, provide them with technical assistance, and set up utility service. A major CE assumption is that users erect their own shelters. This assumption is of great consequence, because there are rarely enough on-site engineers to complete all beddown tasks for the installation to be operationally ready in the required time frame. Following intermediate beddown efforts for a military deployment, users should also be active in developing passive defense measures for their functions (**Figure 6.3.**).

6.2.4. **Likely Beddown Locations.** Some of the more common beddown locations include a main US installation, an allied main base, a bare base, and a civilian community (during disaster relief).

6.2.4.1. **Main Operating Base (MOB).** A MOB has extensive facilities in place for the normal base mission. Runways, POL facilities, munitions storage areas, and permanent maintenance shops exist which are often capable of supporting additive forces. However, depending upon local conditions and the size of the deployed force, additional feeding and housing facilities may be needed as well as supplemental operational structures. The In-Garrison Expeditionary Support Plan (IGESP) should specify which existing facilities incoming forces will use, what modifications to those facilities will be required, and what additional facilities will have to be provided. Lacking an IGESP, an installation must quickly develop a beddown and reception plan when notified of incoming military forces or civilians. The wing logistics plans office usually has the lead for this effort, but civil engineers should have a major input on facilities. AFI 10-404 provides guidance for preparing the installation-wide plan. Sound beddown plans must always have inputs on facility requirements from operations, aircraft maintenance, security forces, services, and other functional areas.

Figure 6.2. Air and Space Expeditionary Task Force (AETF) Force Modules.

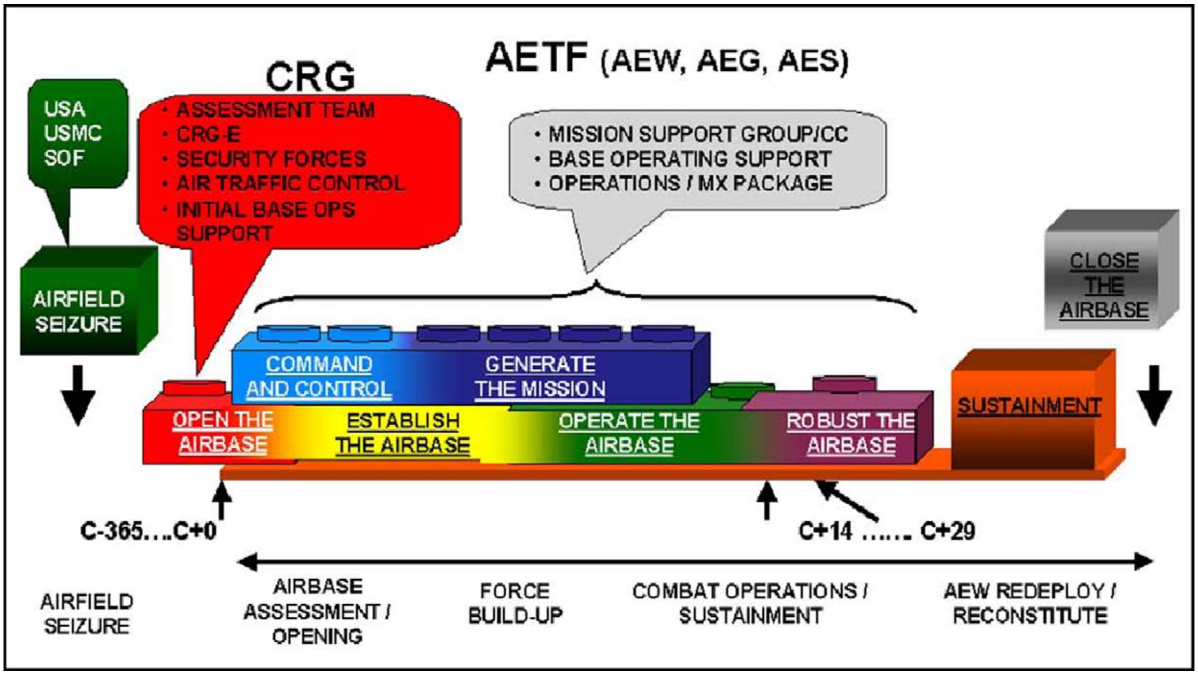


Figure 6.3. Sandbagging Overhead Cover of a Bare Base Shelter.

6.2.4.2. **Collocated Operating Base (COB).** A COB may have facilities similar to a MOB, but those resources are under the control of an allied base commander and may or may not be available for use by the deployed force. At most COBs, joint support plans define responsibilities and identify facilities available for deployed forces. In the absence of such agreements, a formal or informal country-to-country agreement will exist that allows US access to the base. However, local operating and support details may have to be negotiated on the spot with the host base commanders in a short-notice situation.

6.2.4.3. **Bare Base.** Since facilities for use by US forces are nonexistent at bare bases, beddown of deploying forces requires a more extensive effort from civil engineers. With the exception of the runway, aircraft parking areas, and a nearby source of water, civil engineers may have to start from scratch to provide basic services. A tent city, or suitable substitute, must be erected to shelter deployed forces. Basic utilities (including water, electricity, heat, sanitation) and other services must be established. Aircraft parking areas may need to be expanded, revetments constructed, POL facilities developed, aircraft shelters and maintenance shops erected, and the runway modified or repaired.

6.2.4.4. **Civilian Communities.** Less often, civil engineers may be tasked to set up tent cities in civilian communities to temporarily house disaster victims and/or deployed disaster relief forces. As with a bare base environment, permanent facilities may be nonexistent or unavailable, especially following a disaster.

6.2.4.5. **Other Considerations.** The environment that civil engineers encounter at potential deployment locations can be altered at the last moment by unforeseen factors. For example, the contingency situation at the time of deployment can drive a change in the flying mission that may dictate unexpected facility needs to accommodate the adjusted incoming forces. Enemy action or diplomatic problems may preclude use of a planned location, making it necessary to prepare another installation. These possibilities make it essential that civil engineers be qualified to beddown forces in any conceivable environment.

6.2.5. **CONUS Versus Theater Beddown.** Force beddown will most often occur at overseas locations. During war or times of international crises, combat forces quickly deploy to theater locations to support US and allied forces. That scenario drives the need for Air Force civil engineers to have an effective force beddown capability. However, CONUS beddown requirements cannot be ignored. Besides disaster relief support, some CONUS installations are required to beddown large numbers of personnel during periods of increased national readiness.

6.2.6. **Sources of Equipment and Material Support.** Quality sources of equipment and material support are essential if a force beddown is to proceed without delay. Although no sources should be ignored, most materials will come from WRM assets, installation resources, and local area support.

6.2.7. **Manpower.** Engineer manpower for force beddown operations is likely to come from Prime BEEF teams, RED HORSE units, and local contractors. Prime BEEF teams are the cornerstone of engineer beddown support, especially when OPLANs call for simultaneous deployments to many locations. Although limited in number and therefore subject to availability, RED HORSE units have the heavy construction skills and equipment needed for major beddown construction. Even in those instances, Prime BEEF personnel will likely assist in the beddown and will certainly provide the continuing expeditionary combat support (ECS) for the site. In many locations, it is possible to contract support from local construction firms to supplement Air Force engineer capabilities.

6.2.8. **Construction Standards.** The Joint Chiefs of Staff (JCS) established construction standards that outline the types of materials and construction techniques to use when constructing facilities in support of joint operations. According to Joint Publication (JP) 3-34, *Joint Engineer Operations*, these standards minimize the engineer effort and logistics support requirements while providing facilities of a quality consistent with mission requirements, personnel health and safety, and expected availability of construction resources. The standards are the same for all services where mission requirements are similar. The two standards used for short-term contingencies are Initial and Temporary.

6.2.8.1. **Initial Standard.** This standard is characterized by austere facilities with limited life ranging from 1 to 6 months (depending on the specific facility) and, in some cases, requiring replacement by more substantial or durable facilities. These facilities require minimum engineer construction effort. This standard is intended for immediate austere operational support of units upon arrival in theater. Basic Expeditionary Airfield Resources (BEAR) assets satisfy initial standards. This connotation does not mean, however, that they will be replaced after 6 months but that they will be used by Air Forces at the onset of a conflict. It is possible that some of these mobile assets will last several years before needing replacement.

6.2.8.2. **Temporary Standard.** This standard is characterized by minimum facilities requiring additional engineering effort above that required for initial standards. Temporary standard air bases provide for sustained operations above the requirements of initial standards at locations where a long-term presence is not anticipated. The temporary standards may be used from the start of an operation or as an upgrade from initial standards if directed by the combatant commander for mission requirements. Temporary standards should increase the efficiency of operations, safety, durability, morale, and health standards for deployed personnel.

6.2.8.3. Most force beddown operations use the initial standard unless circumstances dictate otherwise. **Table 6.1.** illustrates the types of construction considered under initial and temporary standards. Civil engineers tend to focus on tent and shelter erection activities of a beddown, but this table shows that a beddown can include many other types of work.

Table 6.1. Standards of Construction.

Type of Work	Initial	Temporary
Earthwork	Minimum clearing and grading for facility site including drainage; revetments for POL and ammo storage, A/C parking, command and control facilities.	More extensive clearing and grading to make the site easier to use during the expected period of operation.
Troop Housing/Feeding/ Administration	Tents.	Wood frame structures; relocatable structures.
Electricity	Generators; limited low-voltage distribution.	Generators; high and low voltage distribution.
Water	Water hauled to distribution points.	Limited distribution to hospitals, feeding facilities, latrines, and key users in aircraft maintenance.
Cold Storage	Portable refrigerators with freezer units for medical and food services.	Refrigeration installed in prefabricated/portable structures for medical and food services. Portable refrigerators with freezers for unit use.
Sewage	Organic equipment/pit or burnout latrines.	Water-borne collection to austere treatment facility. Priority: hospitals, dining halls, latrines, and high-volume users.

Type of Work	Initial	Temporary
Airfield Pavement	Expedient surfacing, such as aluminum matting.	Conventional pavement.
Fuel Storage	Bladders.	Bladders and steel tanks.
Roads and Hardstands	Stabilized with local materials.	All weather with selected base course materials.
NOTE: The type of airfield surfacing to be used under temporary standards should be based on expected numbers of landings and takeoffs (cycles) by aircraft type and on the pavement loading by those aircraft.		

6.3. Beddown Facilities and Utilities. Identifying existing facilities or potential cantonment areas for beddown of incoming military forces, federal assistance teams, or disaster victims is an important disaster or attack preparation. However, CE beddown preparations do not end there; potable water sources, electricity, latrines, showers, refuse collection and disposal, and contaminated waste collection and disposal are all areas that must be addressed for expedient beddown operations. This section discusses some general concepts and elements of beddown operations.

6.3.1. **Beddown Facilities.** There are many ways to satisfy contingency facility requirements. Always seek the solution that provides needed facilities in the least possible time. The following options are listed ranging in order from most expedient to most time-consuming.

6.3.1.1. **Identify Like Facilities to Share.** The quickest way to provide a facility is to share or convert a like facility that performs the same function. Sharing requires no civil engineer resources. It is accomplished by increasing the occupancy during a given time period or maintaining a constant occupancy while going to a multiple-shift operation. User input is essential to making this decision. Some facilities are better suited to support beddown operations than others. On MOBs and COBs, there are aircraft hangars, maintenance shops, POL facilities, and munitions storage structures. If these facilities are not totally used by the host forces, parts of them can be made available to the deployed forces. For example, a portion of aircraft maintenance shops and hangars could be devoted to the deployed force's maintenance operation. For billeting, existing temporary quarters may accommodate small numbers of deployed personnel. Doubling or tripling the peacetime occupancy rate of dormitories is an option.

6.3.1.2. **Identify Candidate Facilities to Convert.** Converting a facility is not as quick as sharing but is still faster than constructing a new structure. In converting a facility, the primary concern is function. Do not devote valuable time to cosmetic work to improve the appearance. Deployed personnel expect to live under austere conditions. Amenities can be added later when initial beddown activities are complete. This caution applies to all beddown work. Gymnasiums, theaters, schools, or chapels are candidates for conversion. If feeding facilities are inadequate, service clubs and snack bars with existing kitchen facilities could be quickly converted to provide food to incoming troops. Several factors should be considered when selecting structures for conversion.

6.3.1.2.1. **Facility Size.** Certain aircraft and maintenance operations dictate the size of the facility. For other beddown operations, such as billeting, size is not as critical. For example, one hundred personnel could be billeted in one large structure or several smaller buildings.

However, the construction effort for converting numerous smaller units may be more time-consuming than for converting a single large structure.

6.3.1.2.2. **Facility Location.** The importance of location is a function of the proposed use of the structure. A building used for aircraft maintenance or aircraft operations should logically be in proximity to the base flightline. The location of other facilities may not be as critical, but widely dispersed locations for related functions reduce operational efficiency of the air base.

6.3.1.2.3. **Utilities Available at the Facility.** Rerouting utilities could be the most time- consuming task when converting an existing facility. Therefore, first use the structures that do not require extensive realignment of utility systems. For example, a gymnasium could be an excellent candidate for conversion to a billeting area since hot and cold running water, electricity, heat, latrines, and shower facilities are in place.

6.3.1.2.4. **Construction Required.** The amount of construction required to make a facility suitable for the beddown of forces should be a factor in its selection. Since time is a premium during beddown, construction should be limited to the minimum amount possible to make the facility usable.

6.3.1.2.5. **Construction Priority.** The degree of importance that a facility has to the overall operation of the air base determines its construction priority. For example, a parking area or shelter for deployed combat aircraft will have a higher construction priority than a Base Exchange facility for deployed personnel. The wing commander should set the priorities. Be prepared to give him or her recommendations.

6.3.1.2.6. **Useful Life of the Converted Facility.** Before civil engineers devote extensive man-hours and materials to the conversion of a facility, determine how long it will be needed. A deployed force needing facility space for only a few weeks probably does not warrant major remodeling of buildings or realignment of utility systems.

6.3.1.3. **Identify Temporary Portable Structures if Required.** When existing base facilities are not adequate to support the beddown, planning for temporary structures will be required (such as BEAR assets, locally purchased/contracted portable facilities, or temporary facilities constructed locally) to accommodate the overflow. Planning for temporary facilities must include the following elements:

6.3.1.3.1. **Site Selection.** Good site selection for the temporary facilities improves mission performance and minimizes potential land use conflicts, such as siting structures on poorly drained soil. Always take time to survey the installation and develop a reasonable siting plan, even if it has to be done as war threatens or after a disaster strikes. Do not take a lot of time during a crisis, because the plan does not have to be perfect. The degree of siting flexibility depends on the beddown location. At a MOB or COB, much of the land area may already be developed. At a bare base or other less developed location, civil engineers usually have more latitude. Commanders may have strong opinions on facility siting. Get those inputs early in the beddown effort by presenting a sound siting proposal. Consider the following siting factors which are divided into six general categories:

6.3.1.3.1.1. **Geographic Features of the Installation.** Using maps and visual surveys, determine the physical features of the beddown location. Mark unsuitable areas on the developmental map.

6.3.1.3.1.1.1. **Topography.** The topography of the installation is a major siting factor. Look closely at the natural drainage patterns of the site. Attempt to site all facilities so that cross drainage occurs, and avoid locations susceptible to ponding or flooding. Also, attempt to use natural contours when installing utility systems—let the force of gravity help move water and sewage. This cuts down on the number of pumps needed, which decreases the loads on electrical systems. Lastly, look for areas that require the least amount of site preparation for beddown activities.

6.3.1.3.1.1.2. **Hydrological Conditions.** Consider hydrological conditions such as the height of the ground water table and its seasonal variations and the flood characteristics of rivers and streams bordering the site.

6.3.1.3.1.1.3. **Soil Characteristics.** Evaluate the soil and subgrade to determine allowable vehicle and building loads.

6.3.1.3.1.1.4. **Ground Cover.** Consider the amount of ground cover which must be cleared and grubbed. Since time is a limiting factor under most emergency conditions, avoid sites with excessive ground cover unless facilities can be dispersed within the vegetation without excessive clearing.

6.3.1.3.1.2. **Weather.** The climate and weather at the beddown location may impact siting decisions.

6.3.1.3.1.2.1. **Wind.** Prevailing winds should influence the location of facilities. Locate sewage lagoons downwind of the base complex. Prevailing winds should influence the orientation of buildings; when possible, do not place facility entrances so they face the wind. This lessens the entry of dust and minimizes adverse effects on heating and cooling systems.

6.3.1.3.1.2.2. **Solar Considerations.** Site facilities such that solar effects are properly accommodated; that is, maximized or minimized according to the time of year and latitudinal location. Sometimes the terrain is so featureless that you have few choices, especially in Southwest Asia (SWA).

6.3.1.3.1.2.3. **Rain.** The historical amount and frequency of rain or snow will indicate the likelihood of flooding and reveal how much of a problem an installation can experience with unpaved roads.

6.3.1.3.1.2.4. **Tides.** Consider tidal variations at coastal locations and likely storm surges if the area is subject to hurricanes or other ocean storms during the projected period of beddown.

6.3.1.3.1.3. **Land Use On- and Off-Base.** The activities that must take place on base and, to a lesser extent, off base are important considerations in site planning.

6.3.1.3.1.3.1. **Functional Relationships.** A key consideration when developing site layouts is the functional relationships between base activities. The base layout should attempt to enhance interactions between base organizations. For example, many maintenance facilities must be on the flight line to facilitate on-aircraft maintenance; however, some need not be. The avionics and parachute shops can be removed from the flight line when space is limited since direct access to the aircraft is not necessary. Supply facilities need not be all in one area either. Locate some warehouses near the aircraft maintenance facilities to improve response times to the primary supply customers. Place the civil engineer and vehicle maintenance functions near one another since a large vehicle fleet is involved. Put the main dining hall near the lodging area to better serve the base populace. User inputs are the best way to define these relationships.

6.3.1.3.1.3.2. **Space for Expansion.** Mission requirements change–add additional space in area requirements estimates to allow for expansion. Reserve land for expansion, particularly for functions that could require numerous facility increases, such as billeting and supply warehousing and storage. Consider an additional buffer around munitions storage areas so that increased munitions levels do not expand or shift explosive clear zones into areas where personnel live or work, thereby creating a violation of quantity-distance criteria. Allow sufficient space around utility plants so capacity can be increased without significant modification. Area requirements for a facility should also include space for attendant facilities. For example, aircraft parking ramps should have enough space to park the aircraft plus sufficient additional area to add revetments. Expansion flexibility is too often overlooked in the haste to complete initial siting actions. If not considered up front, it can lead to substantial problems later. Specifically, it saves the chore of relocating facilities and utilities that civil engineers have spent a lot of time erecting or constructing. If wing leadership cannot provide you with information on installation growth, make an educated guess using the information in this paragraph.

6.3.1.3.1.3.3. **Miscellaneous Support.** Another consideration, sometimes overlooked during siting, concerns miscellaneous support facilities. They are usually small structures, sometimes built by the troops themselves. For example, allow adequate space between facility groups to construct protective shelters. On the flight line or in dispersed aircraft parking areas, provide some form of sun shelters at various locations. Latrines also need to be sited near high-use areas when distant from the lodging complex.

6.3.1.3.1.3.4. **Obstructions to Base Operations.** Avoid sites with large physical obstructions that interfere with base operations or that delay the completion of expedient facilities. Check with the operations support squadron to clarify obstruction criteria for aircraft operations.

6.3.1.3.1.3.5. **Noise.** Siting actions should also take noise conditions into consideration. Do not site lodging, dining, medical, or MWR-related facilities where their use is compromised by excessive noise. Keep these functions away from power plants, vehicle maintenance yards, and airfield pavements such as runways, taxiways, and warm up pads. Unfortunately, it is difficult to site facilities to avoid aircraft noise at a bare base. When siting is not an option to minimize noise interference, civil engineers may resort to construction solutions such as berms or walls.

6.3.1.3.1.3.6. **Access Roads and Streets.** In beddown situations, transportation assets and materials handling equipment (fork lifts, etc.) may be very limited. Place facilities such as warehouses near existing roads or streets to improve access and minimize hauling distances where goods and materials must be moved by hand. This minimizes the need for construction of internal roads.

6.3.1.3.1.3.7. **Siting Functions Near the Perimeter.** Siting of functions that disturb civilian neighbors can create complaints which turn into political pressure to move the offending function. When possible, avoid potential problems by keeping nuisance-creating activities away from the installation perimeter. A good public relations effort early on can reduce complaints.

6.3.1.3.1.4. **Resource Protection.** Criteria that protect personnel and equipment must be considered during site planning and layout.

6.3.1.3.1.4.1. **Quantity-Distance (Q-D)/Safety Criteria.** Personnel need to be protected in the event of accidental munitions explosions. Follow the facility separation criteria outlined in AFMAN 91-201, *Explosives Safety Standards*.

6.3.1.3.1.4.2. **Fire Protection.** As a rule of thumb, make sure major firefighting vehicles can comfortably fit between all installation facilities. Not only does this allow vehicle access, but also helps prevent the spread of fire from building to building. If facilities are dispersed, fire protection distance criteria are normally met.

6.3.1.3.1.4.3. **Redundancy and Dispersal.** Siting should consider the need for redundancy and dispersal. Ensure that backup facilities are not located in close proximity to primary facilities. For beddown dispersal, keep at least 60 feet between buildings and 150 feet between facility groups. Remember, as distances increase, so does the need for transporting personnel.

6.3.1.3.1.4.4. **Air Base Defense.** Consider base defense requirements when laying out the air base. Use land features that aid in the defense of the installation perimeter. Consider dual fencing of critical portions of the perimeter if resources allow. Construct access routes to the installation to permit open line of sight and yet act as a deterrent to potential terrorist attacks. Site high-priority assets away from the installation perimeter. Request security forces' involvement in this planning.

6.3.1.3.1.5. **Utilities and Waste Disposal Siting.** A good facility site plan minimizes the need for rerouting utility systems that were installed early in the beddown effort. Rerouting can cause annoying and even untimely service disruptions. See paragraph **6.3.2.** for more information on beddown utilities.

6.3.1.3.1.5.1. **Utilities.** Many parameters affect utility siting. Multiple plants may be needed if the installation population is large or facility dispersal is required. For redundancy and survivability purposes, plan for looped systems if time and materials are available. The degree of facility dispersal dictates the amount of materials needed for installation of the systems. A balance must be achieved between facility dispersal and utility distribution line lengths. When siting water plants, consider the distance from the source or sources–keep the plants on base if possible. Provide water storage at several locations for survivability and firefighting.

6.3.1.3.1.5.2. **Solid Waste Disposal.** Set aside areas for landfills if off-base or contract disposal is not an option. If possible, find locations where clay is available to line the pits and reduce ground water contamination. Landfills tend to attract birds and may reek of an awful odor. Place landfills away from the approach ends of runways and downwind from living areas.

6.3.1.3.1.6. **Available Resources and Other Logistics Factors.** Some logistics issues can influence facility siting.

6.3.1.3.1.6.1. **Transportation.** Availability of transportation can be an important site selection factor. As an illustration, siting lodging for an aircraft maintenance squadron miles from the flight line presents few problems if adequate vehicles are available to transport personnel. However, the same arrangement at an installation with limited transportation would cause excessive delays during shift changes.

6.3.1.3.1.6.2. **Availability of Local Materials.** If all other considerations are equal, select a site in proximity to local resources. This reduces transportation requirements and base development time.

6.3.2. **Beddown Utilities.** Supporting utilities are essential to force beddown (**Figure 6.4.**). Electricity is needed for lighting and to power equipment. An effective sanitation system prevents the outbreak of disease that can disable great numbers of the installation populace. An adequate water supply and distribution system are required for subsistence, hygiene, and construction efforts. Depending upon the climate, there may be a need to provide heating and air conditioning. The following paragraphs present general concepts for providing utilities during beddown operations.

6.3.2.1. **Electrical Systems.** For most contingency situations, some electrical support is required immediately. Although the development of initial electrical service often slightly lags the erection of facilities, it should keep pace.

6.3.2.1.1. **Basic Construction Principle.** Avoid constructing new systems unless absolutely necessary. Use existing electrical production and distribution systems to the maximum extent possible. Delay running power to any facility or function that can do without electricity. For example, a warehouse or storage area not used at night may have no immediate need for electricity.

6.3.2.1.2. **Power Source.** There are two basic sources for satisfying beddown needs—existing commercial power (or base-generated power) and portable generators. While the selection usually depends on availability, a combination of these methods often offers the best solution.

Figure 6.4. Engineers Lay Out Power Cables at Forward Operating Location.

6.3.2.1.3. **Commercial or Base Power.** If available, commercial or base power is the best source. One weakness of this power source is that these sources can be damaged or destroyed during the contingency that prompted the need for force beddown. Commercial power service can often be restored relatively quickly following a disaster. However, the needs of the surrounding civilian community may be such that excess power is unavailable for use by the incoming forces. Power from an base plant depends on the damage it incurred during the emergency and its capacity to provide the additional power for the deployed forces or displaced victims. The configuration of the existing distribution system influences where and how much power can be supplied in support of beddown facilities.

6.3.2.1.4. **Portable Generators.** The likely source of power for most beddown operations is portable generators. To aid base refueling efforts, keep the number of generators to a minimum when considering facility layouts and be sure to prepare a generator refueling plan. Weather can impact generator operations. During extreme cold weather, special lubricants must be used, storage batteries must be checked frequently to prevent freezing, and moisture buildup on equipment must be removed rapidly to prevent problems. When operating in extreme heat, ensure the cooling system is cleaned and flushed at regular intervals and the coolant is maintained at the proper level. It is also a good idea to shelter (**Figure 6.5.**) generators from the effects of solar radiation in hot climates such as in Southwest Asia. Consult AFPAM 10-219, Volumes 5 and 6, and AFH 10-222, Volume 5, for more specific information on bare base electrical systems.

Figure 6.5. Sheltered Generators.

6.3.2.2. **Water System.** Water is the most critical need of any beddown population. An adequate supply of potable water must be available for human use, such as drinking, cooking, and showering. Improperly treated water can spread diseases such as typhoid, dysentery, cholera, and common diarrhea. Non-potable water may be used for firefighting, general decontamination, and construction. Water systems generally consist of four elements: source, treatment, storage, and distribution.

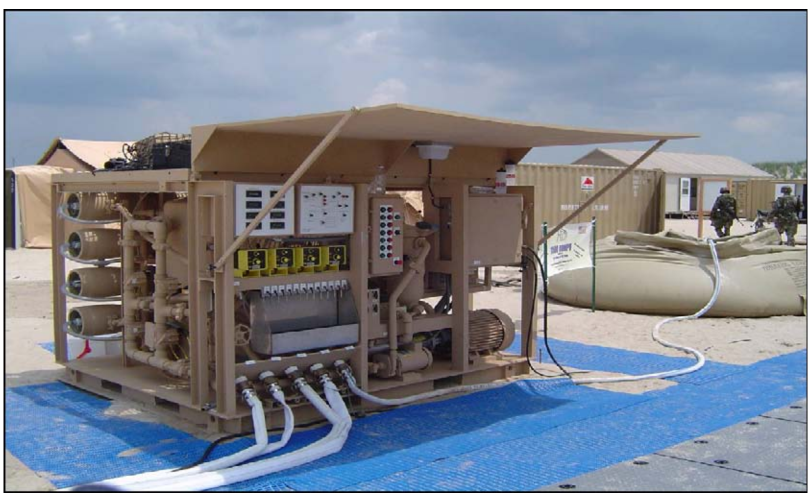
6.3.2.2.1. **Water Sources.** The first choice for a water source should be the existing water supply system. Often, the next best option is to haul potable water from nearby locations. Other sources include lakes, rivers, streams, ponds, wells, springs, ice, snow, distilled sea water, and rain collected in catchments. The value of any source depends on many factors: proximity to beddown location; quantity of water available versus the demand; amount of treatment required; time and effort required to develop the source; ability to pump or transport water from the source to the point of use, etc. If you have to use one of these alternate sources and everything else is equal, pick the one that appears to be the most sanitary. Water taken from any source, except an existing water supply system approved by the Air Force medical team, should be treated before use.

6.3.2.2.2. **Water Treatment.** The degree of water treatment depends on the level of contamination. Water from some ground sources may only require chlorination, while water from a muddy river requires complete treatment. If contaminated sources must be used and local treatment is inadequate, civil engineers must set up at least the treatment and storage components of the water system contained in BEAR assets. The reverse osmosis water purification units (ROWPU) in those packages use a process of forcing feed water under high pressure through a set of membranes that screen out dissolved solids to make water potable. The ROWPU can also purify salt or brackish water. The Air Force currently uses both the 600-GPH unit shown in **Figure 6.6.** and the 1500-GPH unit shown in **Figure 6.7.** Until ROW-

PUs can be set up, potable water must be hauled in by truck or plane, or individuals must treat their own water. This can be accomplished most easily by adding iodine purification tablets or calcium hypochlorite ampules to a canteen of water. When no other method is available, water may be rendered safe by bringing it to a boil for at least 15 seconds. Disadvantages of boiling include the fuel requirement, the time requirement for water to boil and then cool for consumption, and lack of residual protection against recontamination.

Figure 6.6. 600-GPH Reverse Osmosis Water Purification Unit (ROWPU).

Figure 6.7. 1500-GPH Reverse Osmosis Water Purification Unit (ROWPU).



6.3.2.2.3. **Water Storage.** If permanent water storage facilities at the beddown location are not adequate, temporary storage facilities may be provided by using bladders from BEAR assets. Civil engineers can also use tank trucks, water cans, and water bags. Non-potable water for firefighting and other uses may be stored in swimming pools, ornamental pools, and abandoned basements.

6.3.2.2.4. **Water Distribution.** The existing water distribution system should be used when possible. Temporary branch lines can be run from permanent water mains using available pipe or even fire hose. Additionally, if sufficient water booster pumps are available, they may be used to provide pressure to an expedient water distribution system. BEAR assets have components sufficient to provide a complete, pressurized water distribution system. For very short-term beddowns, it may not be practical to lay extensive distribution lines. Water can be hauled to distribution points (water points) where users fill their own water cans and other containers (**Figure 6.8.**). The M149 water trailer is commonly used to distribute water to remote locations. For more specific information on bare base water sources, treatment, and distribution, refer to AFPAM 10-219, Volumes 5 and 6.

Figure 6.8. Water Distribution Point.

6.3.2.3. **Expedient Heating Systems.** The climate gets cold enough in most locations that shelters require heat at least part of the year. The prevailing weather at the time of beddown dictates how soon heat must be provided. BEAR systems provide environmental control units (ECU) to heat and air condition the shelters. The H-45 Space Heater and Preway 70,000 BTU Heaters are also available and work well in temperate climates. However, fuel must be distributed to these heaters; they need to be attended to when they are operating, but they do not require an electrical distribution system like ECUs. See AFPAM 10-219, Volumes 5 and 6, for additional details.

6.3.2.4. **Field Sanitation.** In any contingency situation, personnel must be protected from disease outbreak. Following proper field hygiene and sanitation measures can help control diseases. Such measures apply to individual actions and the operations of the entire camp. Civil engineers are responsible for the design, construction, and operation of many facilities and services necessary for the preservation of health. The primary areas of concern when establishing proper field sanitation are personal hygiene, waste disposal, and pest control.

6.3.2.4.1. **Personal Hygiene Facilities.** Personal hygiene is the practice of health rules to safeguard one's own health and the health of others. Good personal hygiene is one of the most important factors in the prevention of disease. The following facilities developed by civil engineers for force beddown contribute to effective personal hygiene.

6.3.2.4.1.1. **Shower and Lavatory.** Shower and lavatory areas are essential elements in providing for effective hygiene. Personnel must have a place to maintain body cleanliness. Consider the factors in **Table 6.2.** when developing shower and lavatory areas.

Table 6.2. Planning Factors for Showers and Lavatories.

Planning Factors
Direct drainage away from site; otherwise, water may pool around the shower area, creating a bog and growth area for bacteria and mosquitoes. Do not place the structure on grade and assume water will flow quickly away from site.
Shower and lavatory facilities will receive extensive use. If set up in GP medium tents and used more than 30 days, recommend tents be hardbacked.
Heat expedient shower and lavatory areas.
Provide privacy screens at each entrance and exit (plywood or canvas sheet with 2” x 4” bracing). The TEMPER tent vestibules are sufficient.
Provide benches for dressing and undressing. Additionally, a means of hanging clothes and towels improves the usefulness of the facility. This can be done with 1” x 6” or 1” x 4” boards, 8' to 16' long, with nails driven about 1' apart to serve as hooks.
Provide individual shut-off valves at each shower head to conserve water.
Lavatory area for shaving and brushing teeth should be supported by piped water. Each location should have individual water faucets.
Each lavatory location should have a mirror and light. Provide an electrical outlet for every other lavatory location.
In very austere conditions, large trash cans with immersion heaters can be positioned inside to provide hot water. Incorporate procedures to keep them filled and ensure temperature does not exceed 140^{o}F.

6.3.2.4.1.2. **Laundry.** A laundry helps maintain personal hygiene and contributes to the overall comfort level by providing fresh clothing. Laundry facilities may be set up using commercial-type washers and dryers, or a complete field laundry may be operated by a deployed Prime RIBS (Readiness in Base Services) team. Primary civil engineer support to either type of operation will be in the form of electrical power, an adequate water supply, and proper drainage.

6.3.2.4.2. **Waste Disposal.** Improper waste disposal provides breeding grounds for numerous pathogens, greatly increasing the potential for spread of disease. Therefore, an important aspect of force beddown is the development of waste disposal systems. Of primary concern are systems for the disposal of human waste, kitchen and bath liquid waste, garbage, and solid waste. In some circumstances, engineers must also be concerned with toxic wastes. When developing disposal methods, bioenvironmental engineers and the units that generate the waste should be major players. Consult AFH 10-222, Volume 4, *Environmental Guide for Contingency Operations Overseas,* for more information on managing waste and wastewater.

6.3.2.4.2.1. **Human Waste.** Proper disposal of human waste is one of the most important elements in the prevention of disease. Water supplies are easily contaminated by improper disposal, resulting in potentially catastrophic outbreaks of disease ranging from dysentery to hepatitis. Preferably deployed teams use existing sewage systems for disposal of human wastes at MOBs or COBs. At bare bases, BEAR assets will likely be used. When the situation dictates, expedient waste disposal techniques (**Table 6.3.**) may have to be employed. More information and specific construction techniques for these facilities are provided in AFPAM 10-219, Volumes 5 and 7.

Table 6.3. Expedient Waste Disposal Methods.

Expedient Methods for Human Waste Disposal
Portable Toilets
Straddle Trench Latrines
Deep Pit Latrines
Burn-out Latrines
Mound Latrines
Bored Hole Latrines
Pail Latrines
Urine Soakage Pits

6.3.2.4.2.2. **Liquid Waste.** Proper disposal of liquid wastes from kitchen and bath sources prevents breeding grounds for harmful bacteria. On a MOB or COB, force beddown personnel should attempt to connect these facilities to existing sewers. If this is not possible, kitchen liquid waste should be processed through a simply-constructed grease trap to either a soakage pit or evaporation bed. The grease trap captures most oils and fats that prevent, or slow down the clogging of the soil. Grease buildup happens surprisingly quickly in grease traps. Periodically inspect and clean grease traps to ensure they continue to function properly. Details for constructing these expedient facilities are covered in AFPAM 10-219, Volumes 5 and 7.

6.3.2.4.2.3. **Kitchen Garbage.** Large-scale beddown operations generate tons of garbage. When allowed to accumulate without control, it provides an ideal food source for insects, rodents, and other vermin. Two primary means of garbage disposal are incineration and burial. On MOBs or COBs, large-scale garbage incinerators, sanitary landfills, or garbage collection contracts will exist. In less developed locations, civil engineers may have to develop improvised methods to dispose of garbage. In any case, engineers must build garbage collection points near food preparation facilities and arrange for periodic pickup.

6.3.2.4.2.3.1. Garbage for short-term beddown operations can be buried in small pits or trenches. A pit 4 feet square and 4 feet deep can handle one day's garbage for 100 personnel. These pits should be filled no closer than 1 foot below ground surface, sprayed with insecticide, and mounded over with compacted earth to 1 foot above ground surface. Mark each pit with a rectangular sign on top of the mound indicating the type of pit and date closed. When larger pits are used, cover the garbage daily. Insecticide is not required if 2 feet of compacted soil are used for cover.

6.3.2.4.2.3.2. For longer term operations, garbage can be buried in a continuous trench or combined with other solid waste in a sanitary landfill. The size of the trench depends upon the size of the force to be supported and the length of stay. Using this method, dirt excavated while extending the trench is used to cover and mound the garbage already deposited.

6.3.2.4.2.3.3. Under temporary conditions, relatively small amounts of wet garbage can be burned in open incinerators. Expedient open incinerators may be improvised from numerous materials readily available at most beddown locations. For example, 55-gallon drums can be converted to make excellent barrel incinerators. When using a drum for an incinerator, ensure it is free of toxic, flammable, or combustible contents.

6.3.2.4.2.4. **Solid Waste.** A significant amount of solid waste is also generated at beddown sites. Because this waste also provides an excellent breeding ground for insects and rodents, it too must be disposed of properly. Dry combustible waste can be burned, but separating the non-combustible materials is often not worth the effort. Open burning is not without problems. Smoke can interfere with local aircraft operations and be a nuisance downwind. Most often, garbage and solid waste are disposed of in a common sanitary landfill, and each day's deposit is covered with soil. Build collection points throughout the encampment and especially at locations convenient to the major waste producers. Units should carry their own trash to the pickup points. Encourage units to minimize the amount of garbage they generate or at least reduce the volume they create by flattening boxes and cans. Set up a collection schedule and assign trash collection and disposal tasks to one or more crews. See details on sanitary landfills in AFPAM 10-219, Volume 5.

6.3.2.4.2.5. **Toxic Waste.** To minimize ground water contamination and other public health problems, civil engineers may have to develop disposal options for toxic wastes generated on base. The best option is to eliminate the use of those products. When that is not possible, set up procedures with installation units that generate toxic materials to minimize their use, collect the used materials, and temporarily store them. Involve base supply and base transportation when transporting toxic wastes. In some circumstances, the installation may need to follow Environmental Protection Agency (EPA) and Department of Transportation (DOT) rules.

6.3.2.4.2.5.1. Establish one or more hazardous waste accumulation points. Do not commingle incompatible wastes. If possible, construct a holding area to contain any spilled liquids. As soon as possible, work on a method to permanently and properly dispose of those wastes. Burial is an option, but double seal waste materials when possible or place single-sealed containers in a lined pit. If at all possible, do not commingle toxic wastes with regular garbage and solid waste. Mark burial sites and identify the name and amount of each material.

6.3.2.4.2.5.2. Construct oil-water separators to process drainage from activities such as aircraft wash racks, aircraft fuel cell operations, engine maintenance shops, and POL storage and transfer facilities. Be sure to set up responsibilities, procedures, and a schedule to periodically service the oil-water separators.

6.3.2.4.2.6. **Medical Waste.** Work with the site medical team to develop acceptable disposal methods for medical waste.

6.3.2.4.3. **Pest Control.** Control of insects, rodents, and associated vermin is important during force beddown. These pests carry disease and quickly spread contamination throughout the air base if left uncontrolled. The primary means of pest control has already been discussed, that being proper disposal of waste materials and garbage. However, control of the pest population may require extermination. If that becomes necessary, consult qualified CE pest controllers or the medical public health specialists to determine proper procedures. Insects are controlled by spraying an insecticide in and around nesting and feeding areas and fogging or spraying throughout the installation. Rodents are controlled with poisons or traps.

6.4. Summary. An effective force beddown capability is essential to support military operations worldwide. Beddowns are required to accommodate forces deploying to counter an actual or threatened enemy attack and to shelter victims of natural disasters and man-caused accidents. A good understanding of how to determine and satisfy beddown requirements is important. To gain a full understanding of the CE beddown effort, explore the supporting documents listed in **Table 6.4.** They provide additional details on beddown planning, scheduling, and execution and bare base equipment.

Table 6.4. Beddown References.

Other Beddown References
AFPAM 10-219, Volume 5, *Bare Base Conceptual Planning Guide.*
AFPAM 10-219, Volume 6, *Planning and Design of Expeditionary Airbases.*
AFPAM 10-219, Volume 7, *Expedient Methods.*
AFH 10-222, Volume 1, *Guide to Bare Base Development.*
AFH 10-222, Volume 2, *Guide to Bare Base Base Assets.*
AFH 10-222, Volume 4, *Environmental Guide for Contingency Operations Overseas*
AFH 10-222, Volume 22, *Refugee Camp Planning and Construction Handbook.*
AFI 10-404, *Base Support and Expeditionary Site Planning.*
UFC 3-260-01, *Airfield and Heliport Planning and Design.*

Chapter 7

ENVIRONMENTAL HAZARDS

7.1. Introduction. Planning for environmental hazards is an important step of disaster and attack planning and preparations. Installations must have a plan that outlines how the base will respond to a hazardous material release or spill. Although the base civil engineer is responsible for the hazardous materials (HAZMAT) plan, active support by all base organizations is required. Rather than a stand-alone plan, some installations may incorporate the HAZMAT plan as an appendix in the CEMP 10-2. This chapter provides only a brief discussion of HAZMAT *planning*, *capability assessment*, and *spill response considerations*. The primary guidance for establishing and maintaining a HAZMAT program at Air Force installations is AFMAN 32-4013, *Hazardous Material Emergency Planning and Response Guide*, (until rescinded by AFMAN 10-2502 Series publications). For contingency operations in foreign countries, consult AFH 10-222, Volume 4 which contains guidance on environmental considerations for Air Force civil engineer personnel deployed in support of overseas contingency operations.

7.2. HAZMAT Response Planning. In planning a response to a hazardous materials release or spill, a hazards analysis is an important step in the preparation process. The hazards analysis is a three-step, decision-making process of collecting and analyzing information on potential HAZMAT releases. It is used to obtain a clear understanding of what hazards exist and the risk posed to personnel, property, missions, and the environment. The information developed in a hazards analysis provides the basis for notification and reporting requirements, establishes subsequent planning priorities, and provides the documentation to support HAZMAT planning and response efforts. There are three key components associated with hazards analysis: *hazard identification, vulnerability analysis, and risk analysis* (**Table 7.1.**). Developing a complete hazards analysis that examines all hazards, vulnerabilities, and risks may not be practical. The HAZMAT emergency planning team should determine the level of thoroughness needed. Resources should be concentrated on those situations which present the greatest potential risk or those situations most likely to occur.

Table 7.1. Hazards Analysis Process.

Hazard Identification	Vulnerability Analysis	Risk Analysis
Chemical Identity	Vulnerability Zone	Likelihood of a Release Occurring
Location	Human Populations	Severity of the Consequences
Quantity	Critical Facilities	
Nature of Hazard	Environment	

7.2.1. **Hazard Identification.** Hazard Identification is the primary component in hazards analysis which identifies hazardous materials at specific locations or throughout the installation that are at or above the screening levels and the release prevention measures in effect at each location.

7.2.2. **Vulnerability Analysis.** This is an assessment of areas potentially affected by the release of a hazardous material. It includes gathering information on the extent of the vulnerable zone, conditions that influence the zone, size and type of population within the zone, property that might be damaged, and the environment that might be affected.

7.2.3. **Risk Analysis.** Risk analysis is an assessment of the likelihood of an accidental release of a hazardous material and the consequences that might result based on the estimated vulnerable zones. Risk analysis is based on the history of previous incidents at the installation, mathematical modeling, and the best available information.

7.3. HAZMAT Capability Assessment. Following the hazards analysis process, the HAZMAT emergency planning team conducts a thorough capability assessment to identify all installation and local community resources available for response to HAZMAT releases and determines whether any additional resources or requirements are necessary. The goal of the HAZMAT emergency planning team is to implement a risk management program to ensure the resource capability is equal to the installation's potential HAZMAT problems. Senior leadership should determine whether or not an unprotected risk exists, and if one does, modify that risk by either reducing their potential HAZMAT problem, increasing their response capability, or a combination of both. The HAZMAT emergency planning team, in conjunction with members of the emergency operations center and first/emergency responders, should conduct a capability assessment that accomplishes the following:

7.3.1. Identifies installation resources available for responding to a HAZMAT release.

7.3.2. Assesses personnel, funding, information sources, command and control, site management, evacuation, personal protective equipment, monitoring, release control and containment, decontamination, laboratory support, cleanup, and recovery.

7.3.3. Determines whether the installation needs additional resources to respond effectively.

7.3.4. Identifies available local community resources, including available commercial services, to supplement installation shortfalls.

7.3.5. Sets up mutual aid agreements, including HAZMAT emergency response provisions, when using local community HAZMAT capabilities.

7.3.6. Identifies HAZMAT capability deficiencies and tracks them until it has implemented corrective actions.

7.4. HAZMAT Spill Response Considerations. Every installation tries to prevent spills from occurring. However, in the unlikely event a spill does occur, effective planning and response will help mitigate the hazard and return the affected area to productive use (**Figure 7.1.**). Disaster and attack preparations help to ensure trained personnel or contractors, equipment, and materials are available to help the base spill response team with containment, cleanup, and site restoration of hazardous substance spills.

7.4.1. **Spill Response Team.** Spill response teams provide containment and remediation of hazardous waste spills. Members vary by installation and type and size of spill response. The spill response team may consist of representatives from the offices listed in **Table 7.2.,** as warranted by the magnitude of the incident.

Figure 7.1. Firefighters Douse Fire Caused by Accidental Fuel Spill.

Table 7.2. Spill Team Members.

Incident Commander (IC) Directs all spill response actions. Has authority to assemble and use the expertise and resources of the group determining and performing response actions. The senior fire official on duty is designated IC until a higher ranking representative who is IC-qualified arrives.		
Base Civil Engineer	Fire Emergency Services	Environmental Engineer
Readiness and Emergency Management Flight	Bioenvironmental Engineer	Security Forces Squadron
Safety	Fuels Management Flight	Staff Judge Advocate
Public Affairs Office	Hospital or Medical Clinic	Logistics Transportation Flight
Base Weather Flight	Others as needed	

7.4.2. **Containment.** Fire Emergency Services (FES) provides containment during a hazardous materials response. As first responders to the incident, FES personnel provide command and control, rescue, extinguishment, and containment actions based on the conditions present. First responder actions include steps to limit the spread of pollution; evacuation of nonessential personnel; cordoning off the danger area; stopping the release; and preventing the spread of the spilled material into gutters, manholes, and storm drains. Once these actions have been accomplished, FES's involvement normally reverts to a support role.

7.4.3. **Site Cleanup and Restoration.** Site cleanup and restoration normally involve neutralization, recovery, cleanup, and disposition of hazardous waste and are accomplished by trained experts in related fields and are not HAZMAT emergency response team functions. Short-term site restoration requires the removal of contaminated soil, cleaning exposed surfaces, or taking other immediate actions intended to permit workers to resume normal work activities near the spill site. Long-term site restoration may require several months to several years to complete. It includes spill site restoration where hazardous chemicals contaminated large quantities of earth. Long-term site restoration also prevents further contamination, restores contaminated earth, and permits productive use of the spill site.

7.5. Summary. War and disasters can create unexpected environmental problems. How installations respond can reduce the hazards, leave them unchanged, or increase them. In crises, sometimes there are no environmentally acceptable choices of action, but we must have an understanding of the choices we make and their consequences. Do not use an emergency as an excuse to ignore environmental considerations. That is not smart. Poor choices can affect the installation immediately, such as allowing a toxic chemical spill to get into the installation drinking water. As a minimum, civil engineer disaster response actions should not make an environmental problem bigger. This brief discussion should provide some insight into HAZMAT planning and preparations. For more specific information on environmental hazards and response planning, see reference documents listed in **Table 7.3.**

Table 7.3. HAZMAT Planning and Preparation References.

HAZMAT Planning and Preparation References
AFH 10-222, Volume 4, *Environmental Guide for Contingency Operations Overseas.*
AFI 10-2501, *Air Force Emergency Management (EM) Program Planning and Operations.*
AFPAM 10-219, Volume 1, *Contingency and Disaster Planning.*
AFI 32-2001, *The Fire Protection Operations and Fire Prevention Program.*
AFI 32-7006, *Environmental Program in Foreign Countries*.
AFMAN 32-4013, *Hazardous Material Emergency Planning and Response Guide.*
USCENTAF *Spill Response Plan Template.*
USCENTCOM Handbook, *You Spill You Dig.*
US Army Handbook, *You Spill You Dig II.*

Chapter 8

SUPPORT TO AND FROM OTHERS

8.1. Introduction. Support between units is a routine activity at most air bases and is necessary to ensure daily mission accomplishment. Likewise, the support that CE provides to and receives from others during or after an emergency also helps to ensure mission continuity. Although the examples of support briefly discussed in this chapter are not all inclusive, all support provided and received by CE should be coordinated with the supporting/supported unit in advance and included in the Comprehensive Emergency Management Plan (CEMP) 10-2. Training and exercises that periodically test and evaluate support between units are also good practices. Paragraph **8.2.** addresses a few agencies that may provide support to CE during emergencies, and paragraph **8.3.** briefly discusses support that engineers may typically provide to others.

8.2. Support to Civil Engineers. Without the support of other agencies, civil engineers would find it extremely difficult to perform their mission during a crisis. The information in **Table 8.1.** is a sample of installation agencies and the support they could provide to CE after an attack or disaster.

Table 8.1. Support to Civil Engineers.

Who	What Support May Be Needed
Vehicle Maintenance	Normal in-shop and mobile maintenance and repairs, especially for heavy equipment. Mutual support can be very beneficial—try hard to support them when they need help. For example, if base power is lost, set them up with a generator. Not only will it allow them to support the installation, but it also helps to ensure your vehicles get fixed.
Base Fuels	On-site fueling of heavy construction vehicles in the field is most helpful. Field refueling can save a lot of time and problems. If they cannot help, look into setting up your own refueling operation. This also applies to refueling emergency generators.
Supply Support	Establish special supply levels for critical, but little used, items for facility /utility system repairs. This helps ensure items are received quickly. A good working relationship with supply personnel can make the difference.
Mission Support	Coordinates critical manpower support to Readiness and Emergency Management Flight for disaster response through Ready Augmentee Program.
Contracting and Finance	Purchase needed supplies and equipment from local sources. Negotiate and fund expedient contract support for restoration of essential installation capabilities. Advise on best approach to acquire resources.
Aircraft Maintenance	Light carts for nighttime work, air compressors, and portable AC units. When running short of light carts, aircraft maintenance personnel usually have more of them than anyone else on base. They also have air compressors and portable air conditioners that may also be useful.
Services	Provides box lunches or equivalent and rest and relief support for emergency response crews; stocks shelters for contingencies.

8.3. Civil Engineer Support to Others. Whether preparing to beddown incoming forces, respond to a disaster, or prepare for a possible attack at a forward operating base, civil engineers provide critical support to base personnel and agencies. The following paragraphs provide some examples of the support CE provides.

8.3.1. **Individual Unit Assistance.** As mentioned earlier, every unit has the responsibility for preparing their personnel, equipment, and facilities for war, disaster, and other emergencies. One way CE assists individual units is by providing prior instruction in shelter management, CBRN defense, contamination control, specialized teams, and other wartime and emergency management activities. CE also offers units on-the-spot guidance for shelter siting and erecting tents, sandbagging, and defensive fighting positions. Additionally, CE constructs berms, revetments, and ditches to support unit passive defensive measures.

8.3.2. **Mortuary Activities.** The likelihood of a major attack on US air bases has diminished over the years. However, the base mortuary officer still needs to plan for processing and burying human remains if the number of deaths exceeds the installation's capability to store or ship the remains home quickly. Civil engineers provide labor and equipment to assist the mortuary officer in preparing temporary cemeteries and mass burial sites for contaminated and non-contaminated remains. These activities could involve helping the mortuary officer pre-identify burial locations and making sure the burial sites do not create an environmental problem or interfere with other uses for the proposed sites. If necessary, EOD personnel assist during the processing of remains by removing any explosive hazards or residue contained in the remains.

8.3.3. **Casualty and Damage Reports.** Casualty and damage reports are generally provided to the chain of command after an attack or disaster (**Figure 8.1.**). All units (primarily through their UCC and specialized teams) report casualties, facility damage, and other situations to the EOC. However, CE may also be called upon to assist the installation in developing unit casualty and damage reporting procedures.

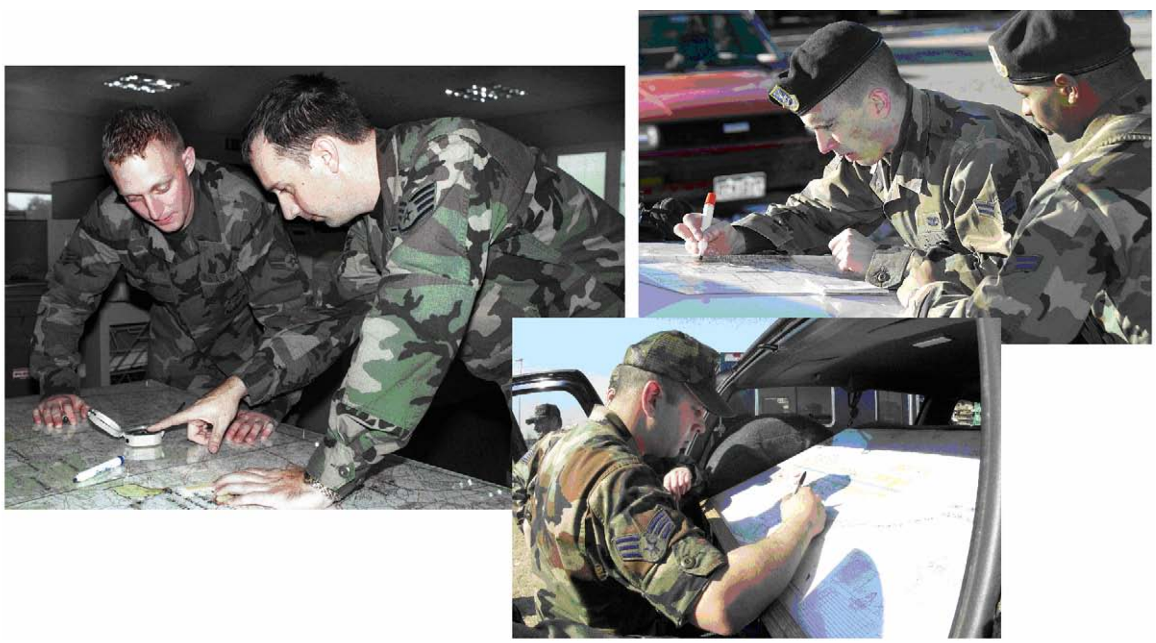
Figure 8.1. Preparations Include Procedures for Recording and Reporting Casualties.

8.3.3.1. **Casualty Reports.** When assisting with casualty reporting preparations, consider what information needs to be reported and what unit members should do with wounded and deceased casualties if discovered. If known, address the location of casualty collection points and be aware that these pre-selected collection points may change if affected by the attack or disaster.

8.3.3.2. **Damage Reports.** As the focal point for facility structure and repair, civil engineers are the logical choice to help the installation develop damage reporting procedures. As previously mentioned, all units should report their facility damage up the chain of command. However, do not expect unit damage reports to be as detailed as comprehensive damage assessment reports submitted by CE damage assessment teams. Consider the following when assisting the installation with damage reporting preparations: ensure procedures to gather damage assessment inputs from installation units are in place; set up damage assessment teams, priorities, and preset travel routes; and set up observation posts as needed.

8.3.4. **Maps and Charts.** Maps and charts are critical to base recovery after an attack or disaster. Although extremely important for decision makers in the ICC, EOC, DCC and other command centers, maps and charts may also be instrumental to unit specialized teams and individuals performing important recovery tasks (**Figure 8.2.**). CE preparations may include preparing a master standard grid map or maps for installation command and control; disaster response forces, damage assessment teams, and CBRN Control Center. Airfield surface maps for minimum operating strip (MOS) selection teams may also be required. Response functions need current on-base and off-base maps to perform their missions. Regardless of who prepares them, copies of all maps should be in the primary and alternate EOC and DCC. A good preparation step is to list installation requirements for maps and charts to support contingency operations and include instructions and an example showing how to read the installation grid map.

Figure 8.2. Command Centers, Specialized Teams, and Individuals Utilize Maps.



8.4. Summary. The support between CE and other installation agencies could be essential after an attack or disaster. The type of support discussed in this chapter highlights only a few examples of the aid and coordination that may be necessary. These and other coordinated activities not only assist in the base recovery, but save lives and protect property. Comprehensive base preparations, including combined training and exercises that test the unit's ability to respond to disasters and attacks, help to ensure mission continuity in an emergency. Refer to the references in **Table 8.2.** for more information on the support that CE provides and receives from other agencies.

Table 8.2. CE Support References.

CE Support References
AFI 10-2501, *Air Force Emergency Management (EM) Program Planning and Operations.*
AFPAM 10-219, Volume 1, *Contingency and Disaster Planning.*
AFPAM 10-219, Volume 3, *Postattack and Postdisaster Procedures.*

Chapter 9

BASE DENIAL

9.1. Introduction. The Department of Defense defines denial measures as actions that hinder or deny the enemy the use of space, personnel, or facilities. It may include destruction, removal, contamination, or erection of obstructions. In CE contingency response planning, base denial is an overseas theater task. It can become a CE task when the theater commander directs base evacuation and the destruction of selected air base systems, military equipment, and supplies. The BCE must prepare in advance a list of candidate targets. Denial of air base infrastructure, for the large part, will be the responsibility of the civil engineers. If available, EOD personnel will assist in carrying out some base denial operations using explosives. However, the BCE has numerous options available to effect denial operations without having to rely on the use of demolition experts. For the main operating base (MOB) civil engineer, a denial responsibility includes all militarily significant civil engineer supplies and equipment, base facilities and utilities, and the airfield pavement system. For BCEs at collocated operating bases (COBs) and bare bases, only USAF organic equipment is normally considered since real property facilities and utility systems are a host nation responsibility. This chapter provides guidance on conventional denial procedures to be used at a deployed location. Non-explosive destruction methods are suggested for each of the basic civil engineer areas of responsibility. This chapter does not address denial operations at captured locations or specially identified targets—these types of missions are normally RED HORSE tasks and will generally have a narrower scope of activity.

9.2. Base Denial Considerations. Because air bases have not normally been highly threatened in previous conflicts, denial of an air base to enemy forces is an undertaking largely unfamiliar to the US military. However, modern warfare and the forward locations of many air bases now make the requirement for base denial a possibility. Engineer forces will play a major role in such activities since they control significant amounts of equipment and supplies useful to an enemy and are most familiar with the utility and facility aspects of any installation. Furthermore, the explosive demolition expertise resident within an engineer squadron makes the unit especially capable in base denial activities. Base denial actions are not haphazard events—they require considerable preplanning and everyone's support to be carried out effectively.

9.2.1. The theater commander will describe the policy and extent to which denial operations are carried out. Denial of key installations and facilities is desirable in most situations. Selected denial targets are integrated into the overall strategic and tactical concepts of the theater operations plan and are executed in accordance with war objectives. Actual denial activities will not start until directed by the installation commander and only after careful consideration has been given to the possible negative impacts of allowing the enemy use of the air base. In addition, consideration must be given to possible future use of the air base by US forces. Taking it with you when you leave (evacuation) is the preferred method of denial and should be used when conditions permit. That which must be abandoned must be denied to the enemy.

9.2.2. Targets for base denial can come in many forms and one must be selective in choosing which targets to address. Base denial carried to the extreme would remove or destroy everything that could aid the enemy in any way (**Figure 9.1.**). Attempting to destroy an entire air base would be an extremely time-consuming task and probably beyond the capability of the normal wartime complement of engineer forces at an air base. Besides matching manpower and time constraints against the scope of the overall denial task, the means selected to deny the intended target should be reasonably available and produce the most damage possible. Targets for base denial could include heavy equipment, fuel supplies, key buildings, utility substations, airfield pavements, and classified materials, to name a few. And each of these could require a differing mode of destruction. In executing base denial responsibilities, the BCE's denial targets should meet one of these criteria:

Figure 9.1. Total Facility Denial.

9.2.2.1. Require the enemy to divert significant engineer and operational efforts for repair, reconstruction, or rehabilitation to resume flying operations or other priority missions.

9.2.2.2. Prevent the use of abandoned materials, supplies, and equipment to reinforce or augment the enemy's combat capabilities.

9.2.3. Once installation targets meeting the above criteria are chosen, they must be placed in a priority sequence for denial actions. This priority listing is important since time will probably be limited for base denial activities, and the most crucial actions (i.e., those actions which cause the greatest degree of resource denial) should be performed first. The priority listing must also take into account the interface and timing between denial actions. If these are not considered, serious problems could result that may interrupt and hinder the entire base denial effort. For example, fuel stores could be destroyed before evacuation vehicles are fully serviced, traffic routes used by other denial teams could be blocked, or power could be cut off to those facilities being used to marshal and prepare equipment and supplies for evacuation.

9.2.4. As mentioned earlier, removal and evacuation of resources is the preferred method of base denial. The reasons for this are obvious—the resources are not harmed or damaged and they remain in US forces' control rather than being lost for the remainder of a conflict. Because evacuation operations will always be constrained by time and many agencies could be potentially involved in the process, base denial must follow a thoroughly developed and well rehearsed plan that the BCE prepared in advance (see AFPAM 10-219, Volume 1, Chapter 2).

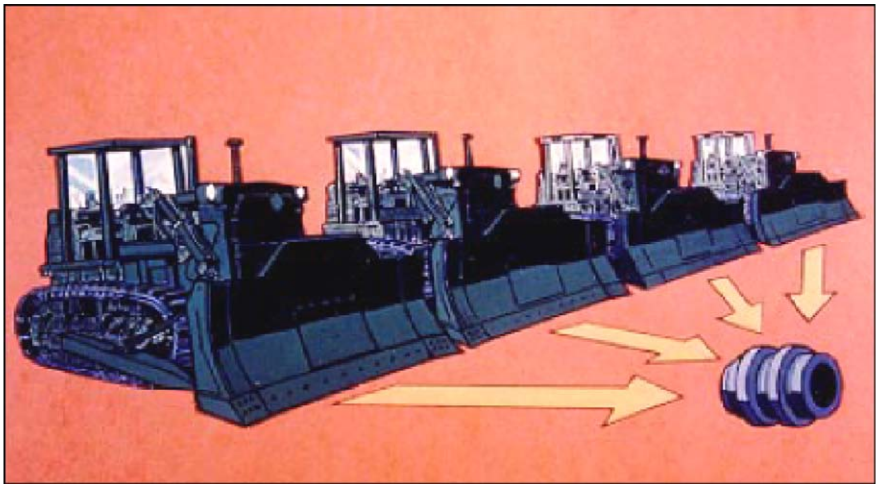
9.3. Conventional Base Denial Methods. There are four conventional ways of accomplishing base denial: item evacuation, selective component removal, destruction, and the use of obstacles. Each method can have a place in the overall base denial scenario. Because time to effect base denial will usually be short, attempt to use the procedure or procedures that will give the most rapid results with the least amount of effort.

9.3.1. **Evacuation.** Always give serious consideration to removal of assets as a primary means of denial. Convoying vehicles and heavy equipment to a safer location not only denies the equipment to the enemy, but also keeps the resource as part of our inventory (**Figure 9.2.**). In addition, it provides transportation for personnel and a means of relocating more critical supplies away from the air base. Obviously, because of the logistics involved (fueling, marshalling, loading, etc.), most evacuation efforts should be started early in the scheme of things and follow a preplanned schedule.

Figure 9.2. Asset Evacuation.

9.3.2. **Component Removal.** If evacuation of a key component is not possible, another excellent denial option is selective component removal. This involves removing one or more components from equipment (i.e., engines) that renders the item or equipment totally inoperative. Component removal can be a fast and easy means of denial; however, one word of caution is in order when using this technique—be sure to remove the same item(s) on all like items of equipment; otherwise, a creative opponent may be able to cannibalize components from various different machines to make some operative again (**Figure 9.3.**). Lastly, do not forget to pick up any similar spares from bench stocks and supply points.

Figure 9.3. Remove Like Components to Prevent Cannibalization.

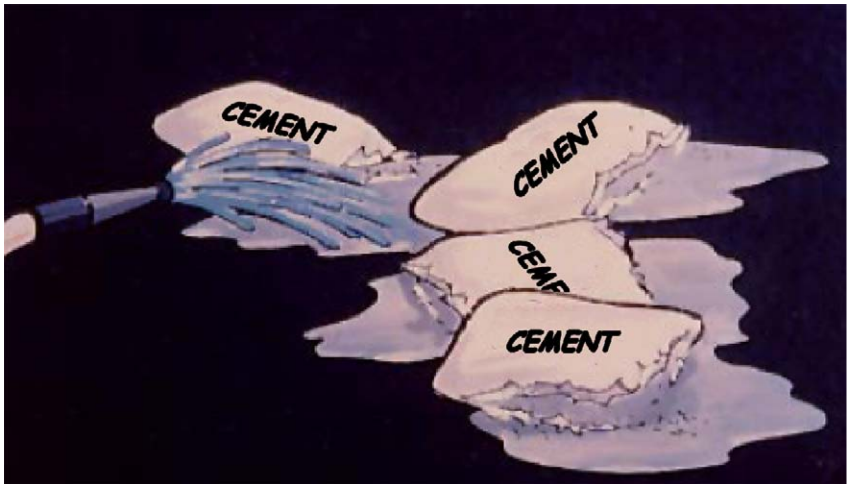


9.3.3. **Destruction.** When using destruction as a means of denial, there are four primary methods employed: burning, soaking with water, mechanically damaging, and contaminating. One non-conventional method of destruction commonly included in many denial plans entails the use of explosives. However, due to the obvious dangers associated with handling this material, its use is normally restricted to specific personnel, namely explosive ordnance disposal (EOD) personnel. Although these personnel are part of an installation's civil engineer complement, they could be heavily tasked to support other installation agencies and may only be able to provide limited help in the civil engineer portion of base denial efforts. The use of conventional, non-explosive methods of base denial will still remain the BCE's primary means of accomplishing the base denial mission.

9.3.3.1. **Fire.** Destruction by fire is a good destruction technique for a wide range of materials and equipment. Heat can often be used in a selective fashion to deform or warp items that will not burn, bringing about dysfunction. Relatively thin gauge ferrous metals are often excellent candidates for this procedure. Even though fire seems from outward appearances to be an ideal way of destroying facilities, this is not always the case. Modern building codes have brought about the development of a large variety of building materials that are highly fire resistant. Some of these less combustible materials may need to be thoroughly saturated with fuel in order to ensure ignition. As a result, it is always a good approach to consult the fire department when destruction by fire is being considered. A final possible negative point to consider when selecting fire as a destruction method is that the smoke normally generated from large burning activities can serve to announce withdrawal intentions to an enemy.

9.3.3.2. **Water Soaking.** Water can also be an effective means to damage many valuable assets. Unlike burning, a great advantage of using water is that it can be done quietly without revealing telltale signs of withdrawal intentions to an enemy. It is an excellent way of destroying electrical components; however, extreme caution must be used to avoid electrocution when dealing with energized circuits. Water can also be used to contaminate a number of substances such as petroleum fuels. In addition, many dry construction materials such as cement can be easily ruined by simply drenching them with water (**Figure 9.4.**).

Figure 9.4. Using Water to Ruin Bags of Cement.



9.3.3.3. **Mechanical Destruction.** This is another means which can be used to destroy assets without revealing withdrawal intentions to an enemy. Sledge hammers, axes, and wrecking bars are some of the more common tools of choice for this destruction technique.

9.3.3.3.1. More often than not, mechanical destruction is conducted in a very selective manner rather than on a random basis. Key components of an item of equipment such as control devices and gauges are usually where the emphasis is placed. A cutting torch can also be a useful tool when used judiciously. Properly trained personnel can use a torch to damage main support members of metal structures such as buildings and bridges, eliminating or greatly hindering their designed use by an enemy. Though less common, large-scale mechanical destruction methods can at times prove to be highly effective as well. This is particularly the case when large quantities of equipment or materials must be destroyed or damaged expediently. In such situations, heavy equipment can be used to crush items on a massive scale. In addition, burial can also prove to be an excellent way of denying a resource to an enemy yet still allow its recovery by friendly forces at a future time.

9.3.3.3.2. On the average MOB, there are normally numerous systems and equipment that require lubricants or coolants for proper operation. Reciprocating engines can be made dysfunctional by simply draining these vital fluids and allowing the engines to run until they overheat and seize-up. Similarly, electrical distribution transformers can be quickly ruined by draining their cooling oil while the system is still energized. Lastly, the use of caustic substances such as sulfuric and nitric acid may provide yet another useful means of destruction denial, particularly when applied to electrical motors and electrical components (**Figure 9.5.**).

9.3.3.3.3. Contaminating or adulterating substances may also be used to make many industrial items unusable. However, since no one substance is universally applicable, a technical knowledge of the denial target is a must. For example, sugar can wreak havoc with most reciprocating engines when placed in the fuel system. And, as was mentioned earlier, water can also cause similar results when mixed with many petroleum-based fuels.

Figure 9.5. Caustic Fluid Destruction.

9.3.4. **Obstacles.** In addition to evacuation, component removal, and destruction, obstacles may be employed to deny the use of certain facilities and resources to an enemy. Obstacles may be categorized as either natural or artificial. Due to the layout of most air bases, your primary concern will focus on the construction of artificial obstacles such as those shown in **Figure 9.6.** Barbed wire entanglements are also effective personnel obstacles (**Figure 9.7.**). They may not completely stop enemy ground movement but can hinder and greatly slow down their forward progress when coupled with the appropriate antipersonnel devices. Check with security forces on your installation concerning the placement and installation of antipersonnel devices; it is their responsibility to place these items. The use of more substantial obstacles, such as concrete and timber, can temporarily delay roadway access or even aircraft operations when applied to airfield surfaces. Depending upon your location, there may be numerous other natural objects that could be employed to delay or even deny an enemy's access to your air base—as with many other Prime BEEF functions, creative thinking can be key to the success of your effort.

Figure 9.6. Typical Obstacles.

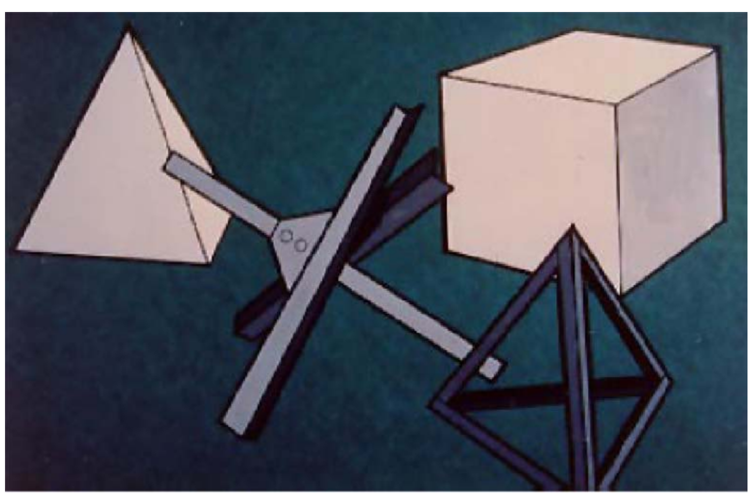


Figure 9.7. Barbed Wire Entanglement.

9.4. Base Denial Responsibilities and Techniques.

9.4.1. **General Information.** Ensuring that individuals know and understand the methods of base denial is only the first step in being able to perform this type of mission. Each individual must also know what his or her responsibilities might be and some of the more common techniques that can be used to physically accomplish the base denial task.

9.4.1.1. Normally, not everyone in an organization will play a role in base denial. In fact, the vast majority of the base population will usually be directed to evacuate before consequential denial actions commence. However, if time permits, base denial activities can be expanded to include a large percentage of the base population, but such situations would be the exception rather than the norm. Realistically, only a very limited number of personnel, those assigned and trained as members of the base denial team, will remain behind to perform this vital role.

9.4.1.2. The actual size and composition of the denial team will be dictated by a number of factors such as the amount of resources identified for destruction, types of items to be destroyed, and the methods of destruction to be employed. Many base denial team assignments will be dictated by Air Force Specialties (AFS). For example, it only makes sense to have electrical personnel accomplish base denial actions on electrical systems since they are, as a matter of course, the ones who are intimately familiar with what type of action will best incapacitate the system. Likewise, the same would apply to HVAC personnel, airfield surfaces and pavements and construction equipment personnel, fuel systems and liquid fuels systems maintenance personnel, and fire protection personnel. A good rule of thumb to follow when determining denial target responsibilities is to use the same areas of responsibility that exist under peacetime operations. In other words, if you are required to maintain or operate it during peacetime, also expect to be the one responsible for denying it to an enemy during wartime.

9.4.2. **Base Denial—Pavement/Equipment Operations.**

9.4.2.1. Pavements and construction equipment personnel will be accountable for roadway, railway, drainage system, and airfield denial. Airfield pavements denial most often will be brought about through the use of a combination of obstacles and explosives. However, the method employed and the extent of damage inflicted will to a large degree be dictated by how soon and even if we can anticipate regaining physical control of the property. If it is not unreasonable to expect to lose control of the assets for only a short period and enemy use of the airfield during that time will be insignificant to the total battle effort, it may be counterproductive to extensively damage the airfield surfaces. The final decision to seriously deny use of airfield pavements will be made at senior command levels, and the BCE must verify the scope of pavement denial requirements before issuing orders to commence denial operations.

9.4.2.2. Methods for performing denial of pavements, railways, drainage systems, and supporting equipment can take several forms. The following are examples of various techniques that can be applied, singularly or in combination, to effect denial actions.

9.4.2.2.1. Use destroyed vehicles and aircraft, concrete blocks, or any kind of material that is readily available to create obstacles on the runway.

9.4.2.2.2. Fill 55-gallon barrels with concrete and place in the aircraft landing area/runway.

9.4.2.2.3. If the airfield has an asphalt overlay, saturate selected areas with fuel to severely damage the surface area.

9.4.2.2.4. Use heavy equipment such as bulldozers and pavement breakers to scar the surface of airfield pavements and damage pavements at intersections and choke points.

9.4.2.2.5. Place destroyed NAVAIDs, distance-to-go markers, and towers on the runway surface.

9.4.2.2.6. Block open drainage ditches with rubble, debris, and airfield damage repair (ADR) fill material to cause flooding conditions.

9.4.2.2.7. Use cement to block major drain areas and break primary drainage piping, particularly in those locations that would cause major airfield flooding.

9.4.2.2.8. Destroy fiberglass and metal ADR matting by driving over it with a bulldozer until severe deformity occurs. Place this damaged ADR matting on the airfield surfaces. Destroy any ADR component kits in the same manner.

9.4.2.2.9. Intertwine barbed tape or concertina wire around any obstacles placed on pavement surfaces.

9.4.2.2.10. Rip up railroad spurs with heavy equipment, burn crossties, and bend rails. However, be careful with timing, because rail movement could be used as a means of personnel and equipment evacuation.

9.4.2.2.11. Destroy and abandon on airfield surfaces any equipment not being evacuated by draining the oil and running the equipment.

9.4.3. **Base Denial—Electrical.**

9.4.3.1. Personnel in the electrical systems AFS will be responsible for destruction of the base power grid and its associated support complexes. This will normally include primary and secondary distribution systems, major transformer substations, and airfield lighting systems. In addition, power production individuals will be responsible for denial activities involving prime power plants, portable generators, and aircraft arresting systems.

9.4.3.2. Methods for physically accomplishing denial of electrical systems are relatively straight forward. Use sledge hammers to destroy regulators, transformers, insulators, gauges, and shop equipment. Use chain saws to cut utility poles and barrier tapes. Vehicles and heavy equipment can be used to pull over towers (e.g., communications, radar, and approach control) and destroy arresting barrier facilities. Generators and arresting barrier units can be destroyed by draining engine oil as the units are running. Lastly, key items in bench stocks, special levels, and war reserve materiel can be destroyed using some of the same methods as above.

9.4.4. **Base Denial—Mechanical.**

9.4.4.1. HVAC personnel will be responsible for disabling all critical base mechanical systems. At some theater locations, this may also include cold storage and ice plant facilities. Liquid fuels system maintenance personnel should take necessary steps to deny the use of both their system and product. The actual physical destruction of the pipeline itself may not be the easiest and most effective way of denying this crucial asset to an enemy. Instead, efforts should concentrate on contamination of bulk storage supplies and the destruction of key distribution system control components such as automatic valves and pumps.

9.4.4.2. Denial of mechanical systems is most easily done by physically destroying the components. Use sledge hammers to break coils, motors, condensers, pumps, gauges, heaters, cooling units, automatic valves, and system control devices. Use cutting torches to destroy boiler units, heavy metal, and spare parts. Contaminate bulk fuel storage facilities by adding water, used oil, or similar substances to the fuel supplies. Due to the extreme hazard posed by some liquid fuels, draining the fuel out of the storage tanks is not recommended. However, burning of tank farms upon evacuation from the installation is a viable denial method.

9.4.5. **Base Denial—Structures and Utilities.**

9.4.5.1. Structures and utility systems personnel have the primary responsibility of destroying buildings and the water and sewage distribution systems. Structures individuals should obtain technical assistance from firefighting personnel in burning facilities and any other bulk materials such as lumber and paint supplies. They should also use their skills with cutting torches to damage metal support structures like bridges and aircraft shelter door rail systems. Utility systems personnel should direct their efforts toward disabling both the potable water and sewage distribution systems. Some of the key areas to concentrate on here include deep well pumps, pumping stations, storage tanks, chlorination equipment, and sewage lift stations.

9.4.5.2. Numerous methods of denying facilities and supporting utility systems are available. Some of the more useful ones include the following:

9.4.5.2.1. Collapse facilities by using vehicles and cables to remove load-bearing members.

9.4.5.2.2. Use cutting torches to cut out supporting beams to buildings such as warehouses, aircraft hangars, and maintenance areas.

9.4.5.2.3. Use sledge hammers and jack hammers to break up bricks, concrete block, and concrete walls.

9.4.5.2.4. Place debris in major drain areas to cause facility flooding.

9.4.5.2.5. Set fire to facilities that are constructed from easily burned materials.

9.4.5.2.6. Flood facilities that have below-ground utility rooms and basements or are entirely underground.

9.4.5.2.7. Use sledge hammers to break up pumps, motors, and main water lines within pump houses and water plants.

9.4.5.2.8. Destroy fire hydrants using heavy construction equipment.

9.4.5.2.9. Drain and puncture water storage facilities.

9.4.5.2.10. Use cutting torches to cut supporting members of elevated water towers.

9.4.5.2.11. Pour cement and debris into main sewage lines and manholes.

9.4.5.2.12. Cut up, burn, or otherwise destroy shop stocks and construction materials.

9.4.6. **Base Denial—Fire Protection.** Fire protection personnel will be looked upon to provide technical assistance during base denial activities primarily with respect to burning of base facilities and supplies. They should also expect to assist in flooding of any base facilities, if necessary. Fire protection vehicles should be included as part of the evacuation contingent and should be loaded with as much firefighting equipment as possible. Any vehicles left behind should be stripped of parts and components, and any firefighting supplies that will not be taken should normally be destroyed.

9.4.7. **Explosive Demolition.** Except in extreme cases, traditional engineer crafts personnel will not actively conduct explosive demolition. The task falls within the scope of responsibility of explosive ordnance disposal (EOD) personnel. Some engineer forces, particularly construction equipment operators, can expect to be tasked to support EOD operations if earthwork, excavation, berming, etc., need to be accomplished as part of the demolition process. Major critical facilities and airfield pavements are the prime candidates for explosive demolition. Procedures governing explosive demolition are contained in T.O. 11A-1-66, *General Instructions, Demolitions.*

9.4.8. **Base Denial Safety.** Regardless of specific responsibilities and techniques, effective implementation of any base denial activity requires a team effort. As has already been brought out, expect time to be very limited and the workload to be excessive. You must follow the priority listing; there is a distinct possibility that limited time or resources will not allow you to complete all desired tasks. Safety is no less important than during peacetime, even in this hectic environment. Just because haste is a prime consideration, do not become a casualty of carelessness. Always let common sense and good judgment prevail. Since accomplishing your mission may be a monumental undertaking, the bottom line is teamwork. Each team member must be totally capable—knowing what to do, how to do it, and when to do it.

9.5. Withdrawal and Evacuation. The final phase of base denial involves withdrawal and evacuation of base denial team personnel and equipment. As explained in Volume 1 of AFPAM 10-219 these activities were preplanned during the attack preparation phase of the contingency.

9.5.1. At the onset of base denial efforts, several key actions must be taken to ensure all personnel are aware of their responsibilities and requirements with respect to withdrawal and evacuation once physical base denial missions have been completed. As a minimum, all personnel must be informed of the following items:

9.5.1.1. Anticipated time available for base denial actions.

9.5.1.2. Assembly location(s) for departure convoys.

9.5.1.3. Convoy method (rail, vehicle, etc.).

9.5.1.4. Personnel accountability procedures.

9.5.1.5. Preplanned withdrawal routes and end point locations.

9.5.1.6. Personal gear requirements.

9.5.2. While physical base denial actions are ongoing, another group of individuals must be designated to prepare the departure convoy for movement. In all likelihood, this group will encompass personnel from several base organizations; however, you can plan on having many engineer personnel involved as well due to the unique nature of much of the engineer equipment that will be evacuated (e.g., fire vehicles, heavy equipment, etc.). These individuals are responsible for accomplishing the following tasks:

9.5.2.1. Gathering and loading supplies and materials to be evacuated on transport vehicles.

9.5.2.2. Setting up the convoy order of march.

9.5.2.3. Fueling and servicing of convoy vehicles.

9.5.2.4. Preparing route maps for convoy drivers.

9.5.2.5. Gathering and checking communications equipment.

9.5.2.6. Reconnoitering the route to be taken checking for obstacles, choke points, proper traffic signs, etc.

9.5.2.7. Coordinating with destination point personnel to ensure support for evacuating personnel.

9.5.2.8. Arranging for en route security forces if necessary.

9.6. Summary. The execution of base denial may be forced by enemy action, or it may be a voluntary, preplanned event. In either case, base denial prevents or hinders enemy occupation and use of the airfield complex, its ancillary facilities, and residual resources. The destructive work associated with the execution of denial measures requires skill and resourcefulness. Employment of explosive demolition methods, a most effective means to ensure destruction of denial targets, may not be possible for a variety of reasons (shortage of EOD personnel or explosives, numerous taskings in too short a time frame, requirements to conceal our intentions, etc.). Highly effective conventional, non-explosive denial methods can be used by each section within the base civil engineer organization. Once physical base denial actions have been accomplished, an orderly withdrawal and evacuation complete the base denial process.

Chapter 10

INFORMATION COLLECTION, RECORDS, AND FORMS.

10.1. Information Collections. No information collections are created by this publication.

10.2. Records. The program records created as a result of the processes prescribed in this publication are maintained in accordance with AFMAN 37-123 (will convert to AFMAN 33-363) and disposed of in accordance with the AFRIMS RDS located at **https://afrims.amc.af.mil/rds_series.cfm**.

10.3. Forms (Adopted and Prescribed).

10.3.1. **Adopted Forms.** AF IMT 847, *Recommendation for Change of Publication*.

10.3.2. **Prescribed Forms.** No prescribed forms are implemented in this publication.

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DCS/Logistics, Installations and Mission Support

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

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Abbreviations and Acronyms

ABD—Air Base Defense

ADR—Airfield Damage Repair

ADVON—Advanced Echelon

AETF—Air and Space Expeditionary Task Force

AF—Air Force

AFCESA—Air Force Civil Engineer Support Agency

AFDD—Air Force Doctrine Document

AFH—Air Force Handbook

AFI—Air Force Instruction

AFIMS—Air Force Incident Management System

AFMAN—Air Force Manual

AFPAM—Air Force Pamphlet

AFRIMS—Air Force Information Management System

AFS—Air Force Specialty

AFTTP—Air Fore Tactics, Techniques, and Procedures

AFVA—Air Force Visual Aid

AGE—Aerospace Ground Equipment

AIR—American Institute for Research

ANG—Air National Guard

AT—Antiterrorism

ATO—Antiterrorism Officer

BCE—Base Civil Engineer

BDOC—Base Defense Operations Center

BEAR—Basic Expeditionary Airfield Resources

BHP—Boiler Horsepower

BSP—Base Support Plan

BTU—British Thermal Unit

C2—Command and Control

CBRN—Chemical, Biological, Radiological, and Nuclear

CBRNE—Chemical, Biological, Radiological, Nuclear, and High-Yield Explosives

C-CBRN—Counter- Chemical, Biological, Radiological, and Nuclear

CEMP—Comprehensive Emergency Management Plan

CCA—Contamination Control Area

CE—Civil Engineer

CO_2—Carbon Dioxide

COB—Collocated Operating Base

COMSEC—Communications Security

CONEX—Container Express

CONUS—Continental United States

COTS—Commercial Off-the-Shelf

CRP—Contingency Response Plan

DART—Damage Assessment Response Team

DCC—Damage Control Center

DEFCON—Defense Readiness Conditions

DOD—Department of Defense

DOT—Department of Transportation

EAID—Equipment Authorization Inventory Data

EAP—Emergency Actions Procedures

ECC—Emergency Communications Center

ECS—Expeditionary Combat Support

ECU—Environmental Control Unit

EM—Emergency Management

EMCS—Energy Monitoring and Control Systems

EOC—Emergency Operations Center

EOD—Explosive Ordnance Disposal

EPA—Environmental Protection Agency

ESF—Emergency Support Function

ESP—Expeditionary Site Plans

ET—Effective Temperature

FAX—Facsimile

FACC—Fire Alarm Communications Center

FES—Fire Emergency Services

FEMA—Federal Emergency Management Agency

FPCON—Force Protection Condition

FPWG—Force Protection Working Group

GPM—Gallons per Minute

GPH—Gallons per Hour

HAZMAT—Hazardous Material

HE—Harvest Eagle

HF—Harvest Falcon

HTHW—High Temperature Hot Water

HVAC—Heating, Ventilation, and Air Conditioning

IC—Incident Commander

ICC—Installation Control Center

IGESP—In-Garrison Expeditionary Site Plans

INWS—Installation Notification and Warning System

IMT—Information Management Tool

IPE—Individual Protective Equipment

JCS—Joint Chiefs of Staff

JFOB—Joint Forward Operations Base

JP—Joint Publication

JSP—Joint Support Plan

kW—Kilowatt

LIMFAC—Limiting Factor

LNG—Liquified Natural Gas

LPG—Liquified Petroleum Gas

MAJCOM—Major Command

MBTU—One Million British Thermal Units

MEOC—Mobile Emergency Operations Center

MNS—Mass Notification System

MOB—Main Operating Base

MOPP—Mission-Oriented Protective Posture

MOS—Minimum Operating Strip

MRE—Meal, Ready-To-Eat

NATO—North Atlantic Treaty Organization

NAVAIDS—Navigational Aids

NBC—Nuclear, Biological, and Chemical

NEO—Non-Combatant Evacuation Operations

NPDES—National Pollutant Discharge Elimination System

NRDL—Naval Radiological Defense Laboratory

NUDET—Nuclear Detonation

OI—Operating Instruction

OPLAN—Operation Plan

OPR—Office of Primary Responsibility

OSHA—Occupational Safety and Health Administration

POL—Petroleum, Oils, and Lubricants

Prime BEEF—Prime Base Engineer Emergency Force

Prime RIBS—Prime Readiness in Base Services

PSI—Pounds per Square Inch

PSIG—Pounds per Square Inch Gauge

RDS—Records Disposition Schedule

RED HORSE—Rapid Engineer Deployable Heavy Operational Repair Squadron, Engineer

ROWPU—Reverse Osmosis Water Purification Unit

RPIE—Real Property Installed Equipment

RPM—Rotations per Minute

SCPS—Survivable Collective Protection Systems

SF—Security Forces

SRR—Survival, Recovery, and Reconstitution

STANAG—Standardization Agreement (used in NATO)

SWA—Southwest Asia

TEMPER—Tent, Extendable Modular Personnel

TOL—Take-Off and Landing

UAV—Unmanned Aerial Vehicle

UCC—Unit Control Center

UFC—Unified Facilities Criteria

UPS—Uninterruptible Power System

US—United States

USAF—United States Air Force

USAFE—United States Air Forces in Europe

UXO—Unexploded Explosive Ordnance

WRM—War Reserve Materiel

Terms

Air Base Defense—Those measures taken to nullify or reduce the effectiveness of enemy attacks on, or sabotage of, air bases to ensure that the senior commander retains the capability to accomplish assigned missions.

Airfield Damage Repair (ADR)—The process of using construction equipment, tools, portable equipment, expendable supplies, and temporary surfacing materials to provide a minimum operating surface through expedient repair methods.

Air Force Civil Engineer Support Agency (AFCESA)—A field operating agency (FOA) located at Tyndall Air Force Base, Florida. The Directorate of Contingency Support (HQ AFCESA/CEX) acts as the Air Force program manager for Base Civil Engineer (BCE) Contingency Response Planning.

Alert Condition—A level of readiness which military forces are to achieve, usually based on a defined level of threat. Predetermined preparation instructions are implemented upon declaration of each alert condition. Examples of alert conditions include defense conditions (DEFCON) and hurricane conditions (HURCON). Within each condition, there are usually five levels of readiness.

B-1 Revetment—A galvanized metal revetment assembled using metal pins and filled with sand or similar material. B-1 revetments are often capped with concrete to prevent water from entering the fill material. They are primarily used to protect parked aircraft, however, they can also be used for facility hardening.

Bare Base—An installation having minimum essential facilities to house, sustain, and support operations to include, if required, a stabilized runway, taxiways, and aircraft parking areas. A bare base must have a source of water that can be made potable. Other requirements to operate under bare base conditions form a necessary part of the force package deployed to the bare base.

Base Denial—The destruction or denial of vital air base resources so the enemy cannot use them against friendly forces or for his benefit.

Basic Expeditionary Airfield Resources (BEAR)—Facilities, equipment, and basic infrastructure to support the beddown of deployed forces and aircraft at austere locations; a critical capability to fielding expeditionary aerospace forces. Also known as BEAR, the resources include tents, field kitchens, latrine systems, shop equipment, electrical and power systems, runway systems, aircraft shelters, and water distribution systems needed to sustain operations.

Beddown—The act of providing facilities, utilities, services, construction, operations and maintenance support to a deployed force with the overall intent of establishing a basic mission capability.

Bitburg Revetment—A fork lift-moveable revetment made of reinforced concrete usually used for facility hardening.

CBRN Control Center—A sub-element of the Emergency Operations Center that directs CBRN reconnaissance activities to shape the hazards and advises the commander on hazards, countermeasures, and protective actions.

Civil Engineer Control Center—The primary center for controlling CE forces responding to a crisis, emergency, or other contingency. Synonymous with Damage Control Center.

Chemical, Biological, Radiological and Nuclear (CBRN) Defense—The methods, plans, procedures and training required to establish defense measures against the effects of attack by nuclear weapons or chemical and biological agents.

Chemical Warfare—All aspects of military operations involving the employment of lethal and incapacitating munitions/agents and the warning and protective measures associated with such offensive operations. Since riot control agents and herbicides are not considered to be chemical warfare agents, those two items will be referred to separately or under the broader term "chemical," which will be used to include all types of chemical munitions/agents collectively. The term "chemical warfare weapons" may be used when it is desired to reflect both lethal and incapacitating munitions/agents of either chemical or biological origin.

Collocated Operating Base (COB)—An active or Reserve allied airfield designated for joint or unilateral use by US Air Force wartime augmentation forces or for wartime relocation of US Air Force in-theater forces. COBs are not US installations.

Command and Control—The exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission.

Communications Security (COMSEC)—The protection resulting from all measures designed to deny unauthorized persons information of value which might be derived from the possession and study of telecommunications, or to mislead unauthorized persons in their interpretation of the results of such possession and study. Communications security includes: cryptosecurity, transmission security, emission security, and physical security of communications security materials and information.

Continental United States (CONUS)—United States territory, including the adjacent territorial waters, located within North America between Canada and Mexico.

Contingency—An emergency involving military forces caused by natural disasters, terrorists, subversives, or by required military operations. Due to the uncertainty of the situation, contingencies require plans, rapid response, and special procedures to ensure the safety and readiness of personnel, installations, and equipment.

Contingency Response Plan—A base civil engineer plan of action developed in anticipation of all types of contingencies, emergencies, and disasters.

Contingency Support Staff—See emergency operations center.

Conventional Weapon—A weapon which is neither nuclear, biological, nor chemical.

Counterterrorism—Offensive measures taken to prevent, deter, and respond to terrorism.

Damage Control Center—A command and control node for engineer forces at unit level which controls CE preparations and recovery activities for disasters and attacks.

Decontamination—The process of making any person, object, or area safe by absorbing, destroying, neutralizing, making harmless, or removing chemical or biological agents or by removing radioactive material clinging to or around it.

Defensive Fighting Positions—Fortifications constructed at various locations around an installation to assist in air base defense operations. These positions can vary from hastily built bunkers to elevated, hardened towers. Usually constructed to support security forces requirements, fighting positions can also be built for work party security purposes or specific point defense needs.

Dispersal—Relocation of forces for the purpose of increasing survivability.

Emergency Communications Center (ECC)—A central dispatch capability that includes the minimum functions of the Fire Alarm Communications Center (FACC), Security Forces Desk, and Medical dispatch (when applicable).

Emergency Operations Center (EOC)—For the purposes of AFIMS, the EOC is the C2 support element that directs, monitors, and supports the installation's actions before, during, and after an incident. The EOC is activated and recalled as necessary by the Installation Commander. The EOC updates the ICC with ongoing incident status and seeks support through the ICC when on-scene requirements surpass the installation's inherent capability and the installation's cumulative capabilities acquired through mutual aid agreements. According to the National Response Plan (NRP), the EOC is defined as "The physical location at which the coordination of information and resources to support attack response and incident management activities normally takes place. An EOC may be a temporary facility or may be located in a more central or permanently established facility, perhaps at a higher level of organization within a jurisdiction. EOCs may be organized by major functional disciplines such as fire, law enforcement, and medical services; by jurisdiction such as Federal, State, regional, county, city, or tribal; or by some combination thereof."

Emergency Support Function (ESF)—ESFs are groupings of capabilities into an organizational structure that provides the support, resources, program implementation, and services that are most likely to be needed during an incident. ESFs also serve as the primary operational-level mechanism that provides support during an incident.

Evacuation—1. Removal of a patient by any of a variety of transport means (air, ground, rail, or sea) from a theater of military operation or between health service support capabilities for the purpose of preventing further illness or injury, providing additional care, or providing disposition of patients from the military health care system. 2. The clearance of personnel, animals, or materiel from a given locality. 3. The controlled process of collecting, classifying, and shipping unserviceable or abandoned materiel, US or foreign, to appropriate reclamation, maintenance, technical intelligence, or disposal facilities. 4. The ordered or authorized departure of non-combatants from a specific area by Department of State, Department of Defense, or appropriate military commander. This refers to the movement from one area to another in the same or different countries. The evacuation is caused by unusual or emergency circumstances and applies equally to command or non-command-sponsored family members.

Expeditionary Site Plan (ESP)—ESPs are chiefly associated with locations without a permanent Air Force presence and may contain only the minimum data necessary to make initial beddown decisions. ESPs may be developed in short time frames to meet contingency needs without full staffing or coordination. It is the installation-level or site plan to support unified and specified command wartime operations plans as well as MAJCOM supporting plans. It cuts across all functional support areas in a consolidated view of installation missions, requirements, capabilities, and limitations to plan for actions and resources supporting war or contingency operations, including deployment, post-deployment, and employment activities (as appropriate).

Explosive Ordnance Disposal (EOD)—The detection, identification, on-site evaluation, rendering-safe, recovery and final disposal of unexploded explosive ordnance. It may also include explosive ordnance which has become hazardous by damage or deterioration.

Facility—A real property entity consisting of one or more of the following: a building, a structure, a utility system, pavement, and underlying land. (FEMA uses the term differently. It can be a base, an installation, an industrial plant, one building or a collection of buildings which together are used to provide a product or service.)

Force Beddown—The provision of expedient facilities for troop support to provide a platform for the projection of force. These facilities may include modular or kit-type substitutes.

General Purpose (GP) Vehicles—Vehicles which have no special capabilities and can be used by any unit. Such vehicles include pickup trucks, sedans, 1 1/2-ton trucks, vans, etc.

Giant Voice System—An installation-wide public address system used to broadcast changes in alert status and provide personnel warning.

Hardening—The process of providing protection against the effects of conventional weapons. It can also apply to protection against the side effects of a nuclear attack or against the effects of a chemical or biological attack.

Harvest Eagle—A nickname for an air transportable package of housekeeping equipment, spare parts, and supplies required for support of US Air Force general-purpose forces and personnel in bare base conditions. Examples of Harvest Eagle equipment are water purification units, tents, and showers. Each kit is designed to provide softwall housekeeping support for 1,100 personnel. (Replaced by Basic Expeditionary Airfield Resources.)

Harvest Falcon—Harvest Falcon is a nickname given to a selected package of mobile facility, utility, and equipment assets required to support forces and aircraft under bare base conditions. These WRM assets are packaged in air transportable sets to include housekeeping, industrial, initial flight line and follow-on flight line. Harvest Falcon sets are designed to support increments of 1,100 personnel and squadron size aircraft deployments. (Replaced by Basic Expeditionary Airfield Resources.)

Hazardous Material (HAZMAT)—Materials which harm personnel or their environment when not properly handled.

High Threat Area—An area which, because of its location or strategic targets, is highly susceptible to enemy attacks.

Host Nation—A nation which receives the forces and/or supplies of allied nations and/or NATO organizations and permits such forces and supplies to be located on, to operate in, or to transit through its territory.

Incident Commander (IC)—The command function is directed by the IC, who is the person in charge at the incident and who must be fully qualified to manage the response. Major responsibilities for the IC include: performing command activities, such as establishing command; protecting life and property; controlling personnel and equipment resources; maintaining accountability for responder and public safety and for task accomplishment; and establishing and maintaining an effective liaison with outside agencies and organizations, including the EOC when it is activated.

In-Garrison Expeditionary Site Plan (IGESP)—Primarily developed for locations with a permanent Air Force presence, and are fully developed by the collaborative planning efforts of many functional experts with a deliberate planning time line. Replaces the former term Base Support Plan (BSP). All plans formerly called BSPs will be redesignated IGESPs. The term IGESP describes all plans developed to meet deliberate planning requirements, contingency planning requirements, and any other site planning requirements. While the term BSP is superseded; the requirement for robust, structured, and standardized site planning based on AFI 10-404 remain.

Installation Control Center (ICC)—The ICC directs actions supporting the installation's mission. As the focal point for installation-wide notification and operation, the ICC receives and sends orders, information, and requests pertinent to the assigned task.

Joint Support Plan (JSP)—A plan for the reception and beddown of forces which is collectively developed by the host nation, the theater in-place sponsor, and the affected augmentation unit. The plan outlines all facets of operations at a collocated operating base to include personnel, facilities, and equipment.

Level of Threat—The relative likelihood that a specific threat will occur and have an impact on a base or on friendly forces in a theater of operation. As the level of a threat increases, military forces prepare for it, usually based on actions predetermined for each defined level of threat.

Limiting Factor (LIMFAC)—A factor or condition that, either temporarily or permanently, impedes mission accomplishment. Illustrative examples are transportation network deficiencies, lack of in-place facilities, malpositioned forces or materiel, extreme climatic conditions, distance, transit or overflight rights, political conditions, etc.

Main Operating Base (MOB)—A base on which all essential buildings and facilities are erected. Total organizational and intermediate maintenance capability exists for assigned weapon systems. The intermediate maintenance capability may be expanded to support specific weapon systems deployed to the MOB.

Minimum Operating Strip (MOS)—As used in this volume, the launch and recovery pavement surface, selected for repair after an attack, which meets the minimum requirements for operating assigned or transient aircraft at maximum or combat gross weight.

Mobile Emergency Operations Center (MEOC)—The MEOC is an emergency response vehicle assigned to the CE Readiness Flight. It provides the IC with command, control, and communications support for emergency response and recovery operations.

Operations Management Center (OMC)—As one of four elements of the installation control center, provides 24-hour manning of the Emergency Action Cell to handle communications to and from higher headquarters, emergency actions, and flight following.

Operations Security (OPSEC)—A process of identifying critical information and subsequently analyzing friendly actions attendant to operations and other activities to: (a) identify those actions that can be observed by adversary intelligence systems, (b) determine indicators hostile intelligence systems might obtain that could be interpreted or pieced together to derive critical information in time to be useful to adversaries, and (c) select and execute measures that eliminate or reduce to an acceptable level the vulnerabilities of friendly actions to adversary exploitation.

Passive Defense—As used in this volume, measures taken on or around an installation to reduce the probability of and to minimize the effects of damage caused by hostile action.

Petroleum, Oils, and Lubricants (POL)—POL is a generic term for class III supplies. In Air Force use, it often is used to refer to jet fuels.

Planning Factor—A multiplier used in planning to estimate the amount and type of effort involved in a contemplated operation. Planning factors are often expressed as rates, ratios, or lengths of time. From an engineering perspective, planning factors are often expressed as lump sums or on a per aircraft or per person basis.

Potable Water—Water which is safe for consumption.

Prime BEEF (Base Engineer Emergency Forces)—Worldwide civil engineer forces organized to provide trained military elements used in direct combat support or emergency recovery from natural disasters.

Readiness—The ability of US military forces to fight and meet the demands of the national military strategy. Readiness is the synthesis of two distinct but interrelated levels: (a) Unit Readiness—The ability to provide capabilities required by the combatant commanders to execute their assigned missions. This is derived from the ability of each unit to deliver the outputs for which it was designed. (This includes the ability to deploy and employ without unacceptable delays.) and (b) Joint Readiness—The combatant commander's ability to integrate and synchronize ready combat and support forces to execute his/her assigned missions. (Readiness is one of four components of military capability. The other three are force structure, modernization, and sustainability.)

RED HORSE—Organizations established to provide the Air Force with a highly mobile, self-sufficient, rapidly deployable civil engineer heavy force beddown and facility repair capability in a high-threat environment.

Reverse Osmosis Water Purification Unit (ROWPU)—A water purification device which uses a series of membranes to eliminate impurities. The ROWPU is capable of removing dissolved minerals.

Sortie Generation—This term refers to all activities needed to get an aircraft ready to fly. It is used most often in conjunction with fighter and attack aircraft during periods of intense flying activity when good coordination of efforts is needed to prepare the maximum number of aircraft for flight in a short period of time over a period of days.

Special Purpose Vehicle—A vehicle incorporating a special chassis and designed to meet a specialized requirement. (Any particular type of special purpose vehicle is generally used by only one or two units on base.)

Standardization Agreement—The record of an agreement among several or all of the member nations to adopt like or similar military equipment, ammunition, supplies, and stores and operational, logistic, and administrative procedures. National acceptance of a NATO allied publication issued by the Military Agency for Standardization may be recorded as a Standardization Agreement (STANAG).

Standoff Distance—A distance maintained between a building or portion thereof and the potential location for an explosive detonation.

Survivability—Capability of a system to accomplish its mission in the face of an unnatural (man-made) hostile, scenario-dependent environment. Survivability may be achieved by avoidance, hardness, proliferation, or reconstitution (or a combination).

TEMPER Tent—A metal framed, fabric covered facility used primarily for billeting and administrative-type functions. It is the most common facility in the BEAR packages (formerly Harvest Eagle and Harvest Falcon).

Unexploded Explosive Ordnance (UXO)—Ordnance which has been fused or armed and has been fired, dropped, launched, or placed and remains unexploded either by malfunction or design.

War and Mobilization Plan (WMP)—The Air Force supporting plan to the Joint Strategic Capabilities Plan. The six volumes of the WMP extend through the Future Years Defense Program to provide continuity in short- and mid-range war and mobilization planning. It provides current planning cycle policies and planning factors for the conduct and support of wartime operations. It establishes requirements for development of mobilization and production planning programs to support sustained contingency operations of the programmed forces. The WMP encompasses all functions necessary to match facilities, manpower, and materiel with planned wartime activity."

War Reserve Materiel (WRM)—Materiel required in addition to primary operating stocks and mobility equipment to attain the operational objectives in the scenarios authorized for sustainability planning in the Defense Planning Guidance. Broad categories are: consumables associated with sortie generation (to include munitions, aircraft external fuel tanks, racks, adapters, and pylons), vehicles, 463L systems, materiel handling equipment, aircraft engines, bare base assets, individual clothing and equipment; munitions and subsistence.

Attachment 2

SAMPLE STATUS CHARTS

A2.1. Charts in General. Displaying up-to-date, key information helps CE leaders control the unit's responses. There is no requirement or standard format for status charts in the CE Damage Control Center (DCC). This attachment offers samples for six charts: personnel, generator, vehicle, special equipment, critical supplies and spares, and installation damage status. Develop charts which fit your needs.

A2.2. Personnel Status. A "Key Personnel" chart (**Table A2.1.**) shows at a glance who is filling what position at the moment. This chart can be modified to show who fills each position during the second shift or a second chart can be used. The personnel status chart (**Table A2.2.**) shows the strength of the unit at a glance. Unit strength can be accounted for by AFS, shop, or team.

Table A2.1. Key Personnel Chart.

KEY PERSONNEL				
Position	Name	Grade	AFS	Remarks
DART 1 Lead	*Johnny O. Thespott*	*MSgt*	*3E071*	*Call Sign DART-1* *Ext. 3-5556*

Table A2.2. Personnel Status Chart.

PERSONNEL STATUS							
AFS Shop/ Team	Number Assigned	TDY/ Leave	Killed	Injured	Missing	Available for Duty	Remarks
Electrical	*9*	*1*	*0*	*0*	*0*	*8*	
Utilities	*10*	*0*	*0*	*0*	*0*	*10*	

A2.3. Generator Status. Recommend you maintain visible information on the status of fixed and mobile generators (**Table A2.3.**). Suggest you list them in facility priority order and include model and serial numbers. Start time reveals when the unit was started. Run time tells how long the unit can run at maximum load until it needs to be refueled.

Table A2.3. Generator Status Chart.

INSTALLED GENERATOR STATUS							
Location Facility # Priority #	Size kVA	Manufacturer / Model	Fuel Mogas/ Diesel	Start Time	Run Time	Last Fueled/ Due	Remarks
Bldg. 201	*750 KW*	*MC11/ MEP012A*	*Diesel*	*19 May 0800*	*14 Days*	*19 May* *2 June*	*Schedule refuel 1 day prior to date due.*
MOBILE UNITS							
Dispersal Location	Size kVA	Manufacturer / Model	Fuel Mogas/ Diesel	Start Time	Run Time	Last Fueled/ Due	Remarks
Aux 1, # 003	*30 KW*	*MEP805A*	*Diesel*	*19 May 0700*	*5 Days*	*19 May* *24 May*	*Schedule refuel 1 day prior to date due.*

A2.4. Vehicle Status. Table A2.4. shows a way to track status of general and special purpose vehicles.

Table A2.4. Vehicle Status Chart.

GENERAL PURPOSE VEHICLES					
Type	Registration Number	Radio Installed Yes/No	Shop/Team Assignment	In/Out Service	Remarks
Truck, P/U 6 Pak 4X4	*B00934*	*Yes*	*Emergency Management*	*In*	*EOC*
SPECIAL PURPOSE VEHICLES					
Type	Registration Number	Radio Yes/ No	Shop/Team Assignment	In/Out Service	Remarks
Bucket Truck	*C00851*	*Yes*	*Electrical*	*In*	

A2.5. Special Equipment Status. Keep track of special equipment items and their status, such as the POL rapid utility repair kits, mobile air compressors, light carts, mobile aircraft arresting systems, and emergency airfield lighting system. (**Table A2.5.**).

Table A2.5. Special Equipment Status.

SPECIAL EQUIPMENT					
Item	Quantity	Location	Shop/Team Assignment	In/Out Service	Remarks
Emergency Light Carts	*2 Sets*	*Bldg. 1340*	*Utilities*	*In*	
MC-17 Air Compressors	*2 Ea.*	*Bldg. 1019*	*Airfield Damage Repair Team*	*In*	
EALS	*1 Set*	*Bldg. 200*	*Electrical Systems*	*In*	

A2.6. Critical Supplies and Spares Status. Show the status of your critical items. **Table A2.6.** shows how you can track items such as stockpiled aggregate, ADR supplies, bulk repair materials, electrical wire and supplies, and spare transformers. These items can also be segregated by shop or team.

Table A2.6. Critical Supplies and Spares Status Charts.

CRITICAL SUPPLIES AND SPARES				
Item	Quantity	Location	Shop/Team Assignment	Remarks
Electrical Wire, 12/2 Non-Aluminum, 50 ft. Roll	*10 ea.*	*Warehouse # 10*	*Electrical*	*2 rolls also maintained in Electrical Shop bench stock*

A2.7. Installation Damage and Repair Status. Charts which show damage to the installation and the repair status are especially useful (**Table A2.7.**). Consider dividing the chart into functional areas such as facility damage, utility system damage, airfield pavement damage, and other pavement damage. If you assign a number to damage assessment reports, tie the visual entry to the paper copy by listing the damage assessment report number. Use the estimated completion and remarks sections to show if repairs will be made; estimated or actual start time; estimated or actual completion time; repair effort in man-hours; and problems with equipment, vehicles, supplies, or personnel which are preventing, stopping, or slowing repairs. Refer to AFPAM 10-219, Volume 3 for more information on damage assessments and repair/work priorities.

Table A2.7. Damage and Repair Status Chart.

INSTALLATION DAMAGE/REPAIR STATUS						
Damage Assessment Report #	Repair Priority	Location--Building #, Coordinates	Function	Damage Description	Est. Comp.	Remarks
FAC 001	*I*	*Bldg. 745*	*Operations Group*	*Damaged Electrical Service Lines*	*1015*	*No power in facility*
FAC 002	*IV*	*Bldg. 1520*	*Logistics Support*	*Heating System Inop.*	*23 Feb*	*Parts Ordered*

A2.8. Critical Infrastructure Status. This chart displays the status of facilities, systems, equipment, services, and other assets so vital to the mission that their incapacity or destruction would have a debilitating impact on the installation's ability to execute its missions (Table A2.8.). Key assets and facilities typically include runways and aircraft taxiways, command, control, and operations centers, fuel systems, munitions handling, airfield control systems, water, electrical power, communications and information systems, operational maintenance and repair facilities, hospitals and decontamination facilities, defensive positions, obstacles, barriers, shelters, lodging and support facilities. Restoration of these facilities and systems after being damaged or destroyed is usually accomplished according to procedures in the Base Comprehensive Emergency Management Plan (CEMP) 10-2 and CE Contingency Response Plan (CRP); however, specific facility repair priorities are normally determined by the installation commander.

Table A2.8. Critical Infrastructure Status.

CRITICAL INFRASTRUCTURE STATUS					
Asset/Facility	Repair Priority	Condition	Work Start	Est. Comp. Time	Remarks
Taxiway 2 East	*I*	*Crater Repair*	*1400*	*1800*	*On schedule.*
Navigational Aids/ Runway Lighting	*I*	*Taxiway Lights Inop.*	*1600*	*1850*	*Damaged electrical power lines-on schedule.*
Command Post	*IV*	*AC Inop.*	*1700*	*1800*	*Repaired cracked refrigerant line/ recharged.*
Hangar 2, Aircraft Maintenance Facility	*II*	*Damaged Hangar Door*	*1545*	*2100*	*Door being removed with heavy-lift equip.*
Fire Station	*IV*	*AC Inop.*	*1830*	*Pending*	*Compressor failed. Parts ordered.*

Attachment 3

HISTORICAL ENERGY DISRUPTIONS EXPERIENCE

A3.1. Through historical Inspector General tests, unplanned outages, and discussions with various installation personnel, the Air Force has gained experience with the effects of electrical disruptions.

A3.2. Below is a partial list of observed or projected effects was compiled from those sources.

A3.2.1. ECM and avionics shops were severely hampered and could not have performed required tests and modifications.

A3.2.2. Doors on hardened aircraft shelters could only be opened by force, after which they could not be closed.

A3.2.3. Carbon monoxide buildup in enclosed buildings forced rapid rotation of personnel.

A3.2.4. For many of the phones, neither bells nor lights worked, making it difficult to tell if calls were coming in.

A3.2.5. Lack of power for personnel shelters led to communications, management, and safety problems.

A3.2.6. Engineers were so heavily tasked restoring power and keeping generators operating that they could not perform other duties such as rapid runway repairs or barrier maintenance and could not participate in a Prime BEEF deployment.

A3.2.7. Security Police had to use manpower-intensive actions to compensate for lack of backup for powered surveillance equipment.

A3.2.8. Many loudspeakers and alarms were not functional.

A3.2.9. Some air traffic control functions were lost.

A3.2.10. The supply squadron's ability to meet refueling requirements was impaired by lack of backup power at fuel pumping and dispensing locations.

A3.2.11. Secure building doors had to be opened to identify personnel requesting entry because outdoor illumination was insufficient.

A3.2.12. Equipment was damaged by connections to inappropriate power supplies.

A3.2.13. Intrabase radio base stations were inoperative.

A3.2.14. Administrative functions were impaired by lack of microfiche readers, word processors, and typewriters.

A3.2.15. Improvisation was needed to save a pressurized communications cable.

A3.2.16. Attack alarm systems frequently were not operable.

A3.2.17. Meteorological support equipment was inoperable.

A3.2.18. Base microwave failed when backup generator went offline.

A3.2.19. Aircraft shelter winches were inoperable.

A3.2.20. Parachute and drogue chute packing could be done only in daytime.

A3.2.21. Pneudraulic shop lost capability.

A3.2.22. Missile check-out was impaired.

A3.2.23. One sector of the installation was without CBRN agent detection capability.

A3.2.24. All communications offbase were lost for 1 hour, 40 minutes.

A3.2.25. An entire missile codes division was inoperable (could not support the coding required to generate ICBMs to alert).

A3.2.26. Joint Service Interior Intrusion Detection System (JSIIDS) failed.

A3.2.27. Poor lighting degraded crews' responses to alert notification.

A3.2.28. Missile data processing system was not functional.

A3.2.29. Weapon storage area did not have equipment necessary to assemble strategic weapons or to load weapons for movement.

A3.2.30. Cypher locks in selected avionics areas were inoperable.

A3.2.31. Weapon storage area test and inspection capabilities for SRAM were lost.

A3.2.32. Portable automatic test equipment lost calibration.

A3.2.33. Supply suffered loss of timely response to customer demands.

A3.2.34. Processing and receiving of some priority items, including war readiness spare kits, were delayed for the duration of the outage.

A3.2.35. Rate of fuel flow of JP4 dropped from 1,000 gallons/minute to 200 gallons/minute.

A3.2.36. Voice and commander radio net were lost each time power failed.

A3.2.37. Weather radars were shut down by fluctuating power.

A3.2.38. Control tower radar display was not functional (unstable power).

A3.2.39. Largest cold-storage food facility did not have backup (commercial power to it was not cut).

A3.2.40. SAC automated command control system maintenance had no backup for shop, and mock-up had to be used for spare parts.

A3.2.41. Installation security system failed and printed circuit board from test set mock-up had to be used for spare parts.

A3.2.42. Armory had no backup.

A3.2.43. Decontamination center had no lights.

A3.2.44. Runway supervisory units had no radio contact to warn of unsafe landing configuration.

A3.2.45. AIM missile loading capability was impaired.

A3.2.46. Hot lines failed to work.

A3.2.47. TACAN, ILS, and approach radar performance were degraded.

A3.2.48. Computers went down because of inadequate power backup and had no backup for ventilation (system/cooling).

A3.2.49. Security Police base station radio failed.

A3.2.50. Military Affiliated Radio System (MARS) failed.

A3.2.51. Microwave control failed.

A3.2.52. UHF and HF ground-to-air communications failed.

A3.2.53. Data display facilities failed.

A3.2.54. Toxic exhaust buildup forced closing of aircraft maintenance repair shop.

A3.2.55. Overhead cranes, conveyor belts, and air compressors became inoperable.

A3.2.56. Failure of teletype limited capability to label hazardous cargo.

A3.2.57. Automatic door levers, door openers, and door closers failed in aircraft shelters.

A3.2.58. Duress alarm system failed.

A3.2.59. Fire deluge had no backup.

A3.2.60. Some water-circulating pumps had no backup.

A3.2.61. Some water wells had no backup power.

A3.2.62. Aircraft shelter doors would have been frozen shut during winter electrical outage.

A3.2.63. Batteries and battery-charging facilities would be inadequate to meet demands.

A3.2.64. Electrical demand reduction plans were inadequate and not readily available at key installations.

A3.2.65. Sufficient spares and fuel for backup generators were not available.

A3.2.66. Electric fork lifts would eventually fail.

A3.2.67. Missile motors could not be maintained in good operating condition.

Attachment 4

BASE COMPREHENSIVE PLAN MAP (AFI 32-7062)

Tab A-Natural and Cultural Resources	Radon Sources
A-1 Areas of Critical Concern	**Tab C-Layout and Vicinity Maps**
Historic Preservation and Archeology	C-1 Installation Layout
Threatened and Endangered Species	C-2 Off-base Sites
Wetlands & Floodplains	C-3 Regional Location Map
State Coastal Zones	C-4 Vicinity Location Map
Lakes, Rivers, Streams, and Water Bodies	C-5 Aerial Photographs
Soil Borings & Soil Types	C-6 Installation Layout-Half Scale
A-2 Management Areas	**Tab D-Land Use Planning**
Geology, Including Surface Features	D-1 Existing Land Use Plan
Topography & Physiology	D-1.1 Future Land Use Plan
Hydrology	D-2 Off-base Sites Land Use
Vegetation Types	D-2.1 Off-base Sites Future Land Use
Forest (Commercial Timber)	D-3 Vicinity Existing Land Use
Agriculture Grazing/Crops	D 4 Vicinity Existing Zoning
Fish and Wildlife	D-5 Real Estate
Prime & Unique Soils	D-6 Composite Installation Constraints and Opportunities
Grounds Categories	D-7 Functional Relationship
Climate & Weather	D-8 Explosive Safety Quantity-Distance
Bird Aircraft Strike Hazard (BASH)	D-9 Hazard Analysis Constraints
Outdoor Recreation	D-10 Area Development Plan (ADP)
Pest Management	**Tab E-Airfield Operations**
Tab B-Environmental Quality	E-1 On base Obstruction to Airfield and Airspace Criteria
B-1 Environmental Regulatory	E-2 Approach and Departure - Zone Obstructions to 10,000 Ft
Hazardous Waste Generation Points	E-3 Approach and Departure Zone Obstructions Beyond 10,000 Ft
Permitted Hazardous Facilities	E-4 Airspace Obstruction - Vicinity
Solid Waste Generation Points	E-5 Terminal Enroute Procedures (TERPS) Automation Plan
Solid Waste Disposal Locations	E-6 Airfield and Airspace Clearances

Fuel Storage Tanks	Waivers
Installation Restoration Program (IRP)	Clear Zones
B-2 Environmental Emissions	Primary Surfaces
Air Emission	Transitional Surface (7:1)
Waste Water NPDES Discharge	Approach and Departure Surface (50:1)
Storm Water NPDES Discharge	Approach and Taxiway Clearances
Drinking Water Supply Sources	E-7 Airfield Pavement Plan
Electromagnetic and Radiation Sources	E-8 Airfield Pavement Details
E-9 Aircraft Parking Plan	**Tab N-Fire Protection**
E-9.1 Proposed Aircraft Parking Plan	N-1 Systems and Utilities
E-10 Airfield Lighting Systems	N-2 Composite Fire Protection Planning Data
Tab F-Air Installation Compatible Use Zone (AICUZ) *(NOTE: May include in the D-6 as D-6/F)	**Tab O-Contingency Planning**
F-1 Compatible Use Districts	O-1 Surge Capability (Beddown and Support of Deployed Forces)
F-2 On-base Noise Contours Development	O-2 Physical Security
Tab G-Utilities System Plan	O-3 Disaster Preparedness Crash Grid Map
G-1 Water Supply System	O-4 Air Base Survivability and Theater-Specific Requirements
G-2 Sanitary Sewerage System	
G-3 Storm Drainage System	
G-4 Electrical Distribution System (Street & Airfield)	
G-5 Central Heating and Cooling System	
G-6 Natural Gas Distribution System	
G-7 Liquid Fuel System	
G-8 Cathodic Protection System	
G-9 Cathodic Protection System Details	
G-10 Industrial Waste and Drain System	
G-11 Composite Utility System Constraints	
G-11.1 Central Aircraft Support System	
G-12 Other Utility Systems	
Tab H-Communication and NAVAID Systems	
H-1 Basewide Communication (Air Force communications units and others)	
H-2 NAVAIDs and Weather Facilities	

Tab I-Transportation System	
I-1 Community Network Access to Base	
I-2 On-base Network	
I-2.1 Future Transportation Plan	
Tab J-Energy Plan	
Tab K-Architectural Compatibility	
Architectural Districts	
Architectural Themes	
Tab L-Landscape Development	
Tab M-Future Development Plan	
M-1 Current Plan	
M-2 Short-Range Development Plan	
M-3 Long-Range Development Plan	

Attachment 5

SAMPLE UTILITY SYSTEM APPENDIX—CE CONTINGENCY RESPONSE PLAN

APPENDIX # TO ANNEX N TO CE CONTINGENCY RESPONSE PLAN

WATER SUPPLY/DISTRIBUTION SYSTEM

REFERENCES: As needed. (This attachment provides an example of how you can present utility system information in the CE Contingency Response Plan. This would be incorporated into an appendix to Annex N.)

1. BASIC DATA

a. Source. White AFB is supplied with potable water from the Local Water District. Treated water is pumped through a 24-inch pipeline which runs from the district's treatment plant, a distance of 4.6 kilometers. The pipeline is buried for its entire length, on the east side of State Highway 1 within the right-of-way. One unmanned booster pumping station is located at distance marker 3.9, immediately south of the point where State Highway 1 crosses the White River. Maintenance and operation of the pipeline is the responsibility of the Water District. Point of contact is:

Local Water District

Superintendent, Mr. J. Federico, Phone 873-2400

Emergency 24 Hour Contact, Phone 873-9110

b. Point of Receipt—Base Facility 1349. The 14-inch pipeline is constantly pressurized to 60 psig ±10 psig. Flow is controlled by a single gate valve housed in Building 1349. This valve is normally closed. It is manually operated by water plant personnel to receive water into Facility 1350, a nominal 1,000,000 gallon reinforced concrete storage reservoir. This facility measures 85'x 85' x 20' and is set in ground to a depth of 15 feet. The top is provided with a reinforced concrete cover. Access is provided by a manhole. The reservoir is at ambient atmospheric pressure. Water is manually controlled to between 15’ and 18’ by means of an intake valve at the pipeline terminus set in the north wall of Facility 1350 (See **Figure A5.1.—**use your own numbering scheme for any figures, drawings or tables you include in your appendices to Annex N).

c. On Base Production and Storage. There are no facilities for production of on-base potable water. Water is supplied from a well field for golf course irrigation. There is no provision to treat this product to supplement the potable system. For other irrigation—including athletic fields, the potable system is used.

2. CONSUMPTION AND STORAGE DATA

a. Average Daily Consumption: 1,750,000 gal. (See **Figure A5.2.**—use your own numbering scheme).

b. Storage Capacity: 1,615,000 gal.

(1) Facility 1350—Receiving Reservoir—810,000 gal.

(2) Facility 650—80' Elevated Tank—700,000 gal.

(3) Facility 2205—75' Tower—105,000 gal.

c. On Base Storage as a Percent of Daily Requirement:

$$\frac{1,615,000}{1,750,000} = 92\%$$

d. Fire Protection Storage Requirement: 1,990,000 gal. (Refer to UFC 3-230-03A, Water Supply, and UFC 3-230-09A for information on calculating requirements. Calculations not shown.)

e. Fire Protection Storage Deficit: 1,990,000 - 1,615,000 = 375,000 gal.

3. RECEIVING POINT DATA. Facility 1351 is locally referred to as the "Water Point." It is in fact a pumping station which transfers water from the receiving reservoir to the base distribution system. Facility 1351 is manned on a 24-hour basis by utility operations personnel (two per shift—phone 32482/3/4). These personnel maintain a constant supply of potable product to the system at a pressure of 30 to 35 psi. Disinfection is accomplished prior to discharge into the system. A single-line schematic follows:

a. Pumps. The plant uses six Fairbanks Morse centrifugal pumps (two in suction and four in discharge) rated nominally at 400 gpm. Pumps are individually driven by Westinghouse direct coupled polyphase squirrel cage motors rated as follows (30 bhp @ 1150 rpm). Primary power is from base distribution.

b. Disinfection. Disinfection is provided by two Wallace and Tierivan Series 800 V-notch chlorinator units, serviced by a bank of four 1-ton containers continuously in service. Maximum daily use is 1000 lbs chlorine chemicals. Four 1-ton containers are kept in reserve at the plant. Base Supply maintains nine 1-ton containers on 30-day bench stock.

c. Emergency Power. Emergency power is provided by a 60-kW EAID generator, pad mounted on the north side of Facility 1351 and connected to the plant power panel via an exterior junction box. Start and load transfer are manual. Sufficient fuel (DF-1) for 18 hours of operation is stored in the day tank and underground on side.

d. Spares. Spares are maintained at the plant. Spares listings are maintained at the plant and on file at the Production Control Center.

4. VULNERABILITY SUMMARY. White AFB is located astride a natural drainage divide of the Red and Yellow River basins. Approximately 75% of the 4,400 acre reservation drains naturally to the southwest into the Red River system. The northeast quadrant drains to the east toward the Yellow River basin. Primary hazards related to the potable water system derive from loss of system pressure and are as follows:

a. Contamination. Loss of, or suspicion of loss of pressure in any portion of the system subjects the system to contamination by infiltration.

b. Fire Flow Requirements. In the event of power loss to the pumping equipment or interdiction of the system, fire protection flow requirements cannot be sustained when system pressures fall below 20 psi.

Figure A5.1. Single-Line Schematic.

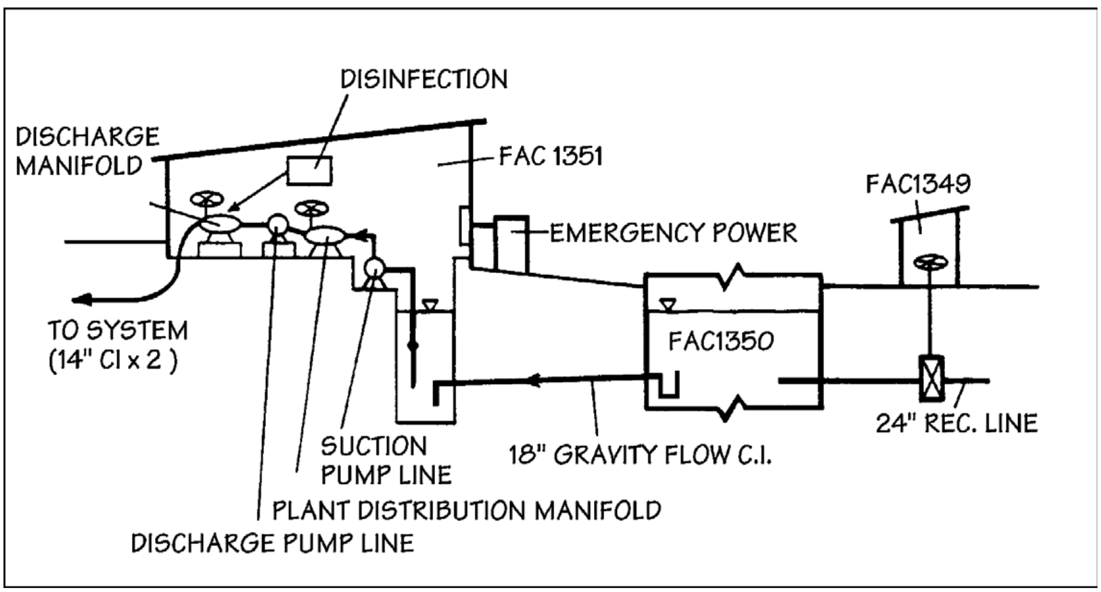

Figure A5.2. Potable Water Consumption.