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Operations

CIVIL ENGINEER CONTINGENCY RESPONSE AND RECOVERY PREPARATIONS

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This publication provides information to help Air Force (AF) Civil Engineer (CE) units prepare their installations for disasters, major accidents, and war. It highlights CE preparations in support of reducing installation vulnerabilities, protecting personnel and resources, beddown of incoming forces, and base denial actions. The information presented in this publication is not intended to provide detailed construction or other "how to" procedures, rather it addresses general CE preparations for natural and manmade disasters, major accidents, terrorism, and war. This publication applies to all AF active, Air National Guard, and AF Reserve Command CE units. This Air Force Pamphlet (AFPAM) supports Air Force Instruction (AFI) 10-210, *Prime Base Engineer Emergency Force (BEEF) Program*, and Air Force Doctrine Annex (AFDA) 3-34, *Engineer Operations*. Refer recommended changes and questions about this publication to the Office of Primary Responsibility (OPR) using the AF Form 847, *Recommendation for Change of Publication*; route AF Form 847s from the field through the appropriate functional chain of command and Major Command (MAJCOM) publications/forms managers. Ensure that all records created as a result of processes prescribed in this publication are maintained IAW Air Force Manual (AFMAN) 33-363, *Management of Records*, and disposed of IAW the Air Force Records Disposition Schedule (RDS) in the Air Force Records Information Management System (AFRIMS). 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 AF. This publication is nondirective.

SUMMARY OF CHANGES

This document has been substantially revised and should be completely reviewed. This revision changes the title, updates terminology and references, and includes or expands information related to expedient construction, hardening, Camouflage, Concealment, and Deception (CCD), base defense, and base denial preparations.

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Chapter 1

INTRODUCTION

1.1. Background. Civil engineers develop and exercise contingency response and recovery procedures in advance because of the unpredictable nature of crises, hostile actions, and natural disasters. Advance preparations help to ensure continuity of installation operations if incidents occur. They also reduce the chaos associated with emergencies and hasten effective response. When preparing for base emergencies, civil engineers focus on protecting personnel, equipment, and facilities; posturing emergency response; and base recovery actions. This publication is non-directive; however, it offers ideas, options, and considerations for CE personnel preparing for incident response and recovery. It does not replace information contained in technical orders or requirements of law, safety, or other areas of standardization or expeditionary environments.

1.2. Roles and Responsibilities. The Base Civil Engineer (BCE) and engineer staff advises the installation commander on contingency planning, response and recovery operations. BCEs provide trained forces, equipment, and materiel so the installation can quickly return to a condition where it can accomplish the primary mission. In support of this responsibility, the BCE establishes a CE Contingency Response Plan (CRP) and maintain contingency response capabilities. Capabilities to restore operations, save lives, mitigate human suffering and minimize damage during and after a crisis on the installation. As the approval authority for the CE CRP, the BCE ensures it is consistent with CE functional programs. Refer to AFI 32-2001, *Fire Emergency Services (FES) Program*, AFI 32-3001, *Explosive Ordnance Disposal (EOD) Program*, and AFI 10-2501, *Air Force Emergency Management (EM) Program*. The BCE also ensures integration of the CE CRP with installation emergency support and war plans to include the Installation Emergency Management Plan (IEMP) 10-2.

1.3. Contingency Response and Recovery Activities. Civil engineers have a major role in providing, operating, and maintaining installations. They also organize for rapid response and base recovery from natural disasters, major accidents, attacks, and other incidents and contingencies. The following paragraphs provide a brief synopsis of CE contingency response and base recovery activities. Details relating to these activities is address in subsequent chapters of this publication.

1.3.1. **Base/Unit Preparations.** Organize, equip, and train specialized teams for the installation Disaster Response Force (DRF), and multi-shop response teams. Support recovery from the effects of natural and manmade disasters, major accidents, terrorist attacks, and war. Also, arrange for support to/from others and stockpile needed materials. Specialized and CE response teams perform essential roles during response and recovery operations. They include assistance protecting lives and key installation functions; hardening facilities and antiterrorism (AT); assessing and repairing damage, and maintain installation operation.

1.3.2. **Command and Control (C2).** Organize key primary and alternate C2 facilities and associated primary, mobile, and backup communications/equipment to support contingency response and recovery operations. These include primary and alternate Emergency Operations Centers (EOC) and CE Unit Control Centers (CE UCC), and mobile communications. Work with the Communications Squadron to design and install an Installation Notification and Warning System and individual building Mass Notification Systems for operation throughout emergency conditions. Ensure the CE UCC and mobile communications have survivable and interoperable communications among the Crisis Action Team (CAT), primary and alternate

Emergency Communications Center (ECC), EOC, and Base Defense Operations Center (BDOC).

1.3.3. **Shelter Preparations.** Designate select facilities as emergency shelters and prepare unit shelter plans for potential disasters and attacks. Stock CE shelter supplies and equipment and address any extended shelter occupation considerations. Organize and train shelter management teams (SMT) and check operation of collective protection (COLPRO) systems in shelters. If applicable, provide training on shelter systems such as power generation and COLPRO or on shelter operation and maintenance (O&M). Provide technical expertise so units can erect their own shelter facilities. Incorporate shelter requirements into new facility designs.

1.3.4. **Expedient Hardening.** Develop expedient hardening plans for facilities supporting key mission functions and other important exposed resources according to each threat identified for your installation/location. Select hardening candidates; consider C2 nodes, access and perimeter gates, utility generating plants, and mission-essential shelters. Review hardening designs, methods, and options including factors such as labor, time, and materials. Arrange for or stockpile expedient hardening materials and incorporate hardening in facility design and new construction.

1.3.5. **Camouflage, Concealment, and Deception (CCD).** Develop expedient and long-term CCD plans to implement command-directed CCD measures, incorporating CCD guidelines and fundamentals. Address facility camouflage and concealment methods and procedures including, design factors and considerations; siting, orientation and layout; and required construction materials. Arrange for and stockpile required CCD supplies and equipment.

1.3.6. **Base Defense Preparations.** Incorporate base defense and security considerations in base comprehensive planning and facility design and construction. Harden base entry points, construct expedient traffic control devices, and assist Security Forces (SF) with the construction of fighting positions and obstacles, when required. Construct bunkers, berms, and trenches as necessary and if required, erect hardened fighting positions, obstacles, and access/traffic controls. **Note:** Base antiterrorism measures on a vulnerability or threat assessment approved by the installation commander.

1.3.7. **Utility System Isolation and Backup.** Maintain accurate utility distribution system drawings within the ECC and CE UCC showing the locations of all cutoff valves and switches. Periodically have appropriate personnel locate and operate these valves and switches to ensure they are operational and control the desired systems. When possible, use geospatial-mapping information from GeoBase to aid in identifying and locating critical equipment and resources. Prepare personnel and identify resources required to promptly reestablish utilities or provide backup systems for critical facilities before or immediately after an attack or disaster.

1.3.8. **Beddown Operations.** Identify existing facilities or potential beddown areas for incoming military forces, federal assistance teams, or disaster victims. Address potential needs for potable water, electricity, latrines, showers, refuse collection and disposal, and contaminated waste collection and disposal.

1.3.9. **Dispersal.** Plan for dispersal of key recovery equipment, vehicles, supplies, and spare parts. Investigate potential on- and off-base dispersal sites; consider facilities, space, access, communications, and security requirements. Develop unit dispersal plans to include load plans for personnel and equipment. Incorporate dispersed siting of critical functions during base comprehensive planning and facility design and construction.

1.3.10. **Base Denial.** Prepare for appropriate denial methods, including item evacuation, selective component removal, destruction, and use of obstacles. In advance, prepare a candidate list of select base systems, equipment, and supplies for potential destruction. This will be helpful should the commander direct base evacuation and denial action.

1.4. Summary. CE personnel often respond to crises around the globe. Our substantial contingency response and installation recovery capabilities can be crucial to mitigating the effects of disasters, major accidents, and wars. Equally important are CE duties that help prepare the installation before a crisis occurs. These include long-term preparations made during peacetime or short-term preparations when given only minimum warning. This publication address general preparations and intends to stimulate ideas when planning and making detailed unit preparations. The information is neither comprehensive nor absolute. Users should review installation contingency and support plans for more detailed and specific requirements.

Chapter 2

BASE AND UNIT PREPARATIONS

2.1. General Information. Preparations for disasters, major accidents, or attacks occur at every installation, from forward and main operating bases, to austere or remote locations. Bases complete many preparations in the luxury of peacetime, but some can only be done at the last minute when disaster or war looms. There is no one "correct way" to prepare every installation, because the threat, mission and locations differ. However, every installation, following MAJCOM and Combatant Command (CCMD) guidance, should determine what preparations are appropriate to make. CE planners consider the installation mission and threats when preparing for a crisis. They should continually seek answers to specific questions affecting their emergency planning and preparations.

2.2. Overview. This chapter reviews general installation preparations and specific CE preparations for war, major accidents, and disasters. For additional information on CE preparations, readers should consult AFI 10-2501, AFPAM 10-219, Volume 1, AFPAM 10-219, Volume 3, *Civil Engineer Contingency Response and Recovery Procedures*. In addition, review relevant task or Air Force Specialty (AFS)-specific guidance.

2.3. Core Considerations. Installation leaders and supervisors consider many factors when preparing their base and personnel for a major crisis. The core considerations addressed in the following paragraphs are relevant to every organization on the base when preparing for contingencies. When determining what preparations are appropriate, realize that no installation can prepare for every possible threat, and there is no need to. DOD published minimum life safety construction and antiterrorism criteria in Unified Facilities Criteria (UFC) 1-201-01, *Non-Permanent DOD Facilities in Support of Military Operations*, for the contingency environment. Geographic combatant commanders (CCDR) each have minimum standards and antiterrorism criteria to mitigate threats within their area of responsibility (AOR). Generally, for each likely threat, preparations should preserve the minimum capability of the base to perform its mission. The following examples summarize this capability:

1. Low threat with low priority mission—minimal preparations to protect personnel

    2.3.1.1. High threat with low priority mission—very limited low cost preparations which primarily protect the C2 function and people

        2.3.1.1.1. High threat and high priority mission—extensive preparations which ensure the mission capability survives

2.3.1. **Protect functions versus individual resources.** This consideration translates into protecting personnel, equipment, facilities, and utility service. However, always find out precisely what assets require protection to preserve a mission-critical function. For some key units, all assets require protection. For others, only personnel and their tools should be protected—not facilities. If you lose sight of this, you can expend significant effort and resources protecting assets that are not critical to preserve the function. In addition, you can fail to protect assets in "low priority" units that provide key support to critical functions.

2.3.2. **Focus on both cost and effectiveness when deciding what to do.** People tend to quickly embrace cheap solutions, 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 situation, doing nothing may be preferable to doing something poorly. Preparations can also be expensive and elaborate, but may not have to be. Less effective, lower cost options may be sufficient. Maintaining a focus on cost and effectiveness usually minimizes the total time and resources spent on preparations.

2.3.3. **Units involvement in base wide planning.** To avoid making insufficient preparations, assigned units should be part of the installation-wide planning effort. Doing so will help clearly define what task to accomplish, to what quality, and why. Many preparations can be mutually supportive, so look for opportunities to integrate efforts.

2.3.4. **Keep a long-range perspective at permanent installations.** Develop and prioritize each protective measures in order to focus limited resources on the most critical protective measures to deploy rapidly. Ensure that minimum protective facilities are in place before occupancy.

2.3.5. **Unit participation speeds preparations.** Every base needs to prepare its personnel, equipment, and facilities. However, CE units do not have to do all facility preparations. With prior instruction or on-the-spot CE guidance, units can do many non-technical tasks such as sandbagging and erecting tents. If an installation relies entirely on its CE personnel for facility preparations, especially the last minute ones, the entire effort slows down.

2.3.6. **Have periodic reality checks.** Make sure efforts do not conflict with those of other units. This requires more than reviewing plans, it also means looking at what is being done in the field, and when.

2.4. Choosing Solutions and Determining Priorities. During contingency operations, a base may have much to do and limited time or resources to prepare and recover from crisis events. Defining the solutions and setting priorities is key to base and unit response and recovery preparations. **Table 2.1** lists risk assessment factors to consider when deciding tasks to perform, extent of preparations, methods, and task priorities and phases. Key considerations are the Design Basis Threat (DBT) and All-Hazards Threat Assessment. Readers should refer to AFI 10-245, *Antiterrorism (AT)* and AFI 10-2501 for specific details and CE requirements. Additional information is available in AFMAN 10-2502, *Air Force Incident Management System (AFIMS) Standards and Procedures*, AFMAN 10-2503, *Operations in a Chemical, Biological, Radiological, Nuclear, and High-Yield Explosive (CBRNE) Environment*, and UFC 4-020-01, *DoD Security Engineering Facilities Planning Manual*.

Table 2.1. Risk Assessment Factors.

Threats and Hazard Assessment: 1. What is the installation's DBT? 2. What are the natural events, accidents, or intentional acts that may result in harm? 3. What are the aggressors, tactics, associated weapons, tools, or explosives against which assets within a building should be protected and upon which the security engineering design is based? 4. What is the intensity and areas affected by each threat? 5. How much advance warning time is likely?
Criticality Assessment: 1. How important is the contribution of the host wing's mission to the overall theater warfighting capability or to MAJCOM peacetime activities? 2. 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?
Vulnerability Assessment: • How important is the function to base mission? • How important is the function or asset to the enemy?
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 near critical activities that cannot be moved, 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 or fully operational following relocation?
Alternatives: 1. What options are available for protecting assets? 2. Are the resources available for employing those options?
Effectiveness of a Preparation: 1. How effective is an option? 2. Can it be combined with one or more other options to further improve the effectiveness of the preparations?
Cost: • What can the base afford?

2.5. An Approach to Preparing Your Installation. Usually, base preparations focus on protecting the most important installation functions, personnel and assets, and getting units ready for quick response. Timely preparations should include a "whole base" look at the installation's important functions. Integrate all host and tenant unit functions into a prioritized list for further planning actions. An installation and its units should have game plans for accomplishing short-notice and long-term preparations. Both are important and planners can develop them concurrently.

2.5.1. **Short-Notice.** Short-notice preparations normally center on expedient measures and response team 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 begins when the corresponding threat/defense condition is declared. Plans for short-notice preparations should specify who does what, with what resources, and when.

2.5.1.1. The first phase often involves rounding up the resources (personnel, equipment, vehicles, and supplies) needed if an increase in the threat/defense condition is declared. Early preparations need not provide the final solution. Add to or modify preparations as the situation develops. For example, to protect an unhardened installation C2 center, CE personnel push up a 6-foot high earth berm around it in phase one. In phase two, with one CE person to train them, personnel from the owning activity place sandbags on the berm and extend its height to 8 feet. In phase three, place camouflage netting over and around the structure to help it blend with the background. This phased approach may be necessary to ensure the work that is most important to the installation occur first. However, phasing work can sometimes be inefficient because of the added time required to relocate CE personnel, equipment, and materials to a previous work site. This inefficiency reduces when other units do some or most of their own preparations.

2.5.1.2. When executing short-notice preparations, set up a work control function in the CE UCC to keep track of what civil engineers are supposed to do and what they are 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 that support other installation units.

2.5.1.3. 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; for example, when a nation chooses to become antagonistic or an adversary chooses peace. More often threats change slowly, such as when a threatening nation gradually increases the number/quality of its weapons.

2.5.2. **Long-Term.** 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. The plan should be self-explanatory so new personnel can understand its intent and how to fulfill plan objectives.

2.6. Standard Preparations. Installations always prepare for potential crises. Although, they make most of the preparations during peacetime, they make some under the threat of war or disaster. Standard peacetime preparations support all short-notice, emergency response installation recovery activities. When bases combine standard preparations with those for specific tasks, threats, or incidents, they form the basis for a comprehensive contingency response and recovery capability. **Table 2.2** lists key standard preparations to organize, train, and equip CE forces for base recovery. They should be part of ongoing unit preparations for natural and manmade disasters, major accidents, terrorist attacks, war, and other challenging emergencies.

Table 2.2. Standard Peacetime Preparations.

CE Preparations
• Organize response teams
• Arrange for support you need from others
• Develop unit and team response procedures
• Equip the teams
• Stockpile materials that are likely to be needed
• Train response teams

2.6.1. **Organize Response Teams.** Properly organized, trained and equipped response teams are the backbone of any installation response and recovery operation. When organizing response teams, identify each team member by name; what skills and equipment each person brings to the team; and who is in charge. Assign tasks to existing shops or sections when possible. See AFPAM 10-219, Volumes 1 and 3 for potential composition, organization, and tasks for various CE response teams.

2.6.2. **Arrange for Support from Others.** Without the support of other agencies, CE units would find it difficult to perform their mission during a crisis. Know what support will be available (in terms of workers, equipment, or capability) and when you are to get the support. Identify how to get the support (i.e., who to contact, phone number, address, etc.). The information in **Table 2.3** is a sample of installation agencies and the support they could provide to civil engineers in a crisis.

Table 2.3. 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 (R&EM) Flight for disaster response through the Ready Augmentee Program.
Contracting and Finance	Purchase needed supplies and equipment from local sources. Work with base finance personnel to identify an expeditionary site plan funding code for events requiring significant and unforeseen purchases. 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 air conditioning units. When running short of light carts, aircraft maintenance personnel usually have more of them than anyone else does on base. They also have air compressors and portable air conditioners that may be useful.
Services	Provides box lunches or equivalent and rest and relief support for emergency response crews; stocks shelters for contingencies.
Comm. Squadron	Support and integration of communications infrastructure. Normally, communications unit and CE are setting up their infrastructure simultaneously; use the opportunity to coordinate and share resources.

2.6.3. **Develop Unit and Team Procedures.** Outline specific and detailed response procedures. Identify what is to be done, who is to do it, when, with what resources, and how teams will communicate.

2.6.4. **Equip the Teams.** Assign vehicles and special equipment to teams. Order equipment if required. Do not forget extra hand tools such as shovels, picks, saws, buckets, sandbags, and brooms.

2.6.5. **Stockpile Materials.** Stockpile likely needed materials. Periodically check those items to make sure they are still available in the quantities needed. Stockpiles should be convenient to their point of use, dispersed to improve survivability, and secured from pilferage.

2.6.6. **Train Response Teams.** Keep response team and installation recovery skills sharp. Preparations should enable teams to respond well and quickly. Unlike many preparations usually done once, practicing response team and installation recovery procedures should be an ongoing effort. Periodically exercise some/all procedures and checklists to familiarize new personnel and identify potential revisions.

2.6.6.1. Response teams should practice often and realistically with the vehicles, equipment, tools, and materials they anticipate using (**Figure 2.1**). Team members should know what tasks are required; how to do them; who is in charge and second in command; who to report to; location of vehicles, equipment, and materials; when and where to report and with what, and know what actions to take first.

Figure 2.1. Realistic Practice Keeps Response Teams' Skills Sharp.

2.6.6.2. Along with ensuring CE response teams' skills remain sharp, coordinate with other units and instruct them on how to prepare their facilities and protect their personnel and key resources. Examples include erecting tents and laying sandbags. This makes those units more self-reliant and less dependent on limited CE resources.

2.6.7. **CE Support to Others.** Support between units is a routine activity at most installations and is necessary to ensure daily mission accomplishment. Likewise, the support civil engineers provide to others during or after an emergency also helps to ensure mission continuity. The examples of support briefly discussed here are not all inclusive. Any support CE units provide should be coordinated with the supported unit in advance and included in the IEMP 10-2. Training and exercises that periodically test and evaluate support between units are also good preparations. **Table 2.4** and subsequent paragraphs address some potential support civil engineers provide to others. Readers should refer to AFI 10-2501, and AFPAM 10-219, Volumes 1 and 3, for more information on the support civil engineers might provide to other agencies.

2.6.7.1. **Mortuary Activities.** During overseas contingency operations, mortuary officers plan for temporary interment of human remains if the number of deaths exceeds the installation's capability to store or ship remains home quickly. CE units may provide labor and equipment to help mortuary officers prepare temporary cemeteries and burial sites for contaminated and non-contaminated remains. These activities may involve pre-identifying burial locations. Including making sure the burial sites do not create environmental problems or interfere with other proposed uses for the sites. If necessary, EOD personnel assist during the processing of remains by removing any explosive hazards or residue contained in the remains. Consult AFI 34-501, *Mortuary Affairs Program*, for additional details regarding CE support to the installation Mortuary Officer.

Table 2.4. Preparations Supporting Other Units.

CE Support to Others
1. Provide prior instruction in shelter management, Chemical, Biological, Radiological, and Nuclear (CBRN) defense, contamination control, specialized teams, and other wartime and EM activities to units.
2. Offer units on-the-spot guidance for shelter siting and erecting tents, sandbagging, and defensive fighting positions.
3. Construct berms, revetments, and ditches to support unit passive defensive measures.
4. Provide labor and equipment to assist the mortuary officer in preparing temporary cemeteries and mass burial sites for contaminated and non-contaminated remains.
5. Assist the base in developing unit casualty and damage reporting procedures.
6. Prepare a master standard grid map or maps for installation C2, DRFs, damage assessment teams, and CBRN Control Center. Provide Geo Base and Geo Reach digital base mapping support capability.
7. Prepare airfield surface maps for minimum airfield operating surface (MAOS) selection teams.
8. Provide maps/map data to primary and alternate EOCs and UCCs and update map overlays for common operational picture (COP).
9. Assist in the installation's annual assessment of hazardous chemicals it regularly uses, stores, or ships.

2.6.7.2. **Unit Casualty and Damage Reports.** Units provide casualty and damage reports to the chain of command after an attack or disaster. All units (primarily through their UCC and specialized teams) report casualties, facility damage, and other situations to the EOC. However, CE units sometimes assist the installation in preparing unit casualty and damage reporting procedures. When unit members assist with casualty reporting preparations, consider information reporting requirements and handling procedures for discovered wounded and deceased casualties. If known, address the location of casualty collection points. Be aware these pre-selected collection points may change if affected by the attack or disaster.

2.6.7.3. **Maps and Charts.** Maps and charts are critical to installation recovery after an attack or disaster. They are extremely important for decision makers in the CAT, EOC, UCC and other command centers. Maps and charts may also be instrumental to unit specialized teams and individuals performing important recovery tasks. CE preparations may include preparing a master standard grid map or maps for installation C2, DRFs, damage assessment teams, and CBRN Control Center. Airfield surface maps for MAOS 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 required maps should be in the primary and alternate EOC and UCC. Good preparations include defining installation requirements for maps and charts that support contingency operations. Include maps, instructions, and an example showing how to read the installation grid map.

2.6.7.4. The support between civil engineers and other installation agencies could be essential after an attack or disaster. The type of support addressed here highlights only a few examples of the aid and coordination that may be necessary. These and other coordinated activities not only assist in installation recovery, but can save lives and protect property. Comprehensive base preparations, including combined training and exercises testing the unit's ability to respond to disasters and attacks help to ensure mission continuity in an emergency.

2.6.8. Standard peacetime preparations apply to many potential crises. However, units also prepare for specific incidents such as fires, floods, major accidents, hazardous material (HAZMAT) spills, CBRN threats, and installation attacks. Together, these preparations enhance overall installation recovery capability and mitigate the effects of a crisis at home station or abroad.

2.7. Preparations for War and Terrorism. Highlighted in **Table 2.5** through **Table 2.10** are common preparations for war and terrorism, by category, which civil engineers might make on their bases. Most tables in this section lists preparations in two areas. One column for preparations to do when given only minimum warning (including the actions you take in peacetime to prepare for those minimum alert tasks). The other column for long-term preparations completed in peacetime. The "standard" preparations to organize, equip, and train response teams are inherent to each task, but not detailed in these tables. Review **paragraph 2.5** for information regarding CE Standard Preparations.

Table 2.5. C2 Preparations.

Minimum Warning Preparations	Long-Term Preparations
• Set up the EOC and help organize the staff; develop operating procedures and arrange for augmentees • Set up CE UCC and organize staff and procedures • Arrange for telephone and radio service for EOC and CE UCC facilities • Arrange for continuity of operations (i.e., set up alternate EOC and CE UCC facilities, skeleton staffs, and procedures) • Verify unit recall procedures and publish alert conditions and alarm signals	• Construct permanent EOC, UCC and alternate facilities • Set up communication systems

Table 2.6. Vulnerability Reduction/Resource Protection Preparations.

Minimum Warning Preparations	Long-Term Preparations
Dispersal	
• Check out potential on- and off-base dispersal sites • Develop CE dispersal plans to include load plans for people and equipment • Disperse key recovery equipment, vehicles, supplies and spare parts	• Incorporate dispersed siting of critical functions during installation comprehensive planning and facility design and construction
Hardening	
• Develop expedient hardening plans for facilities supporting key mission functions and other important exposed resources • Arrange for or stockpile expedient hardening materials	• Include hardening in facility construction
Shelters	
• Develop expedient shelter plans for unit personnel; if needed, assist other units in developing their shelter plans • Check operation of COLPRO systems in shelters • Arrange for and stock CE shelter supplies and equipment • Assign unit personnel to shelters • Organize and train SMTs as required by installation guidelines	• Incorporate shelter requirements into new facility designs • Construct stand-alone shelters

Redundancy	
• Identify substitute facilities in case prime facilities are rendered inoperable or destroyed	• Construct utility systems to support key functions from two directions; construct loop systems • Construct alternate launch and recovery surfaces • Widen taxiways and likely choke points, etc.
CCD	
• Prepare expedient and long-term camouflage plans • Arrange for/stockpile required CCD supplies and equipment • Prepare unit blackout plans	• Plant native trees to hide key functions • Plant shrubs, grass, or crops to disguise or blend land uses • Tone down facilities • Apply permanent camouflage coatings

Table 2.7. Force Beddown Preparations.

Minimum Warning Preparations	Long-Term Preparations
• Develop facility use and site plans to beddown incoming Operation Plan (OPLAN) forces and non-combatant evacuees • Get and store expedient beddown materials and equipment • Arrange for temporary utility service, latrines, showers, and collection of sewage, garbage, and refuse	• Develop "permanent" beddown sites with utility service, drainage, and roads

Table 2.8. CBRN Defensive Preparations.

Minimum Warning Preparations	Long-Term Preparations
• Gather and prepare CBRN detection equipment • Inspect or ops check CBRN defense equipment • Set up CBRN monitoring teams and manual or remote monitoring sites • Check the operation of COLPRO systems in shelters • Set up contamination control areas (CCA)/ decontamination sites • Set up temporary equipment and vehicle decontamination sites	• Build permanent vehicle and equipment decontamination sites

Table 2.9. Common Attack Preparations.

Minimum Warning Preparations	Long-Term Preparations
Utility System Isolation and Backup	
• Isolate utility lines prior to attack, as required • Arrange for backup generators to support mission critical functions • Provide for alternate water supplies and water distribution points	• Install isolation valves and switches • Install double-throw switches and quick-connect panels at key facilities to permit quick hookup of emergency generators
HVAC System	
• Provide expedient protection for key system components • Isolate service to likely targets to segregate damage and limit system down time	• Incorporate protection in original construction • Develop back-up plans to operate without this utility

<table>
<tr><th colspan="2">Security/Base Defense/AT</th></tr>
<tr><td>Assist SF erect expedient fighting positions and obstacles
Harden base entry points and construct expedient traffic control devices</td><td>Incorporate security considerations in base comprehensive planning and facility design and construction
Build permanent fighting positions and obstacles
Construct permanent access/traffic control devices</td></tr>
<tr><th colspan="2">Sanitation and Debris Removal</th></tr>
<tr><td>Preplan disposal sites for: human remains, garbage, debris
Arrange for collection of wastes: wet garbage, trash, human waste, etc.</td><td>Incorporate long-term base and CCMD waste management plans (e.g., sanitary landfills, incinerators, composting, contracted removal and disposal, recycling, etc.</td></tr>
<tr><th colspan="2">Base Evacuation</th></tr>
<tr><td>Make evacuation preparations IAW local IEMP 10-2 and CE CRP
Develop unit evacuation plans to include vehicle load plans</td><td></td></tr>
<tr><th colspan="2">Base Denial</th></tr>
<tr><td>Prepare unit denial plans and support for other base denial requirements
Organize denial teams and procedures</td><td>Place demolition tubes under runways and taxiways</td></tr>
</table>

Table 2.10. Installation Attack Recovery Preparations.

Minimum Warning Preparations	Long-Term Preparations
Damage Assessment	
• Set up damage assessment teams, priorities, and preset travel routes • Set up observation posts • Develop procedures to gather damage assessment inputs from other base units	• Install airfield pavement reference marking system
UXO Reconnaissance and Disposal	
• Get EOD explosives • Get UXO marking materials for unit and EOD flight • Create UXO holding points • Grade or dig trenches alongside runways and taxiways to temporarily hold small UXO	
Airfield Damage Repair (ADR)	
1. Get heavy equipment on hand 2. Organize and equip ADR teams • Service and disperse equipment	• Get ADR materials and disperse stockpiles
Facility/Utility System Repair	
• Organize and equip repair teams	• Stockpile repair materials

2.8. Preparations for Disasters and Major Accidents. Several preparations listed in the previous tables may also apply to peacetime crises. **Table 2.11** through **Table 2.13** highlight CE preparations to consider for natural and manmade disasters and accidents. The tables list short-notice preparations (including advance actions taken in peacetime) and long-term preparations. Because of the unpredictability of peacetime disasters, most of the actions fall in the short-notice category.

Table 2.11. C2 Preparations.

Short-Notice Preparations	Long-Term Preparations
• Set up the EOC facility and help organize the staff; develop operating procedures and arrange for augmentees • Set up CE UCC and organize staff and procedures • Arrange for telephone and radio service to EOC and UCC facilities • Publish alert conditions and alarm signals • Ensure unit recall procedures/notification lists are up-to-date • Ready mobile communications and keep serviced and prepared for operation	• Construct permanent EOC, UCC and alternate facilities • Set up permanent communication systems

Table 2.12. Emergency Response Preparations.

Short-Notice Preparations	Long-Term Preparations
Fire Protection	
• Prepare Prefire plans • Establish and train unit auxiliary firefighters • Organize and equip search and rescue teams	
HAZMAT	
• Equip a HAZMAT response trailer or vehicle • Organize and equip follow-on HAZMAT response teams	• Construct containment structures

Table 2.13. Vulnerability Reduction/Resource Protection Preparations.

Short-Notice Preparations	Long-Term Preparations
Dispersal/Evacuation	
• Disperse key recovery equipment items and vehicles (includes spare parts for those items) • Investigate potential on- and off-base dispersal sites • Develop unit dispersal plans to include load and movement plans for people and equipment • Develop unit procedures to disseminate and execute base evacuation orders/information	
Hardening/Flood Control	
• Protect windows from wind-blown debris • Berm water treatment plants, and power substations to prevent flooding • Build levees to prevent flooding. Find out where to get materials quickly. Stockpile materials • Set up pumps to keep key facilities from flooding. Arrange for pumps	• Build new facilities above flood stages • Build flood walls to protect facilities from storm surge
Shelter Preparations	
• Designate facilities to serve as emergency shelters • Organize base and CE SMTs • Arrange for shelter supplies and equipment • Assign people to shelters	• Incorporate shelter requirements into design of new facilities
Vital Records Protection	
• Protect important real estate records and engineering record drawings • Backup computer files and place in a safe place or take with you	• Build water and fire proof vaults to store irreplaceable historical documents and vital records/ drawings

2.9. Summary. In general, preparations for war and disaster are applicable to all installations. However, some preparations may be unnecessary or impractical to do at certain installations or locations. Some preparations may only apply to overseas installations, and only if there is a credible enemy threat. The mission and threat usually dictate what preparations are important to make on an installation. Threats to an installation with a high-priority mission usually dictate extensive preparations that ensure the mission capability (MISCAP) survive. Conventional air threats, ground threats, terrorist threats, major accidents, and natural disasters are all future possibilities.

2.9.1. Air and ground threats could be low at your contingency location. Nevertheless, terrorist threats continue unabated; natural disasters always exist; and accidents will happen. Realistically, preparations will never be complete and there will always be something more to do, or do better. To keep preparations relevant, units should continually build and modify their plans and preparations as circumstances and requirements change. For additional information on base and unit preparations, consult the references listed in **Table 2.14**.

Table 2.14. Chapter 2 Quick Reference.

Base and Unit Preparations Chapter References	
AFI 10-245	*Antiterrorism (AT)*
AFI 10-2501	*Air Force Emergency Management Program*
AFMAN 10-2502	*Air Force Incident Management System (AFIMS) Standards and Procedures*
AFMAN 10-2503	*Operations in a Chemical, Biological, Radiological, Nuclear, and High-Yield Explosive (CBRNE) Environment*
AFPAM 10-219V1	*Contingency and Disaster Planning*
AFPAM 10-219V3	*Civil Engineer Contingency Response and Recovery Procedures*
AFI 34-501	*Mortuary Affairs Program*
UFC 1-201-01	*Non-Permanent DOD Facilities in Support of Military Operations,*
UFC 4-020-01	*DoD Security Engineering Facilities Planning Manual*

Chapter 3

CE COMMAND AND CONTROL PREPARATIONS

3.1. General Information. Effective C2 is at the core of any coordinated military activity—it is crucial during installation recovery after a disaster or other major crisis. AF and Joint guidance indicate personnel, facilities, equipment, and communication procedures are extremely important factors in exercising installation C2 during emergencies. Civil engineer C2 preparations involve a number of activities. They may include setting up facilities; organizing control center teams; establishing EOC and CE UCC operating procedures; putting communications equipment and procedures in place; publishing installation alert conditions and alarm signals; developing unit procedures for recall, authentication codes and passwords, and making provisions for C2 continuity. The following paragraphs briefly address basic C2 preparations. However, detailed information regarding CE C2 preparations for installation emergencies is available in AFI 10-2501, AFMAN 10-2502, and AFMAN 10-2503.

3.2. EOC Preparations. In addition to setting up the CE UCC, civil engineers may have the added responsibility of setting up and managing the installation EOC. Preparations include ensuring the EOC communications systems and related equipment is in place and operational.

3.2.1. **EOC Facility.** Ideally, the EOC should be located adjacent to or collocated with the CAT; however, some EOCs are located in separate facilities and still operate effectively. When separate facilities are used, consider linking them virtually to expedite information flow during disasters and contingencies. Design and construct the EOC for improved survivability and for continued operation during and after the natural or manmade event. Be sure to provide backup electrical power or a connection for quick hookup of an emergency generator. On the inside, arrange workstations so emergency support function (ESF) personnel have easy access to view maps, situation status, and other Common Installation Picture (CIP) or COP information. ESF personnel should also be able to communicate easily with each other and the EOC director. Geospatial databases continue to grow, expand, and encompass more and more installations globally. Many EOC facilities use on-line GeoBase resources (i.e., digital maps, facility overlays, etc.) to maintain CIP or COP.

3.2.1.1. **Maps.** Accurate, up-to-date, and standardized response maps help maintain a "common picture" of the crisis and the installation response. GeoBase digital maps and data overlays can provide near real-time updates and other CIP/COP information to supervisors and decision-makers. Listed in **Table 3.1** are response maps (including geospatial mapping data) typically available in the EOC.

Table 3.1. Response Maps.

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

3.2.1.1.1. During wartime, personnel use airfield pavements maps to plot damage and repairs to airfield pavements. These maps consist of takeoff and landing surfaces with runway and taxiway station marking systems annotated.

3.2.1.1.2. Use CBRN maps when plotting CBRN hazards and establishing CBRN zones (boundaries; access and transition points) to help manage protective actions, Individual Protective Equipment (IPE), and Mission-Oriented Protective Posture (MOPP). As outlined in AFMAN 32-1007, *Readiness and Emergency Management (R&EM) Flight Operations*, response maps should support the Military Grid Reference System (MGRS) according to guidance in Chairman, Joint Chiefs of Staff Instruction (CJCSI) 3900.01C, *Position (Point and Area) Reference Procedures*. Using MGRS coordinates standardizes position reporting for ground operations across the Services.

3.2.1.1.3. Consider presenting maps and status information using electronic/digital medium in lieu of hardcopy documents and status boards. It will help ensure accuracy and currency of information across the DRF. However, some hardcopy maps are too large to display digitally.

3.2.1.2. **Situation Status Displays.** Situation displays within the EOC helps the staff monitor and disseminate the status and condition of the installation, unit, and the recovery effort. **Table 3.2** lists some suggested status displays (electronic, digital or status boards) that may be useful. For additional information regarding the display of Force Protection Condition (FPCON), alert conditions and stages, alarm conditions, MOPP levels, Hurricane Condition (HURCON), etc., refer to AFI 10-245, AFMAN 10-2502, and AFMAN 10-2503.

Table 3.2. Situation Status Displays.

Incident Status Information/Data
Alert Condition/FPCON/HURCON
Alarm Condition/Alert Stage/Watches and Warnings
MOPP Levels
Chemical Downwind Message Status
Effective Downwind Message Status
Shelter Status
Unit Status, including Manpower
Facility/Utility System Damage Status
Casualty Status
Generator Status
Aircraft Arresting Systems Status

3.2.2. **EOC Communications.** 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. Contemporary information and data systems provide various innovative ways to send and receive messages, view information, extract data, and update databases. While these types of systems and services are part of Information Technology (IT) resources at many installations, they are beyond the scope of this section. Here, the focus is on basic communications systems and equipment preparations that could apply to almost any unit operations center or control center. Each communications method listed below has a distinct function and its own limitations.

3.2.2.1. **Landline Phones.** One multi-line unit is ideal for each workstation. Consider preparing a list with phone numbers of key personnel and frequently called organizations. Include counterparts for joint operations and local communities (i.e., joint and local EOCs). Remember, non-secure phones on landlines have two obvious vulnerabilities; simple to monitor and lines can be easily cut. The "Hot Line" phone provides a direct line to the CAT and UCC. Hot lines are useful between functional representatives in the EOC and their UCCs. While a little slower and sometimes in-use by the receiver, standard landline phones and cellphones can do this job.

3.2.2.2. **Smartphones/Cellular Devices.** These devices significantly expand the communication options in the United States (US) and overseas. They are especially useful in disaster situations. Cellular services provides two-way communication (voice, data, texting, etc.) utilizing a wireless telephone network and is highly mobile allowing the user to roam.

3.2.2.3. **Intra-Base Radios.** Intra-base radios are for normal use on the base radio network. 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.

3.2.2.4. **Tactical Radios.** These radios are for use on the emergency communications network (very high frequency or ultrahigh frequency radio network). They are for communicating with emergency responders, other response elements, and between agencies, departments, and functional units (e.g., ECC and UCC). Radios should be capable of communicating on all frequencies associated with the emergency response.

3.2.2.5. **Installation Public Address System.** A public address system is a one-way (usually base- wide), communications method that is part of the Installation Notification and Warning System. It provides the EOC a method to pass time-sensitive threat warning conditions to the base population.

3.2.2.6. **Fax Machines.** Widespread use of commercial fax machines began over fifty years ago. However, fax machines can still be a useful method of transmitting documents and information. While one machine in a control center is sufficient, consider identifying a backup machine or one that is relocatable to the EOC.

3.2.2.7. **Computer Systems.** Computer systems facilitate the quick transfer of data and other information between the EOC, CAT, and UCCs. It significantly reduces 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. If computers connect the Incident Commander (IC) to the EOC wirelessly, it allows digital photos and other real-time data from the scene to the EOC. However, wireless communications and some other uses can present firewall problems, ensure these issues are worked out in advance with your local communications squadron.

3.2.2.7.1. To be efficient, each key person in the control center should have easy access to a network computer so status information can be easily shared; the server should be protected from damage, and the computers should have secure power. You cannot afford to lose the information or lose access to it. Be sure to safeguard classified checklists, plans, and other materials.

3.3. CE UCC Preparations. The CE UCC is the unit commander's communications conduit for assigned personnel. It is set up after an incident to support installation response and recovery. Normally managed by the CE chief of operations, the UCC monitors and coordinates CE recovery actions related to installation damage assessment, damage recovery and repairs, decontamination, and other CE CRP tasks. The unit designates CE operations management personnel and senior supervisors from infrastructure support, heavy repair, facility maintenance, and other engineering fields as staff members. Select and prepare the UCC staff and facilities in advance of a crisis.

3.3.1. **UCC Facility.** Oftentimes, the best place for the CE UCC is within walking distance of the CE shops. This makes communications easier if phones or radios become unavailable or inoperable. Inside the UCC, provide workstations for the staff along with appropriate communications equipment, references, maps, status displays and charts, etc. For potential power-out situations, consider installing a backup power source. For additional CE UCC preparations and recommendations, refer to AFPAM 10-219, Volumes 1 and 3. Many of the resources available in the EOC may also be appropriate for the CE UCC. Below are some of these potential resources:

3.3.1.1. **Maps.** As with the EOC, appropriate facility and airfield maps should be readily available in the CE UCC for coordinating and plotting response activities. GeoBase provides maps, functional overlays, site-mapping information, services, and other information critical to response personnel. When GeoBase is not accessible, the UCC may also have installation maps of the airfield and utility systems. The suggested scale for utility system maps is 1" = 400'. If necessary at big bases, use 1" = 600' or 1" = 800'.

3.3.1.2. **Operations Plans and Support Plans.** Keep in the CE UCC at least one copy of each operations plan, support plan, and base plan that civil engineers support. **Table 3.3** lists three support plans to maintain in the UCC. Maintain additional plans as required.

Table 3.3. Support Plans and Their Purpose.

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

3.3.1.3. **Additional Documents.** Other documents that may be useful to have in the UCC include AFPAM 10-219-series, Air Force Handbook (AFH) 10-222-series, and a local area telephone directory with yellow pages (if applicable). If the air base is subject to enemy attack, Air Force Tactics, Techniques and Procedures (AFTTP) 3-32.12, *Minimum Airfield Operating Surface Selection and Repair Quality Criteria*, and associated MAOS selection templates can also be useful. Access the AFPAMs, AFHs, and AFTTPs on the e-Publishing web site at **www.e-publishing.af.mil**.

3.3.1.4. **Status Charts.** Similar to charts in the EOC, the UCC should maintain visible status charts like those listed in **Table 3.4** to help control CE responses to a crisis. Consider displaying these charts (electronic or hardcopy) and any others you may find helpful. **Attachment 2** illustrates examples of status charts. Develop your own unit charts and displays according to local requirements and guidance.

Table 3.4. UCC Status Charts.

Status Charts	
Personnel status: 1. key personnel/team 2. shift assignments 3. accountability by AFS 4. casualty status	Alert condition: 1. defense condition 2. warning condition 3. threat condition 4. natural disaster threat condition 5. 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

3.3.2. **UCC Communications.** Ensure communications equipment such as telephones, radios, hot lines, computers, and FAXs are available for the UCC. Consider all possibilities, including cell phones and other devices as long as personnel can maintain appropriate communications security (COMSEC) and operations security (OPSEC). The UCC should be able to contact functions, units, and teams like those listed in **Table 3.5**. Although the table shows routine methods of communication, other methods may be acceptable. Try to establish at least two independent methods. Also, prepare for manual communications to collect damage assessment information during disruptions to installation communication and computer systems.

Table 3.5. UCC Communication Methods.

Potential CE UCC Contacts	Sample Communication Methods
CAT	Phone (land line, cellular, satellite)/FAX/ Computers/Runners
EOC and alternate EOC	Hot Line/Phone (land line, cellular, satellite)/ Radio/FAX/Computers/Runners
Alternate UCC (if there is one)	Hot Line/ Phone (land line, cellular, satellite)/ Radio/FAX/Runners
CE Response and Repair Teams	Radio/ Phone (cellular, satellite)/Runners
CE Shelters	Telephone/Radio/ Phone (cellular, satellite)/ Runners
ECC	Phone (land line, cellular, satellite)/Radio/Hot Line
BDOC and Alternate BDOC	Phone (land line, cellular, satellite)/Radio
Hospital	Phone (land line, cellular, satellite)
Other Installation units	Phone (land line, cellular, satellite)

3.3.2.1. **Radios Communications.** Radios in the UCC should be equipped with both speakers and headsets.

3.3.2.1.1. Call Signs. Set up call signs for CE shops and 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.

3.3.2.1.2. Dead Spots. Provide dead-spot information to CE personnel and update the information as a critical GeoBase data layer. Annotate this information on UCC maps. **Note:** Check with operations personnel in base communications because they may already have this information.

3.3.2.2. **Unit Recalls.** Develop procedures to recall CE personnel to duty stations during non-duty periods. The most common method is the telephone pyramid recall, but use runners when needed. 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 to recall 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 should be ready for use.

3.3.2.3. **Alternate Communications.** Prepare and practice comm-out/radio silence procedures. In a crisis, count on losing communications with someone or some organization. In addition, 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, consider positioning a vehicle with a radio nearby or just the use the radio with a battery. Likely, you will have to use other radios in between your destination to relay the messages. Establish manual procedures, such as the use of runners or signal flags, for collecting and disseminating information during disruptions in installation communications and computer systems.

3.3.2.3.1. 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 may have a poor knowledge of the installation and a poor sense of direction.

3.3.2.3.2. 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.

3.3.2.4. UCC Continuity of Operations. Although there are several ways to prepare for CE UCC continuity during wartime, potential scenarios may include:

3.3.2.4.1. Doing nothing until the UCC receives damage. Then consolidate or collocate the lost control center function with another control center where communication equipment is available. Recall the off-duty shift to pick up control, and form another relief shift. If possible, try to coordinate this backup plan in advance and understand that crowding will likely be a major issue in this scenario.

3.3.2.4.2. 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 machine capability and computer link would be helpful.

3.4. Notification and Warning Systems. Every AF installation is required to have a rapid and effective system to disseminate emergency information quickly. However, not every installation may have a system with all the audible, visual, and electronic communications elements and methods available. 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, *Design and O&M: Mass Notification Systems*, for additional details on notification and warning system standards. See **Attachment 3** for hyperlinks to UFCs, AF publications, and several other references and reach-back resources.

3.5. 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 advance actions can reduce damage and injury. Everyone on base should know the meaning of each signal. Pass signals 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. Repeat signals as often as necessary to make sure the entire base population responds. The AF has standard emergency notification and alarm signals located in AFTTP 3-4, Airmen's Manual, titled CBRN Operations.

3.5.1. Bases may use additional signals to meet the peculiar needs of any command or installation. Installations in overseas areas use the signals prescribed by the geographic combatant commander (GCC).

3.6. Summary. Sound C2 preparations enhance coordination, communications, and cooperation between agencies and personnel during an emergency. It also improves installation response, recovery, and mission sustainment. For additional information on CE C2 preparations, consult references listed in **Table 3.6**.

Table 3.6. Chapter 3 Quick Reference.

CE C2 Chapter References	
AFI 10-2501	*Air Force Emergency Management Program*
AFI 10-245	*Antiterrorism (AT)*
AFMAN 10-2502	*Air Force Incident Management System (AFIMS) Standards and Procedures*
AFMAN 10-2503	*Operations in a Chemical, Biological, Radiological, Nuclear, and High-Yield Explosive (CBRNE) Environment*
AFMAN 32-1007	*Readiness and Emergency Management (R&EM) Flight Operations*
AFPAM 10-219V1	*Contingency and Disaster Planning*
AFPAM 10-219V3	*Civil Engineer Contingency Response and Recovery Procedures*
AFTTP 3-32.12	*Minimum Airfield Operating Surface Selection and Repair Quality Criteria*
CJCSI 3900.01D	*Position (Point and Area) Reference Procedures*
UFC 4-021-01	*Design and O&M: Mass Notification Systems*

Chapter 4

SHELTERS

4.1. General Information. Protecting personnel from the effects of a disaster or an attack on the installation is always an important force protection (FP) concern. Protective shelters help save lives, prevent injuries, and safeguard essential assets needed to restore and continue the mission after a crisis. Civil engineers assist unit and base shelter programs through effective planning and preparation. They can identify and evaluate potential shelter facilities, train SMTs, and provide on-site guidance and expertise for unit shelter programs and operations. Units should consider accomplishing those very time-consuming shelter preparations well before a crisis occurs. Personnel may need shelter for short periods in response to an immediate threat (**Figure 4.1**) or for longer periods as refuge during a disaster, or protection from the lingering effects of CBRN weapons.

Figure 4.1. Taking Cover in Concrete Bunker.

4.2. Overview. This chapter provides a brief review of basic shelter preparations, short-term shelters (bunkers), and longer-term shelter arrangements for contingencies. While not specific for force beddown housing or humanitarian relief camps, some of the long-term shelter preparations highlighted here may be applicable. Readers should review **Chapter 8** for specific details on force beddown preparations. For additional information on shelter planning, preparedness, and procedures, refer to AFI 10-2501, AFMAN 10-2503, and AFMAN 10-2504, *Air Force Incident Management Guidance for Major Accidents and Natural Disasters*. 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 AFTTP 3-2.46, *Multiservice Tactics, Techniques, and Procedures for Nuclear, Biological, and Chemical (NBC) Protection*, and UFC 4-024-01, *Procedures for Designing Airborne Chemical, Biological, and Radiological Protection for Buildings*, for additional information.

4.3. Basic Shelter Preparations. Ensuring the base has sufficient shelters for emergencies can be challenging. For war and overseas contingency operations, bunkers usually provide limited shelter protection against attacks, but for shelters with adequate protection and provisions for extended stays, it typically requires significant planning and preparation. Whether at home station or deployed, advanced shelter preparations help ensure optimal use of often-limited shelter space. The BCE usually has responsibility to identify and evaluate installation facilities for use as rest and relief shelters. Once shelters are designated, individual units have responsibility for preparing and operating the shelters.

4.3.1. Units should arrange for shelter supplies and equipment and provide personnel for SMTs (if required). Those on-base agencies providing a service to the population (Services, Medical, etc.) will normally be required to provide that service to shelter occupants. The CE units provide power, water, sanitary facilities and trash removal as necessary.

4.3.2. **Identifying and Preparing Shelters.** In broad terms, shelters are defined here as a location (internal or standalone) used for the temporary protection of personnel against the established threat. Understanding the threat and type/duration of protection needed are keys to identifying and preparing installation facilities as shelters. Civil engineers survey base facilities to determine which ones satisfy anticipated shelter necessities (e.g., protection level, location, capacity, utilities). Once potential shelters are selected and approved, they are added to the base shelter list and units prepare them IAW AFI 10-2501 and AFMAN 10-2503, and local contingency plans.

4.3.2.1. The CE CRP should identify those shelters that civil engineers will occupy or manage. It should also contain CE sheltering instructions for before, during, and after the crisis. Include the following information in the CRP for each CE shelter: capacity; type of shelter (e.g., CBRN, tornado, flood); the owner, operator, and occupants; duration it should be prepared for occupancy; available utilities (e.g., heat, power, backup power, and communications), and protection factor relative to radiological defense. If the entire building is not for sheltering, identify the section of the facility planned as shelter space.

4.3.2.2. Include shelter preparation and operating instructions (OI) for CE SMTs. Provide shelter assignment instructions for CE shops and teams. Check and follow your MAJCOM specific guidance.

4.3.3. **Base SMTs.** Organize and train SMTs according to unit guidelines. Specifically, installations should establish SMTs when a requirement exists for extended sheltering of base personnel during natural disasters or wartime operations. Units with designated shelters should appoint a team responsible for all shelter operations. As a minimum, appoint and train a shelter supervisor and assistant (contact R&EM Flight for training). Appoint and brief additional members on their responsibilities after shelter activation. Shelter operations will vary according to the threat (e.g., CBRN attack, natural disaster, HAZMAT accident).

4.3.4. **Sheltering for Major Accidents/Disasters.** Shelters for major accidents and disasters should be pre-designated and relevant to the potential event or threat (e.g., nuclear or aircraft accident, hurricane, earthquake, tornado, fire, flood). Likely threat conditions are major considerations during shelter selection since some facilities provide better protection than others do. Shelters occupied for extended periods should address health, sanitation, utilities, food, and water concerns. Refer to **paragraph 4.5** for emergency and long-term shelter requirements.

4.3.5. **Sheltering for War and Counterterrorism.** Shelter preparations for war and terrorism focus on protecting people from the effects of Weapons of Mass Destruction (WMD). These shelters may provide short-term protection or extended occupation. Bunkers provide short-term personnel protection from explosives hazards, whereas long-term, rest and relief shelters may provide extended protection and/or periodic respite in CBRN and other hazardous environments. In either case, the specific threat usually drives the suitability of structures as shelters. The following paragraphs address various types of bunkers suitable for use in areas where people live or work in unprotected facilities but need short-term protection in case of attack. Subsequent paragraphs address shelters for extended occupation and CBRN protection.

4.4. Bunkers. For the purpose of this chapter, bunkers are a subset of shelters; they are structures (internal or standalone) that protects occupants from blast fragments and other projectiles. Just as other FP measures, the type and quantity of protective shelters at a base depends on the threat environment. During heightened threats, many deployed locations, especially those consisting of temporary construction, have field expedient bunkers as emergency protection for personnel that live and work in unprotected facilities. Such bunkers may be the only alternative when insufficient hardened facilities exist or are not available in appropriate locations. This is especially true at initial contingency locations or during dispersed operations. Generally, these bunkers are fortified structures set above or below ground with overhead protection. For defensive purposes, some bunker designs are useful as fighting positions; see **Chapter 7** for specific information on fighting bunkers. When bunkers are constructed using field-expedient designs, a structural engineer should inspect the design to ensure occupant safety.

4.4.1. Personnel bunkers should have as much overhead cover as possible. They should be limited to about 25 personnel and dispersed. For planning purposes, Graphic Training Aid (GTA) 90-01-011, *Joint Forward Operations Base (JFOB) Force Protection Handbook*, Sixth Edition (at **https://redi.usace.army.mil/sites/jfp/Portal/products.html**), recommended occupancy criteria is 5 square feet of floor area per person for a two-hour occupancy and 20 square feet/person for a 24-hour occupancy. When possible, hide bunkers next to buildings, behind hills, in woods, or in natural depressions in the terrain, but not in drainage paths. Bunkers may be constructed aboveground, partially belowground (cut-and-cover), or belowground.

4.4.1.1. **Aboveground Bunkers.** Aboveground bunkers provide the best observation and are easier to enter and exit than belowground bunkers. Although they may provide less protection from conventional weapons than belowground bunkers, they can provide sufficient protection against liquid droplets of chemical agents. Use aboveground bunkers in locations with high water tables or in areas where hard ground makes digging a belowground bunker impractical.

4.4.1.2. **Cut-and-Cover Bunkers.** Dig cut-and-cover bunkers partially into the ground and top with as thick a layer of cover material as possible. These bunkers can provide excellent protection from enemy action and the weather.

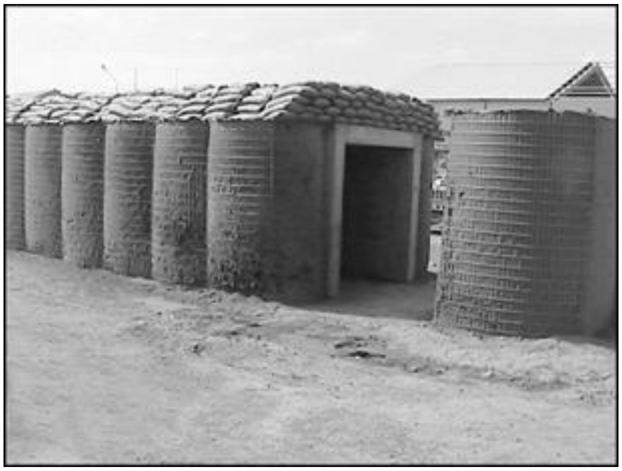
4.4.1.3. **Belowground Bunkers.** Belowground bunkers require the most construction effort but generally provide the highest level of protection from conventional and chemical weapons.

4.4.2. Several types of bunkers are constructed using general construction materials. Many of these materials can be located when establishing an austere base. Items such as 55-gallon drums, revetment material, structural steel shapes, wood packing materials, ship dunnage, and steel or precast concrete culvert sections can be set aside for this purpose. Many of today's bunkers use prefabricated, relocatable, reinforced-concrete culvert sections fortified with sandbags and/or soil-filled wire and fabric containers. These contemporary structures (**Figure 4.2** through **Figure 4.4**) are an effective means to provide base personnel expedient shelter from indirect weapons attacks. Refer to GTA 90-01-011 and Army Techniques Publications (ATP) 3-37.34, *Survivability Operations*, at **http://armypubs.army.mil/ProductMaps/PubForm/ATP.aspx** for more information on field expedient bunker design and construction.

Figure 4.2. Relocating Prefabricated Concrete Bunker.

Figure 4.3. Concrete Bunker with Sandbag Reinforcement.

Figure 4.4. Concrete Bunker Reinforced with Soil-Filled Containers.



4.5. Long-Term Shelters. Base planners often identify existing permanent facilities for shelters capable of supporting extended occupancy. When those shelters need to protect occupants from the effects of tornados and hurricanes, base engineers, emergency managers, and facility planners should be familiar with the Federal Emergency Management Agency (FEMA) and International Code Council (ICC) guidance and standards in **Table 4.1**. **Note:** Locate FEMA documents at **https://www.fema.gov/media-library/resources-documents**.

4.5.1. During contingency operations when permanent facilities are unavailable, initial and temporary shelters (e.g., tent systems, modular building systems, Commercial Off-the-Shelf [COTS] products) can be modified and equipped to support extended living or splinter-protected against potential wartime and terrorist threats. Depending on the type of shelter, CE may need to provide training on shelter systems such as power generation and COLPRO, or on shelter operation and maintenance. Regardless of shelter design, type, or construction, review factors related to extended shelter occupation. Consider requirements for space, structure, ventilation, water supply, health and sanitation, electrical power, and food.

4.5.2. **Space.** Physical space for human occupancy is the first shelter requirement. The approximate volume of the adult human body is 2.3 cubic feet. The US uses an area of 10 square feet and 65 cubic feet of volume per person as an emergency shelter standard. The recommended 10 square feet of usable area is a desired goal but not always practical. Allotments reduced to 5 square feet is tolerable when there are no better alternatives. The minimum space standards for AF contingency lodging are relatively generous at 50 square feet per person. However, IAW AFI 34-135, *Air Force Lodging Program*, installation commanders may authorize lodging in facilities not meeting minimum standards for reasons of military necessity (contingency operations, natural disasters, emergencies, etc.).

4.5.3. **Structure.** Most long-term occupancy shelters are located in permanently constructed facilities. The building structure, or at least the shelter portion, should be able to withstand the physical effects of the disaster or threat weapons. Existing structures can be upgraded using expedient and supplemental hardening techniques discussed later in **Chapter 5**.

4.5.4. **Ventilation and Air Quality.** Longer-term shelters require ventilation to maintain a minimum oxygen level, prevent an excessive buildup of carbon dioxide (CO_2), and control shelter temperature. Ventilation with outside air provides air quality and temperature control. Typical building ventilation systems usually rely on commercial electric power, which may not always be available. Natural ventilation may be adequate in aboveground shelters with enough opened windows. In basements, ventilation improves if cooler air flows 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 a backup generator (with fuel supply) to operate all or a portion of the building's ventilation system. If not an option, consider using a number of pedestal fans for this purpose. Other options include using aerospace ground equipment (AGE) air conditioning units from the flightline or spare environmental control units. If used, personnel can run ducts directly into the shelter or tie into the shelter's air distribution ducts.

4.5.4.1. Oxygen Level. Fresh air contains about 21 percent oxygen. However, when the oxygen content drops below 19.5 percent, the Occupational Safety and Health Administration (OSHA) considers workplace atmospheres oxygen-deficient. If so, workers are required to be on supplied air (29 Code of Federal Regulation [CFR] 1910.134, *OSHA Respiratory Protection Standard*). In contrast, FEMA-131, *Attack Environment Manual, Chapter 7, Shelter Environment*, indicate, “For healthy, young adults, no noticeable or harmful effects occur if the oxygen content drops as low as 14 percent.” However, at these low oxygen concentration levels, any physical exertion will likely result in increased breathing rates and rapid exhaustion. Fortunately, only a small amount of fresh air keeps oxygen concentrations in the safe zone. For example, 0.4 cubic feet of fresh air per minute per person should maintain oxygen levels at about 17 percent. Increasing the flow of fresh air can quickly restore oxygen concentration to safe levels.

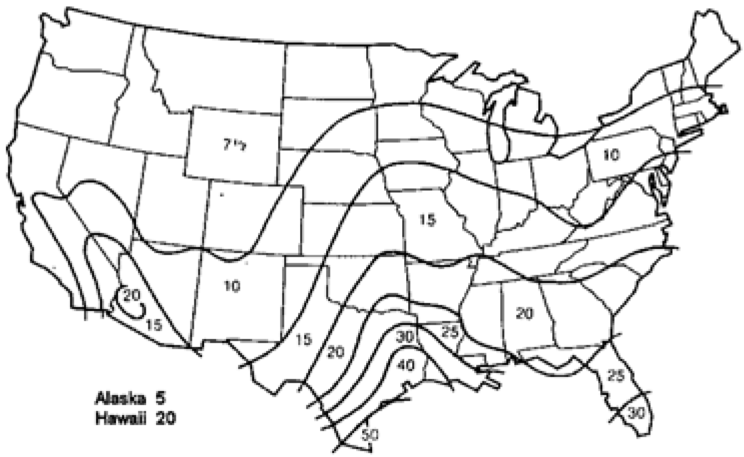
4.5.4.2. CO_2 Concentration. High CO_2 concentration in shelters is a bigger problem. The results of prolonged exposure to higher levels of CO_2 have shown the desirability of keeping the level below 1 percent. FEMA has established a goal of not more than 0.5 percent of inhaled air. This limit requires 3 cubic feet of fresh air per minute per person, which more than satisfies the oxygen requirement as well.

4.5.4.3. Temperature and Humidity. 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 emits as “sensible” heat that is measurable by a thermometer. The other part is “latent” heat given off in water vapor. During winter months, this may be very welcome heat. However, during summertime, use proper ventilation for clearing shelters of excess heat and moisture to prevent body temperatures from rising to dangerous levels.

4.5.4.3.1. 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 ET. For a relative humidity of more than 50 percent, a common summertime level, an ET of 82 degrees would correspond to air temperatures in the mid-90s.

4.5.4.3.2. Using 82 degrees as the minimum ET, the map in **Figure 4.5** 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 ET 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 ET also provides sufficient oxygen and control of CO_2 buildup.

Figure 4.5. Required Ventilation to Control Temperature.

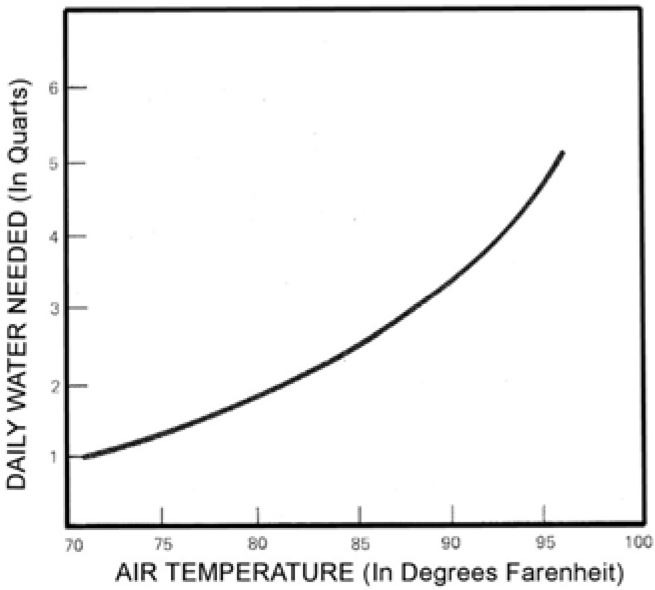


4.5.5. **Water Supply.** An assured water supply is important if shelter occupancy is for extended periods. During wintertime, or in an uncrowded shelter, 3.5 gallons per person should last approximately 2 weeks; this may last only 3 days in hot weather. **Figure 4.6** illustrates the relationship of 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 do disposal of liquid wastes). Plastic and metal trashcans, with plastic bags as liners, are suitable and readily available as are 1-gallon plastic jugs and 5-gallon plastic cans.

4.5.5.1. 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 daily 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.

4.5.5.2. 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 should avoid dehydration to prevent injury to the unborn child. Generally, there is nothing gained by stretching out inadequate water supplies to cover a presumed shelter stay. It is best to maintain health by delaying any dehydration as long as possible. Focus water management 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.

Figure 4.6. Minimum Water Required.



4.5.6. **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 should be limited. The contents of chemical toilets can be disposed of by dumping into the conventional toilets.

4.5.6.1. If water is available, occupants can then flush conventional toilets intermittently. Otherwise, use emptied water containers, plastic bags, or other containers to store wastes. As a rough rule of thumb, waste storage capacity should be able to handle about 1/2 gallon of sewage per person per day.

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

4.5.6.3. 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 trashcans, brooms, and mops, are not usually available. Additional supplies of heavy-duty plastic bags are invaluable.

4.5.6.4. Water for washing and bathing is not a necessity for an extended shelter stay, but food handlers need some water to wash their hands; this reduces the transmission of disease.

4.5.6.5. 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."

4.5.7. **Electrical Power.** Backup power is important for ventilation and for providing 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.

4.5.8. **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. Civil engineer 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 need, and will likely leave the shelter if it is not available.

4.5.8.1. If shelter occupants will be participating installation recovery operations, they should 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 present sanitation problems. Avoid perishable foods, but if brought in, consume those first.

4.5.8.2. The "best" foods are crackers and canned goods that 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, so handle them carefully if unable to avoid. Shelter occupants should bring ready-to-eat food to supplement any shelter stocks.

4.6. COLPRO. Collective protection is important when determining personnel shelter requirements in a CBRN environment. Ideally, COLPRO provides a temperature-controlled, contamination-free environment to allow personnel relief from continuous wear of IPE. Each installation should assess COLPRO requirements based upon likely threats and mission requirements. If entry of CBRN contamination is an issue, install CBRN filters in the ventilation system. Specific COLPRO solutions may include a mixture of permanent, mobile, or expedient or temporary COLPRO systems. Refer to UFC 4-024-01 and AFTTP 3-2.46 for additional information on shelters with COLPRO systems.

4.6.1. **Basic Concept.** The basic concept for most facility COLPRO solutions is to provide overpressure, filtration, and controlled entry and exit. Maintaining a higher internal air pressure than external pressure and filtering incoming air to prevent contaminated external air from infiltrating the shelter.

4.6.1.1. **Toxic-Free Area (TFA)/Protective Enclosure.** The protective enclosure or TFA is the basic component of the shelter. It may range from a large permanent building, a hardened underground bunker, or even a room with a flexible, inflatable liner added. Regardless of the degree of sophistication, the enclosure should be relatively airtight or makeable airtight. The TFA is only maintainable by pressurization with filtered air.

Without pressurization and filtration, personnel should wear protective masks continually and may need special clothing for protection from liquid contamination.

4.6.1.2. **CCA.** Personnel cannot safely transition into or out of the TFA without a CCA in which they can put on and remove IPE. This also means personnel cannot safely transfer food, water, and equipment to personnel inside the TFA. To enter the TFA, personnel enter the CCA and decontaminate and remove their outer garments; then move to the airlock entrance.

4.6.1.3. **Air Lock (AL)/Protective Entrance.** The AL is perhaps the most important feature that prevents toxic vapors from entering the TFA during ingress and egress. It allows people to move from the contaminated outside environment into the toxic-free environment without contaminating the shelter. The protective entrance helps prevent weather and chemical agent fallout from entering the AL. The AL normally consists of a small vestibule with two doors and supplied with filtered air. When transitioning from the CCA to the TFA, personnel proceed through the protected entrance and step into the AL through the outer door; then wait in the AL until the filter unit has cleared the air. He or she then proceeds into the TFA through the inner door. The system design is such that airflow is always from the inner chamber, through the air lock, to the exterior.

4.6.1.4. **Gas-Particulate Filter Unit (FU).** The FU removes dust and toxic agents from the air and supplies filtered air to the protective enclosure. Additionally, this unit serves to maintain the positive internal air pressure for the shelter. A typical unit would consist of a blower, a particulate filter, and a gas filter.

4.6.2. **Miscellaneous Equipment.** COLPRO systems have miscellaneous hardware, such as air duct hoses, air pressure regulators, and anti-backdraft valves, to control the flow of filtered air through the shelter.

4.6.3. **Converting an Existing Structure to a Chemical Protective Shelter.** Sometimes, converting an existing structure into a shelter offers the simplest, and often the only, alternative for providing COLPRO. Provided the structure is sound, use expedient methods to convert it to a chemical shelter in a short time.

4.6.3.1. **Selection.** When selecting candidates for conversion, consider the following factors:

- Shelter can support the planned function
- Locations are shielded from attacks and enemy detection
- Avoid low-lying areas where heavier than air gaseous chemical agents can settle
- Structures are resistant to blast effects
- The ability to reduce or eliminate the structure's air leakage
- Availability of required utilities (utilities may be inoperative after an attack) and backup power

4.6.3.2. **Reduction of Air Leakage.** The prime source of leakage is around windows and exterior doors; cracks in walls and ceiling; porous walls, floors, and ceilings; around baseboards and joints; and at openings for the passage of pipes or ducts. Cover windows and unused doors on the inside with sheets of plastic film that extend beyond any trim and seal the plastic to the wall with adhesive tape. Seal cracks, joints, and other small openings with duct tape, a sealant, or flexible caulking compound. Seal porous walls, floors, and ceilings with a spray-type sealant or paint. To convert larger areas to a more manageable space, partition shelter area with plywood or sheet rock and seal.

4.6.3.3. **Filtered Air Requirement.** The filtered air required for the shelter depends on area size, number of shelter occupants, facility air tightness, and desired overpressure. At a minimum, filtered air supplied to the protective shelter should be adequate to produce the desired level of overpressure, provide adequate purging, and meet ventilation requirements. The ventilation requirements in **paragraph 4.5.3** apply.

4.6.3.4. **Filtered Air Source.** Filtered air for a protective shelter is from an engine or an electric motor driven FU. If the FU must be located inside the protective shelter, use the electric-motor-driven unit. However, remember that filter replacement within the protected area is extremely hazardous due to the possibility of contamination. It is not advisable to operate a gasoline or diesel engine driven FU inside a protective shelter because of carbon monoxide buildup, the noise, filtered air consumed for combustion, the possibility of toxic fumes entering the shelter, the generation of heat, and the required handling of combustible gasoline. If these problems cannot be resolved, the best location for a FU is outside and protected from the weather and from weapon effects. If possible, filtered air should enter the protective shelter at a point that is farthest from the vent, or vents, where it exits. This arrangement results in maximum ventilation and purging.

4.6.3.5. Protective Entrance/Air Lock. The protective entrance/airlock is very important when converting an existing structure to a chemical protective shelter. Regardless of the structure's airtightness, it will not be effective in a chemical environment unless an airlock prevents contamination during personnel entry and exit. If possible, the protective entrance/airlock should be located inside the converted structure and mated to a doorway in the partition separating the protected area from the remaining structure. This arrangement protects the entrance from weather and from liquid chemical agent fallout.

4.6.3.5.1. If not feasible to locate the protective entrance/airlock inside the converted structure, erect a protective tarp or shelter around it to provide protection against chemical agents. The protective entrance/airlock for a converted structure can be prefabricated or improvised using standard construction materials. The prefabricated protective entrance/airlock normally comes with an adapter allowing it to mate to various doors sizes.

4.6.3.5.2. If necessary, consider constructing an improvised airlock on site using rigid materials, such as plywood and lumber. Once construction is complete, seal cracks and joints to make the protective entrance as airtight as possible.

4.7. Summary. Shelters protect people from weapons effects and disasters, minimize damage to critical assets, and help preserve the installation mission. Since local circumstances generally dictate shelter requirements, knowing the type and duration of protection needed is critical to identify potential shelters or constructing new ones. Whatever the threat, good disaster and attack preparations can help ensure shelters are available when the need arises. For additional information on protective shelters, see reference documents listed in **Table 4.1**.

Table 4.1. Chapter 4 Quick-Reference.

Protective Shelters Chapter References	
AFI 10-2501	*Air Force Emergency Management Program*
AFI 34-135	*Air Force Lodging Program*
AFI 48-137	*Respiratory Protection Program*
AFMAN 10-2503	*Operations in a Chemical, Biological, Radiological, Nuclear, and High-Yield Explosive (CBRNE) Environment*
AFMAN 10-2504	*Air Force Incident Management Guidance for Major Accidents and Natural Disasters*
AFPAM 10-219V7	*Expedient Methods*
AFTTP 3-2.46	*Multiservice Tactics, Techniques, and Procedures for Nuclear, Biological, and Chemical (NBC) Protection*
ATP 3-37.34	*Survivability Operations*
GTA 90-01-011	*Joint Forward Operations Base (JFOB) Force Protection Handbook, Sixth Edition (For Official Use Only [FOUO])*
UFC 4-024-01	*Procedures for Designing Airborne Chemical, Biological, and Radiological Protection for Buildings*
FEMA P-320	*Taking Shelter from the Storm: Building a Safe Room for Your Home or Small Business*
FEMA P-361	*Safe Rooms for Tornadoes and Hurricanes: Guidance for Community and Residential Safe Rooms*
FEMA P-431	*Tornado Protection–Selecting Refuge Areas in Buildings*
ICC-500	*Standard for the Design and Construction of Storm Shelters*

Chapter 5

EXPEDIENT HARDENING

5.1. General Information. Hardening is a key part of base preparations for disasters and attacks. The hardening requirements for protection against manmade threats is determined using the risk assessment model found in Chapter 3 of UFC 4-020-01. From a CE perspective, hardening is the process of strengthening buildings and utility systems to resist the destructive effects of weapons or natural forces. Incorporate permanent hardening into facilities during initial construction or add later as supplemental and expedient hardening. Normally, installations accomplish permanent hardening during peacetime because there is not enough time for detailed engineering designs or elaborate construction when an enemy or disaster threatens.

5.1.1. For permanent hardening, engineers perform a structural analysis to determine the appropriate hardening method. They examine the threat, in terms of the type of munitions weapon (fuzing, size, angle of impact, etc.), and the facility's function. Because the analysis is very detailed, it is mostly for permanent construction or peacetime retrofit of existing structures.

5.1.2. Permanent hardening measures are beyond the scope of this chapter and only mentioned incidentally. Conversely, expedient hardening is the primary hardening method for expeditionary forces and involves constructing berms, revetments, walls, barriers, bunkers, and other splinter protection for installation facilities, systems, and personnel.

5.2. Overview. This chapter addresses CE preparations for expedient hardening, including hardening concepts, candidate selection, design, considerations, factors, and specific options. Additional hardening information and techniques are available in AFMAN 10-2503, AFH 10-222, Volume 3, *Civil Engineer Guide to Expeditionary Force Protection*, AFH 10-222, Volume 14, *Civil Engineer Guide to Fighting Positions, Shelters, Obstacles, and Revetments*, GTA 90-01-011 (JFOB Handbook), and UFC 4-023-07, *Design to Resist Direct Fire Weapons Effect*. Other resources containing hardening information are UFC 3-340-01, *Design and Analysis of Hardened Structures to Conventional Weapons Effects*, UFC 4-010-01, *DOD Minimum Antiterrorism Standards for Buildings*, and UFC 4-020-03FA, *Security Engineering: Final Design*, and ATP 3-37.34.

5.3. Expedient Hardening Concepts. During wartime, hardening expeditionary and temporary construction to mitigate attacks from indirect fire weapons is often impractical because the structures are commonly made of metal frames, fabric or wood frames, and rigid walls. This makes the structures difficult to harden against potential threats. Therefore, to increase protection for personnel and critical facilities, units sometimes use a combination of solutions. Usually, the solutions are a combination of standoff distances, facility dispersal, compartmentalization, sidewall protection, and expedient bunker construction.

5.3.1. Sidewall protection is the main approach to providing protection for expeditionary and temporary construction. Sidewall protection, compartmentalization and facility dispersal measures all prevent one weapon from damaging multiple facilities or assets. Although these methods significantly improve overall survivability, CE units also enhance survival of personnel and critical facilities by providing supplemental or expedient facility hardening and helping units with shelter and bunker construction. Supplemental hardening usually involves facility retrofits, while expedient hardening consists of building non-permanent structures, defensive barriers, and other protective measures.

5.3.2. Expedient hardening utilizes local materials and prefabricated components for non-permanent construction or enhancements to existing structures. To help protect personnel in at risk facilities, construct expedient shelters or bunkers so personnel can evacuate to safety during attacks on the installation.

5.4. Hardening Selection and Design. The BCE is usually responsible for ensuring installation hardening measures are accomplished. Installation planners prepare expedient hardening plans (including hardening priority list) for base facilities supporting key mission functions and other important exposed resources. Planners may also provide design and construction advice for various hardening measures, but civil engineers have significant expertise and resources (design, labor, equipment, and materials) to help base organizations with hardening efforts. Hardening can help prevent the loss of critical resources, facility functions, and vital utility systems. It also enhances protection around the base perimeter, entry control points (ECP), and airfields. In addition, hardening creates strategically placed bunkers for personnel protection. At expeditionary beddown locations, hardening may simply be individual units placing sandbags or soil-filled containers around tents and critical operations. On the other hand, it may be as extensive as building overhead cover for important buildings or structures. Base camp planners should integrate facility hardening into the base layout plan by ensuring that adequate space is available around structures or groups of structures to fit in required hardening measures.

5.4.1. **Selection of Candidates for Hardening.** When selecting facilities and other assets for hardening, normally the areas that are most essential to continuing the base mission receive priority for protection. Installation commanders want to provide the best protection possible and certain structures will receive the highest priorities. These may include C2 facilities, critical radar units, ammunition storage and holding areas, fuel storage areas, and personnel housing. Other common sites include medical facilities, dining facilities (DFAC), and power generation equipment. Access/perimeter gates and utility generating plants are also considered high priority for hardening during base comprehensive planning, initial construction, and during renovation of existing facilities.

5.4.2. **Hardening Design.** Most facility hardening methods applied in the expeditionary environment is site-work measures designed to mitigate the effects of direct- and indirect fire weapons. It is mostly impractical to significantly harden or retrofit expeditionary and temporary construction. Therefore, increased standoff distance, protective barriers, and structure separation distance play significant roles in hardening design in many expeditionary environments. As a result, standoff and structure separation distance will commonly drive the need for larger sites. In addition, more temporary or improvised barriers and bunker construction will likely be necessary as compared to permanent construction. Consider these and other factors addressed here when determining appropriate hardening design criteria.

5.5. Expedient Hardening Considerations and Factors. Installation planners consider several factors when determining ways to protect non-hardened and critical resources from the effects of conventional weapons. **Table 5.1** and subsequent paragraphs provide basic factors to consider for expedient hardening. Planners should also review the minimum protective requirements in UFC 4-010-01 as well as any CCMD protection requirements.

Table 5.1. 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

5.5.1. **Threat.** The first place you look for the site threat is the CCDR's Operational Order (OPORD) for antiterrorism. The OPORD should identify what the regional threat is and what are the minimum protective requirements. Detailed analysis should determine if more protection is required. The variety of weapons available for attacking base facilities is almost unlimited, ranging from small arms to heavy aerially delivered weapons. Furthermore, weapons 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. Find additional information on conventional and CBRN weapons and their effects in UFC 3-340-01 and AFMAN 10-2503, respectively.

5.5.2. **Protection of Resources and Facilities.** Civil engineers should evaluate the hardening mitigation measures for each resource and facility type planned for upgrade. Evaluate each structural component against the effects of the probable threat weapons and the expected duration of use to determine design features. If protecting aircraft, consider length, wingspan, and aircraft height. 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.

5.5.3. **Time.** Normally, the nearer an air base is to the potential battle area, the more vital the time element becomes. Save time by efficient use of labor, heavy equipment, hand tools, materials, and other facilities available. CE units will need good planning, scheduling, and supervision during construction. Develop task priorities and assign crews and equipment to specific work areas to minimize travel. Sequence operations to best utilize all equipment.

5.5.4. **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, conserve materials, particularly those shipped from the CONUS. Units should arrange for or stockpile expedient hardening materials as appropriate and use local materials whenever practicable. The following paragraphs address potential expedient and improvised hardening materials. For information regarding the thickness of various protective material approved for protection against threat weapons, readers should consult UFC 4-020-01, JFOB Handbook, and ATP 3-34.37.

Table 5.2. 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.
Soil-Filled Wire/Fabric Containers	Backhoe/Loader Hand Shovel[1] Truck/Trailer[5]	Unskilled Skilled[2]	Soil Containers	3-5 ft.[8]
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.
Metal or Wood 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.

[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 non-hardened 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 used to protect corners of revetment array.
[8] Spacing for the most commonly used product.

5.5.5. **Equipment and Labor.** Base the selection of the hardening method 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, using bin revetments to protect the structure walls while using sandbags and loose soil to cover the roof. A number of innovative concepts are possible for expedient hardening. **Table 5.2** shows the equipment, labor, materials, and space required for the various methods. Personnel can perform a quick screening of each method using this table. For example, if space is very limited, soil berms are not usually an option. In addition, some methods such as sand grid forms require special materials.

5.5.6. **Topography.** Consider the area's topography near the deployment site 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) offering good observation for effective mortar or direct fire may destroy the effectiveness of revetments unless air base defense plans address 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.

5.5.7. **Terrain.** Planners should study the slopes, drainage, vegetation, character of soil, likelihood of floods, and other conditions affecting construction and layout of expedient hardening.

5.5.8. **Effects of Soil Moisture.** Wet soil may be the only option for revetments if dry material is not available, but it is uneconomical since larger quantities are required to resist penetration. Wet soil should 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 conserve labor and materials. Of the various soils, wet clay is the easiest penetrated 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.

5.5.9. **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 effectiveness. Dampness also has an adverse effect on the durability of other materials used in the hardening process. Wood rots and steel rusts quickly under these conditions unless well covered with protective coatings.

5.6. Hardening Options. 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 typically used. Other options include soil-filled wire and fabric containers, bin revetments, sandbags, and sand grids. These options do not provide the level of multiple-attack protection provided by soil berms. Under repeated attacks, these relatively vulnerable soil-confining systems tend to break down, allowing the soil to spill out. Concrete modular revetments provide good protection, although they do not provide the same level of protection afforded by a large mass of soil.

5.6.1. Units can employ these and other expedient measures to mitigate blast effects on unprotected and exposed facilities. The examples of expedient and improvised hardening techniques addressed below highlight different ways of using hardening in expeditionary and austere base environments. For specific design and construction details, refer to GTA 90-01-011, UFCs 3-340-01, UFC 4-020-01, UFC 4-020-03FA, ATP 3-37.34, and AFH 10-222, Volume 14.

5.6.2. **Soil Berms.** Soil or earthen berms are among the oldest and simplest methods of providing improved and expedient protection to existing structures, personnel, and other assets. Engineers have used these traditional military field structures as breastworks throughout history. They are still widely used as an expedient hardening method to protect resources and critical operations. Soil berms are extremely effective in protecting against modern weapons, particularly when coupled with semi-hardened structures. Build soil berms as freestanding structures, constructed against exterior walls of buildings, or placed against retaining walls.

5.6.2.1. Soil berms are often large structures with a massive footprint. During most construction projects for berms, CE personnel use heavy equipment to move, place, and compact the soil. However, preparing for an attack should be an installation-wide effort. Unskilled labor from other units can help complete tasks such as placing sod and sandbags, waterproofing, and digging drainage channels around berms, when necessary.

5.6.2.2. The main disadvantage of berms is their large space requirements. Berming may not be a practical hardening option for structures in very rocky terrains or if grading equipment is unavailable. At air base facilities, berms 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 originally designed to withstand loadings associated with weapon effects have ample capacity to support additional dead loads associated with berming. Be sure to investigate the capacity of conventional wall structures to determine the need for additional support. Simple earth berms and bermed walls can be effective 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.

5.6.3. **Soil-Filled Wire and Fabric Containers.** Recent CONUS and OCONUS contingency operations have seen a proliferation in the use of soil-filled wire and fabric containers as an expedient hardening method. Each container is a collapsible wire mesh cell, and lined with a geotextile fabric. It can be set up and filled with soil very rapidly. They are more economical, less cumbersome, and less time-consuming than constructing metal, timber, wooden, or concrete bins or sandbag walls. Units use these easily transportable, lightweight, expandable, and extremely versatile containers to build protective barriers and walls, revetments, bunkers, DFPs, and other expedient protective construction (**Figure 5.5**).

5.6.3.1. The protection provided by these structures is similar to that provided by other earthen walls. The level of protection depends on the dimensions of the completed container wall structure, as compared to the resource it is protecting. If fragments destroy the container's fabric causing the soil contents to spill out, little second attack protection remains and the structure acts only as a low earthen wall. Like other wall structures, these containers can deny line-of-sight to vulnerable facilities and areas.

Figure 5.1. Building Protective Barriers with Soil-Filled Wire and Fabric Containers.

5.6.4. **Sandbags.** Sandbagging is a traditional method of providing essential protection from small arms fire and explosive munitions fragments. They are especially useful as expedient field fortifications when heavy equipment or skilled labor is in short supply. Civil engineers might use sandbags to contain the blast from a terrorist's bomb. Sandbags also make effective temporary barriers to prevent access to critical installation areas during times of increased alert. In addition, use them as quick replacement protection lost through battle damage, for example, temporarily filling a hole blasted in a revetment with sandbags during a lull in the battle to provide protection during the next attack.

5.6.4.1. Units can also use sandbag structures to protect vital resources from natural or manmade disasters. During a flood or hurricane, sandbag dikes can prevent important resources from being swept away or seriously damaged by high water. Another application may prevent the spread of highly flammable material if a rupture occurs in a large fuel storage tank. Sandbags used for temporary, expedient hardening or emergency flood control are normally filled with soil; for culvert headwalls and revetment designs with multi-year design life, a soil-cement combination is sometimes used.

5.6.4.2. Although soil-filled wire and fabric containers are replacing many expedient sandbag applications, sandbags are still widely used to augment expedient shelter and bunker construction, fighting positions (**Figure 5.2**), and expedient hardening and flood control methods. Whatever the application or fortification, sandbags usually do not require heavy equipment or skilled labor for construction.

Figure 5.2. Sandbags Used in Construction of Fighting Position.

5.6.5. **Modular Concrete Barriers.** Modular reinforced concrete barriers provide an expedient method for hardening structures and protecting exposed assets. The concrete walls, panels, and revetments provide a versatile, durable, and relocatable method for protecting essential facilities and resources (**Figure 5.3**). Units use various models during contingencies and expeditionary operations to protect living quarters, medical facilities, DFACs, and operations centers. The barriers also provide protection for mission essential assets such as vehicles, power production equipment, AGE, liquid oxygen storage tanks, war reserve materiel (WRM) assets, and mobile generators.

Figure 5.3. Civil Engineers Placing Interlocking Concrete Barriers.

5.6.5.1. These concrete barriers are sometimes placed in aircraft parking areas (on and off paved surfaces), and used to deny line-of-sight to doors and other vulnerable openings. Their modular construction permits a wide variety of configurations and applications. The height, width, and thickness vary by type and design. The major distinguishing feature of modular barriers, when compared to other hardening measures, is their portability. These barriers can also be bermed with soil to improve protection.

5.6.5.2. The factors limiting the use of concrete barriers are usually the resources necessary to fabricate and deploy them. It takes a lot of time to make the barriers. Therefore, to use them as an expedient measure, they must be prefabricated in advance. Usually during an extended buildup phase before hostilities begin or before a disaster threatens. Additionally, cranes and forklifts are required to position the barriers. Further, bermed concrete barriers also have large space requirements, in addition to other limitations associated with soil berms and bermed walls. Refer to GTA 90-01-011 for information on barrier specifications and use.

5.6.6. **Bin Revetments.** Bin revetments refer to hardening methods used to create vertical walls of soil, gravel, or rock rubble. There are many variations and life spans to bin revetments. Some are permanent while others have only a limited life. Bases use bin revetment systems the same way as soil berms, but they combine the protective qualities of soil structures with efficient use of space. The thickness of the soil or geologic material is the primary means of providing protection. The wall structure consists of walls or panels (e.g., concrete or masonry, timber, lumber, metal) to confine the soil or rock plus a structure to hold the panels in place.

5.6.6.1. Concrete or masonry bin revetments generally require significant construction resources. However, metal bins are prefabricated and do not take much more time or expertise to install than soil-filled wire and fabric containers revetments. The hearty construction of previously constructed metal bin revetments ensures they will probably be around at numerous theater airfields and installations for a long time. In fact, metal bin revetments constructed decades ago are still in use in FP and expedient hardening schemes at some MOBs and FOBs (**Figure 5.4**). Bin revetments provide essentially the same protection as other earth walls and they deny line-of-sight to doors and other vulnerable openings.

Figure 5.4. Steel Bin Revetments on Flightline at FOB (2013).

5.6.6.2. Soil bin revetments generally require significant construction resources. If built of expedient materials, they tend to be temporary measures. When constructed of reinforced concrete or masonry, they are usually part of permanent upgrades or new facility construction.

5.6.7. **Sand Grids.** Originally developed as a soil-confining system for use in roadway construction over loose soils, sand grids have proven to be an effective and versatile method of providing expedient hardening. Sand grids are primarily soil structures and are similar to soil berms and sandbags in their use. The principal advantages of using sand grids instead of 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 and filled with granular material such as sand, gravel, or other soil (**Figure 5.5**). Currently available sand grids are 38 inches wide in place. Sand grids are durable and do not rot.

Figure 5.5. Gravel-Filled Sand Grid.

5.6.8. **Predetonation Screens.** Vertical predetonation screens (sometimes called standoff or triggering screens) placed in front of a facility or fighting position should detonate incoming contact-fuzed munitions. These screens supplement the protection inherent in the protected structure or position and reduce structure damage. The screen may be wood, sheet steel, fencing, metal mesh, and other acceptable materials. It may be solid material or open screen. Use open screens (e.g., chain link fence or metal mesh) when observation through the screen is required. For information on constructing and siting predetonation screens, refer to GTA 90-01-011 and UFC 4-023-07. **Note:** Predetonation layers may provide overhead protection for expeditionary and temporary structures when incorporated with adequate shielding layers.

5.6.9. **Unconventional Hardening.** In extreme, time-critical situations, previously discussed hardening methods may not 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. Use them as a shield for high-value or mission-critical base assets. Obviously, one should weigh the risk involved versus the possible destruction of equipment used as a shield. The point is, do not overlook any technique simply because it is not a "standard" hardening methods.

5.6.10. **Flood Control Hardening.** Flooding can cause significant damage to base facilities and easily create wholesale disruption of installation operations. Implement hardening/flood control measures to protect critical facilities and utilities (e.g. C2, water treatment plants, power plants and substations) from the effects of flooding. Depending on the immediacy of the situation, either expedient or long-term measures apply. Expedient measures may include building dikes as a flood threatens, berming water treatment plants/power substations to prevent flooding, building levees to prevent flooding, and arranging for and setting up pumps to prevent key facilities from flooding. Long-term or permanent measures may include building new facilities above flood stages, building floodwalls to protect facilities from storm surge, or building permanent dikes in advance.

5.7. Summary. Hardening includes both standard and non-standard hardening techniques. During deployments, improvisation is often required to compensate for the lack of traditional construction materials or specialized equipment. Expedient construction methods may take advantage of available local materials and terrain features. AFH 10-222, Volume 14 and GTA 90-01-011 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.

5.7.1. Unit personnel with minimal training can usually accomplish expedient hardening. When planning hardening actions, recognize the most effective hardening measures may not be best to employ under every situation. Consider factors such as the estimated construction time, work force and equipment availability, life-span requirement, and availability of materials. Implement specific actions based on these considerations and the decision of the senior AF commander. For more information on hardening criteria and procedures, refer to the references in **Table 5.3**.

Table 5.3. Chapter 5 Quick-Reference.

Expedient Hardening Chapter References	
AFH 10-222V3	*Civil Engineer Guide to Expeditionary Force Protection*
AFH 10-222V14	*Civil Engineer Guide to Fighting Positions, Obstacles, and Revetments*
ATP 3-37.34	*Survivability Operations*
AFMAN 10-2503	*Operations in a Chemical, Biological, Radiological, Nuclear, and High-Yield Explosive (CBRNE) Environment*
GTA 90-01-011	*Joint Forward Operations Base (JFOB) Force Protection Handbook, Sixth Edition (FOUO)*
UFC 3-340-01	*Design and Analysis of Hardened Structures to Conventional Weapons Effects*
UFC 4-010-01	*DOD Minimum Antiterrorism Standards for Buildings*
UFC 4-020-03FA	*Security Engineering: Final Design*
UFC 4-023-07	*Design to Resist Direct Fire Weapons Effect*

Chapter 6

CAMOUFLAGE, CONCEALMENT, AND DECEPTION (CCD)

6.1. General Information. Installation planners use CCD as an added measure to enhance the hardening protection of vulnerable base facilities and systems. The objective of CCD is to reduce the effectiveness of enemy air and ground attacks and reconnaissance. Essentially, unit CCD measures can confuse our adversaries by altering the factors of recognition, which they use to find targets. Because CCD is site dependent, there is no standard design and efforts will vary from base to base and between facilities on a base. The amount of CCD needed to defeat a threat also varies with the physical characteristics of the protected resources, their location and orientation, the surrounding terrain and land-use, and the threat. In most cases, CCD measures partner with permanent, expedient or supplemental hardening.

6.2. Overview. Although CCD measures can be applicable to any base organization, certain design and construction expertise for CCD reside within the CE unit. In an expeditionary environment, CE units and other organizations may disguise and conceal critical installation facilities and assets to minimize detection and identification by potential attackers. This may include netting buildings or vehicles, applying tone-down and foliage matching paint to blend equipment with terrain, disguising potential targets, setting up decoys, and other CCD measures. This chapter addresses basic preparations for implementing command-directed CCD measures. It highlights general CCD guidelines and fundamentals, including a brief examination of methods, materials, and uses at permanent and austere installations. It also addresses routine facility camouflage and concealment preparations; including a brief review of design factors and considerations, siting, orientation and layout, and construction materials. Additional information on CCD design, factors and techniques are available in UFC 3-340-01, UFC 4-020-03FA, and AFH 10-222, Volume 10, *Civil Engineer Camouflage, Concealment & Deception (CCD) Measures*. **Note:** Although the CCD information in UFC 3-340-01 focuses on CCD techniques and design approaches for permanent and hardened structures, many of the CCD techniques and designs potentially apply to expeditionary and temporary construction.

6.3. General Guidelines. The fact an installation exists or is under construction is difficult to conceal from the enemy. Base planners should conclude the enemy has an idea of the character of the base. The location of existing airfields is well known and marked on commercial maps. If any large-scale force beddown effort is required, concealing that effort is impractical since the area will probably be under surveillance. The general aim of CCD, therefore, is to make it difficult for the enemy to use the information he possesses. Specifically, CCD efforts should concentrate on decreasing the range of target acquisition by delaying recognition of targets and by concealing, confusing, or decoying individual objects within the target area, thus hampering precision bombing and point target attack with mortars, cannons, rockets, missiles, and other weapons.

6.3.1. **Benefits of CCD.** Personnel can count the number of bombs dropped on targets, but planners and analysts can only estimate the number of bombs not delivered, or delivered off target by enemy aircrews baffled by CCD. Tests indicate the bomb-release effectiveness by pilots attacking a site previously attacked when not camouflaged, reduced by approximately half with the addition of camouflage. Although difficult to quantify, the value of hindering the bomb release of high-speed aircraft by as little as one second is obvious. A one-second release delay causing a delivery error of a few hundred yards could prevent target destruction.

6.3.2. **Planning and Design of CCD.** Installation working groups (e.g. Threat Working Group, Integrated Defense Working Group, EM Working Group, and AT Working Group) ensure comprehensive plans are prepared to accomplish installation CCD measures. All functional areas should be aware of unit CCD responsibilities. Address the CCD measures for CE units in the CE CRP. Include both expedient and long-term camouflage plans; arrange for or stockpile required CCD supplies and equipment; prepare unit blackout plans, and other procedures deemed necessary. Depending on the perceived threat and resources available, implementation of CCD actions may be immediate, short-term, or long-term. Most likely, extensive CCD efforts for permanent facilities extend over a period of years due to routine fiscal constraints. Several factors determine the kind and degree of CCD, including:

- Value of the installation
- Vulnerability of the installation and key resources
- Intelligence info about the installation that may be available to potential adversaries
- Profiles, directions and timing of potential installation attacks

6.3.3. **CCD and Military Deception.** Unit CCD efforts should confuse and deceive installation attackers, but do not confuse it with Military Deception (MILDEC), which is a much broader, information-related capability. AF and Joint doctrine indicate MILDEC actions should mislead adversary decision makers causing them to take specific actions or inactions that contribute to accomplishment of the friendly mission. Although significantly different, CCD still has a connection to MILDEC. For example, CCD can potentially support MILDEC by altering the appearance and hiding certain installation activities, capabilities, and assets. On the other hand, installation CCD could be detrimental if it ultimately projects or sends a different message than that intended by any planned or ongoing MAJCOM or CCMD MILDEC operations. Therefore, by conveying what CCD measures to implement and when, commanders can ensure installation CCD actions are not inconsistent with any MILDEC objectives. For specific information on MILDEC, refer to AFI 10-704, *Military Deception Program* (S), AFDA 3-13, *Information Operations*, and Joint Publication (JP) 3-13.4, *Military Deception*.

6.3.4. **Permanent and Expedient CCD.** CCD measures fall into two general categories—permanent and expedient. Permanent methods involve using CCD measures with sufficient durability to withstand the rigors of operations and weather. Vegetation, coatings, earthwork, and construction are examples of permanent CCD methods. Conversely, expedient CCD measures are commonly of a temporary nature and rapidly applied. Nets, water, and some coatings are examples of expedient measures, which are less durable than permanent CCD measures. Permanent measures should add to the attractiveness of a base. If they have to be ugly, make them expedient measures.

6.3.5. **Limitations.** Numerous factors may dictate or limit the CCD options used at a given base and location on base. Each of the following may be important considerations:

6.3.5.1. Prominent landmarks, which enemy aircraft could use as orientation points. It may not be practical to camouflage or conceal these landmarks.

6.3.5.2. Operational demands of the installation. The level of operational activity may limit or even preclude certain CCD measures.

6.3.5.3. Geographic dimension and time available. The size of the area to be treated and the time available for completion of the project dictate the type of construction feasible.

6.3.5.4. Expected useful life of the installation. Determines whether a short or long-range CCD program is appropriate.

6.3.5.5. Suitable areas for creation of a decoy installation.

6.3.5.6. Available CCD materials, labor, and equipment.

6.3.5.7. Expected CCD maintenance requirements. A review of past weather data (precipitation, wind, and temperature ranges) should reveal the magnitude of maintenance required.

6.3.5.8. Probable enemy use of geospatial, satellites and overhead imagery prior to commencement of hostilities.

6.3.5.9. Anticipated security requirements to maintain secrecy during CCD construction.

6.3.5.10. Existing or planned CCD of adjacent military installations. Coordination is essential when allied installations employ techniques markedly different from US doctrine.

6.3.6. **Siting Considerations.** Planners normally select base locations for reasons other than providing good camouflage and concealment. Even so, there are terrain and manmade features that can enhance CCD even though the site location may not be optimum for it. Planners should determine these features and decide how to take advantage of them to provide the best concealment possible.

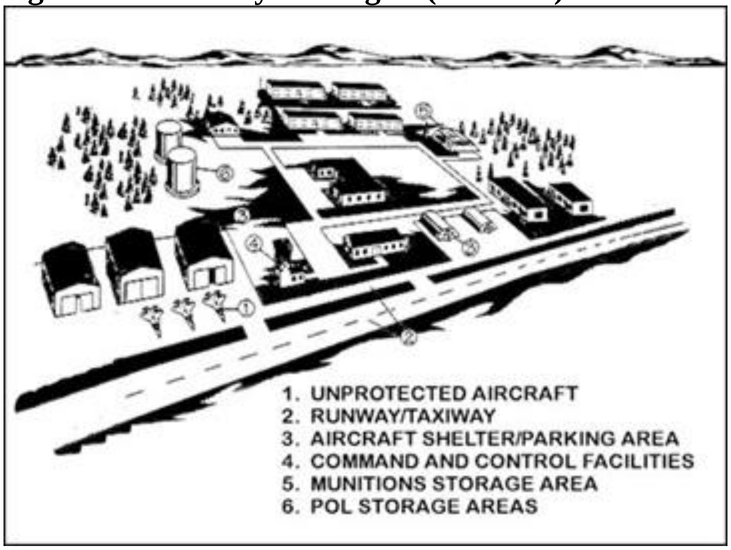
6.3.6.1. Terrain irregularities such as embankments, escarpments, rock outcroppings, depressions, vegetation, and ground color patterns offer opportunities for concealment. Shadow casting terrain features are particularly important.

6.3.6.2. Identify terrain features useable for enhancing security. Consider using existing roads and trails rather than creating new ones.

6.3.6.3. Nearby civilian structures can sometimes be used to advantage. They may physically conceal items or be imitated by disguising base facilities to appear as local construction. Whatever camouflage is planned from the runway on down, it should be done with a minimum of disturbance to the natural ground patterns. Try to avoid stereotypical sites and equipment locations.

6.3.7. **Priorities.** Installation planners develop CCD priorities after the threat and vulnerability has been determined. First, identify facilities and activities most critical to mission accomplishment. From these, determine which items require protection and how to protect them. Then establish a time sequence for accomplishing the work relative to the resources available. The nature of the threat, the importance of the base mission, and the base vulnerability all influence CCD priorities. In threat evaluations, the intelligence community assumes that the attacker's main mission will be to destroy, paralyze or at least degrade the aerospace assets. Shown in **Figure 6.1** is a notional priority list of targets. When possible, consider off-base aim points and other key reference points in this planning. Be sure to preserve OPSEC during planning. As a final comment on priorities, CCD efforts and priorities should mesh with other base preparations.

Figure 6.1. Priority of Targets (Notional).



6.3.8. **Resources.** Installation CCD planners should determine what materials, work force, and equipment are available for CCD employment. Be willing to substitute one type of camouflage method for another in case of unforeseen delays. Camouflaging of facilities and equipment is labor intensive, and except for earth moving, unit personnel apply CCD measures mostly by hand.

6.3.9. **CCD Implementation Options.** The decision to incorporate CCD measures should consider the work required, the priorities and situation at the time, and the amount of time available. Options to consider include:

- Camouflaging or concealing assets during initial construction or set up of an austere base
- Camouflaging the base in successive sections during ongoing operational activities
- Camouflaging only vital assets when given minimum warning
- Expediently camouflaging key assets initially and then replacing or augmenting those measures later by more comprehensive or permanent work

6.3.10. **Work Scheduling.** Prepare a schedule for expedient CCD preparations. The schedule should take into account:

- Priority of assets to be protected
- Compatibility with the operational mission
- Delivery of materials in a manner which avoids storage problems and does not arouse enemy attention (unless drawing enemy attention is part of the plan)
- Potential conflicts with other work being carried on simultaneously in the same area

6.3.11. **Construction Practices.** If the final camouflage product is to be effective, maintain good practices during the construction process. Good discipline prevents the activities at the construction site from becoming obvious to enemy observers. Effective discipline requires constant supervision to ensure the area does not attract attention. Land clearing should be limited to only that which is necessary. Scrap lumber, packing boxes, empty paint cans and other forms of refuse or debris should be disposed of or camouflaged as soon as possible. Establish a traffic plan and strictly adhered to it in order to prevent excessive earth scarring.

Conceal or remove from the site any idle equipment and stockpiles. If dictated for operational security reasons, screen all work activities.

6.3.12. **Inspection of Installation CCD Measures.** During construction, periodically check materials for suitability, quality, color, and proper application. Even after careful research, planners cannot predict the final appearance of the camouflage from photographs, sketches, and drawings. Check CCD measures from the air at different times of the day during application. Do it early to permit change in material, design, color, or construction. Follow-up low angle aerial photographs of the area, plus radar and infrared images, are very useful for detailed evaluations of CCD effectiveness. Periodically re-evaluate the installation "picture" to ensure the key resources remain well protected from enemy detection. Correct any deficiencies immediately. Also, check throughout the year to ensure CCD measures remain effective during the different seasons. Document those seasonal changes with photographs to help when designing needed changes.

6.3.13. **CCD Maintenance.** Camouflage requires periodic maintenance to repair netting and structural supports, to renew the coloration of ground patterns due to wear, or to replace vegetation that has withered. Use cut vegetation sparingly on the installation because vegetation is only good for a few days before it withers. In just a few weeks, you could deplete an area of live vegetation while trying to keep the dead vegetation looking alive. That obviously defeats the whole effort. If using cut vegetation, cut just a little from any one plant or tree, and do not cut it all from one small area. Concentrated cutting creates a visible difference in texture and color and therefore a recognition cue.

6.3.14. **CCD Discipline.** Good CCD requires everyone on the installation to practice discipline. The most skillfully applied camouflage is useless if "routine" activities of the base fail to support the CCD. A breech of discipline by just one person can ruin the entire effort. The most common mistakes are careless creation of new, repeated tracks in an otherwise unmarked area, improper disposal of spoil or excavated dirt, careless scattering of debris around the area, and turning on unprotected lights during blackout periods. The installation should have a set of camouflage rules because most personnel may not be aware of the many things they do which could compromise the camouflage effort.

6.3.14.1. Post and enforce blackout rules, particularly at maintenance and operations shelters. A light leak from a structure is visible from great distances at night. Exercise particular care to prevent light leaks from tents. If soft wall shelters are single layered or uninsulated, they are generally not light proof. Park vehicles at a distance of 200 to 300 yards from critical facilities. Even with an item carefully camouflaged, litter and vehicle tracks around the area can compromise security. An airborne observer can determine that the item is important without even knowing what it is.

6.3.15. **Permanent and Austere Bases.** Understandably, CCD methods for enduring installations and austere bases differ in size, complexity, and permanence. Plan CCD measures in advance for permanent installations. When practical, incorporate CCD into the design and construction of new facilities. At austere or initial contingency locations, time, personnel, money, and materiel often limit implementation of CCD measures. Additionally, the location of an austere base can restrict flexibility in the employment of certain CCD procedures. At austere bases, expedient CCD methods generally focus on delaying enemy detection of the target rather than complete concealment.

6.3.16. **CCD Planning Aids.** The following geospatial map information and aids can be valuable to installation planners when developing CCD plans:

6.3.16.1. Medium and large-scale topographic maps of the base and adjacent areas.

6.3.16.2. Aeronautical charts. These documents provide information regarding flight paths for various approaches to the air base and are useful in determining placement of camouflage to avoid conflicts with air traffic.

6.3.16.3. Aerial photographs of the base and surrounding area taken from likely enemy approach directions and attack angles, and during various seasons and weather conditions.

6.3.16.4. Town plans and country maps.

6.4. CCD Fundamentals. Most CCD measures are part of a multitude of procedures and preparations units make to ensure the survival of installation facilities, equipment and personnel. Understanding CCD basics is the first step to executing good CCD at any installation or operating location. The following paragraphs address common recognition factors (how potential observers see and distinguish objects on the ground) and the four basic principles of CCD.

6.4.1. **Signature and Recognition Cues.** There are certain elements or characteristics of every object or activity that makes them visible or recognizable. These characteristics, cues, or signatures change as the perspective of the observer changes. Features that enable an observer to identify an object are high contrast, large size, shape, pattern, and movement. These features apply to the thermal and radar spectrum as well as to the visual. Installations use CCD measures to alter or conceal these signatures to prevent detection and recognition.

6.4.1.1. Other factors affect target detection and recognition: the acuity of the eye, sensor capabilities, the quality of the atmosphere between the object and enemy observer, the distance between the object and the observer, the angle of observation, the approach speed of attacking aircraft, pilot distraction caused by air defenses, etc. Some of these factors combine to simplify the CCD problem. Sometimes, only a single cue, along with some deductive logic by the observer, is enough to detect or identify an object.

6.4.1.2. Often, it is not feasible to prevent detection by CCD. However, while the enemy may be well aware of the existence of something in the camouflaged position, he or she may not be able to recognize it as a worthwhile target. Prevention of recognition, therefore, is frequently just as useful in a military sense as is prevention of detection. This section provides additional comment on shadows, shape, texture, color, position, and movement.

6.4.1.3. **Shadows.** In areas where clear skies are common, a key problem is concealment of shadows. In areas where sunlight is less continuous and where trees and other vegetation on the installation make it possible to hide shadows, the shadow problem is not so acute. When viewed from the air, observers can easily detect and recognize the shadows of objects more frequently than the objects themselves. Personnel can disguise or disrupt the shadows, but not eliminate them. Shadows are easier to recognize than the tops of large objects, since a shadow reveals the shape of an object to an observer. Disrupting the shadow may be enough to prevent recognition from the air.

6.4.1.3.1. The ideal situation is to reduce the shadow by burying or digging-in all key assets. Obviously the lower the object, the shorter the shadow. The more realistic solution is to merge shadows with nets or natural materials. Since shadows move throughout the day, look at the shadow footprint.

6.4.1.4. **Shape.** This is a fundamental recognition cue. Observers often recognize the object's profile long before seeing specific details of the object. Several things distract the perception of shape. Examples include pattern painting, netting to blend with the background, or using shape disrupters (**Figure 6.2** and **Figure 6.3**).

Figure 6.2. Shape Disrupter—Camouflage Nets and 55-Gallon Barrels.

Figure 6.3. Shape Disrupter—Sail Design.

6.4.1.5. **Texture.** Texture is the relative roughness or smoothness of the surface of an object. Texture affects the way the object reflects light or radar signals. Rough surfaces have shadows and reflect incident light and radar signals in many directions; they appear dark in photographs. Smooth surfaces reflect more and appear light in photographs. A very smooth surface produces an easily detected shine or glint. The shine from upturned surfaces (such as generated by tents or shelters) is less conspicuous in a barren desert environment than when present in a more textured woodland background.

6.4.1.5.1. Distance affects the eyes ability to perceive texture. The greater the observer's distance, the smaller the details and the more the eye tends to see a smooth surface that is devoid of texture. Therefore, items such as grass on the side of a building may show texture when viewed from close ranges, but appear smooth at a distance. Rough surfaces also tend to absorb more solar energy, which helps thermal sensors distinguish between targets and their background. Although photographs can sometimes be deceiving, state-of-the-art of optics, film, and associated advances continues to improve camera limitations and technology.

6.4.1.6. **Color.** Contrasts in color attract attention. The greater the contrast between a target and its background, the more noticeable an object appears. Color differences tend to disappear as the distance from the observer increases. From a camouflage standpoint, a major problem in a desert environment is "toning up" or making items appear lighter to blend into the background. This is exactly the opposite of the problem in a woodland environment where "toning down" is the objective in order to make objects darker.

6.4.1.7. **Movement.** Movement, while not a major factor in recognizing and identifying an object, is a major factor in revealing its presence. Observers can easily detect movement with their peripheral vision. A pilot in a fast aircraft can more easily detect motion that is perpendicular to his flight path than parallel motion. In addition, motion parallel to the flight path but in opposite directions is noted before parallel motion in the same direction, due to the relative closing speeds.

6.4.1.8. **Position/Pattern.** Certain objects are always in proximity to other objects, and recognition of one may disclose the other. For example, larger structures adjacent to an airfield are usually hangars. Many uniform-size mounds in remote areas of the base are usually munitions storage bunkers. Objects observed on runways or taxiways are usually aircraft; aircraft identified on the ground are seldom away from airfields. Although difficult to counter, be aware that prominent landmarks can guide attacking aircraft to specific targets.

6.4.2. **Four Basic Principles.** The basic principles of CCD include hide, blend, disguise, and decoy. In most CCD programs, methods that combine these principles provide the most effective results. It is important to understand each of the concepts, especially when used in combination. A good understanding keeps you from employing measures that conflict with each other and reduce overall CCD effectiveness.

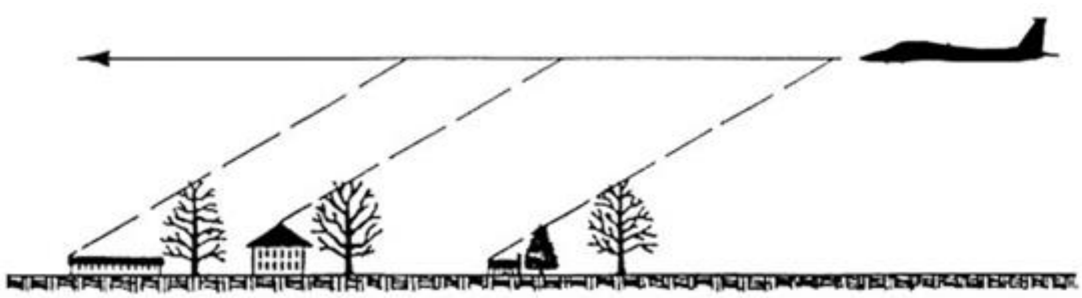
6.4.2.1. **Hide.** Hiding means completely concealing or screening target areas, facilities, equipment, or personnel from detection by the enemy's sensors. Base personnel can prevent enemy discovery of important targets by positioning a barrier to block the view of the sensor. Techniques useful for hiding targets include vegetation, nets, screens, and smoke. The selected methods should be able to hide a target and fit into the total camouflage plan. **Figure 6.4** shows how to use camouflage nets to hide assets. In this figure, the camouflage is obvious but not the assets hidden by the net. If the assets were next to natural trees, it would improve overall CCD effectiveness. **Figure 6.5** illustrates the use of vegetation to hide structures from a low flying aircraft.

6.4.2.1.1. When concerned with aircraft attacking at low altitudes, the screen only needs to be tall enough to prevent direct observation from a very low angle. If an attacking aircraft does not detect the target until it is within 5,000 feet, it is normally too late to conduct an effective attack.

6.4.2.1.2. For a physical barrier or screen to be effective in hiding an object, it is necessary to know the directions for which shielding is important. This is an important part of threat evaluation. The height of the shield is a function of the size of the area or object needing protection. Both the height and width (or length) of an object are important as well as the altitude of the attacker. Refer to UFC 3-340-01 to calculate required shield height for a given object.

Figure 6.4. Camouflage Nets Hiding Assets.

Figure 6.5. Using Vegetation to Hide Structures.



6.4.2.1.3. The requirements for hiding a thermal target are generally the same as those used for a visual target with respect to height and position (direction) of the shield. However, the location of a thermal shield may be critical. Shields located very close to, or over a hot object (for example a generator or an exhaust vent), may heat up, making it an obvious target on a thermal IR sensor. Keeping an air gap between the hot object and the shield generally prevents this problem. Nets or shields draped over heat generating objects to cover them from all directions are particularly prone to heat absorption and, consequently, detection by thermal sensors.

6.4.2.1.4. Hiding is obviously more effective for the protection of a single target or a number of widely dispersed targets. Generally, it would be impractical to attempt to hide an entire base or similar large area. An exception is the extensive use of smoke or artificial fogs. Smoke or fog generators can hide significant portions of an installation and its key resources. Smokes and artificial fogs are capable of providing large clouds, or screens, over an area for several hours. However, wind conditions can affect persistency; consequently, continuous generation may be required to provide ample coverage. Smoke or fog generators should be mobile to permit movement to the windward side of areas as needed. Consult Technical Order (T.O.) 11C12-2-7-1, *Generator, Smoke, Mechanical A/E32U-13 and Control, Remote, Smoke Generator MXK-856/E32U-13*, for information related to the operation of smoke generators.

6.4.2.2. **Blend.** The objective of blending is to make an object look like or appear to be a part of the background. In the visual band, this normally means coordinating the color and brightness of the target with its background. **Figure 6.6** is an example of how camouflage nets can blend with a natural background. In the thermal band, the objective is to reduce the radiated temperature difference between the target and its background to a level below the minimum threshold of the enemy's IR sensor. Blending deals with the average tone or brightness of the target and background as seen through the threat sensor, but planners should consider other factors to achieve optimum contrast reduction. The following characteristics cause military facilities to stand out from civilian facilities on the same landscape.

6.4.2.2.1. Size. Military facilities such as runways, parking aprons, and aircraft hangars are usually large and therefore conspicuous. Large objects are visible from long ranges.

6.4.2.2.2. Shape. The shapes of many military buildings relate to the function of the building and are quite distinct from civilian structures. Unusual shapes are conspicuous. Straight lines indicate human influence.

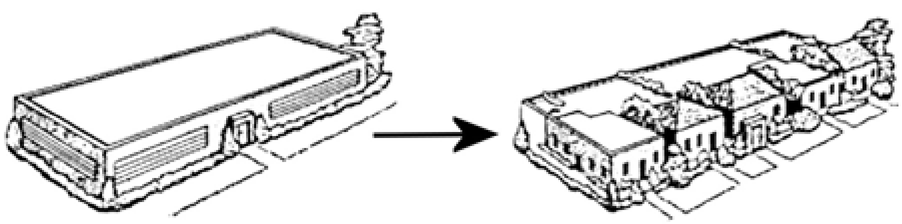
6.4.2.2.3. Pattern. Many installations in different parts of the world, but with the same function, have the same configuration. Standardization enhances recognition.

6.4.2.2.4. Texture. Natural vegetation has a broken surface with considerable texture and smooth contours. Lawns and traffic surfaces appear smooth without texture. Buildings present distinct shapes with sharp outlines. Changes in texture are easily recognized.

Figure 6.6. Camouflage Net Blending with Background Hill and Vegetation.

6.4.2.3. **Disguise.** Disguise intends to generate a false appearance to mislead the attacker as to the identity of the target. It makes the target look like some other feature, rather than blending it into the background. For example, a large building made to appear like a group of small houses (**Figure 6.7**). The amount of detail for disguise in the thermal band is less critical due to the lower level of detail commonly available in thermal imagery. However, it is essential that the visual and thermal appearance of a disguise is compatible. The disguise would be obvious if a thermal image showed a single large hot chimney or exhaust rather than a warm chimney for each residence as expected from the visual image.

Figure 6.7. Disguising Large Building as a Group of Smaller Buildings.



6.4.2.4. **Decoy.** Operations to deceive the enemy and to cause him to waste his strength on worthless targets are an essential aspect of deception. Decoys are important tools in the hands of a good CCD planner. During WW II, allied forces deployed decoy aircraft, armored vehicles, and other equipment prior to the D-Day invasion of Western Europe in an attempt to convince the enemy that the invasion would take place at another location. As weapon systems have become more sophisticated, the design of decoys has improved. Generally, CCD uses three types of decoys: targets, cues, and distractors.

6.4.2.4.1. Target decoys are realistic imitations of targets. Placed them at locations where they become effective false targets and munitions absorbers and where weapon detonation should have little impact. Target decoys may represent aircraft or other high value assets. They are most effective when support equipment is nearby, just as in normal operations. Decoy cues disorient the attacker who is looking for specific identification features and aiming at orientation points. Road intersections, towers, water bodies, and other conspicuous features may serve as important orientation cues for the attacker.

6.4.2.4.2. Concealing or camouflaging real cues and substituting false cues can be useful. Distractors are the third decoy type. Distractors create confusion, disorientation, or distract an attacker's attention at a time to the advantage of the defender. Distractors or disrupters should always draw attention away from critical targets. Commanders provide specific requirements and tasks for deployment of decoys.

6.4.3. **Design Considerations.** Whether developing a new installation or adding to an existing base, CCD schemes can be more effective with proper siting, design, and use of materials. Oftentimes, the success of any camouflage is dependent upon proper choice of position and camouflage discipline of the site. When possible, design new facilities to resemble civilian structures in the area. Unfortunately, the unique shape of many military structures (e.g., cylindrical shelters, runways, large parking ramps, control towers, large metal buildings) make them easy to recognize. New facility designs should reduce the conspicuousness of structures without limiting their functional use.

6.4.3.1. The addition of natural or artificial camouflage materials can make CCD schemes more effective. While natural camouflage materials are usually preferred, they may not be adequate, making artificial materials necessary.

6.4.3.2. **Natural Camouflage.** Proper use of vegetation can be one of the best overall camouflage methods in the visual, radar, and IR bands. Use natural vegetation to hide, blend, and disguise, but be sure to consider flight safety and security restrictions when planning tree location. The range of natural materials available to tone-down certain parts of a base is extensive. Permanent natural tone-down materials are grasses, trees, and shrubs. Expedient tone-down materials include straw, cut tree branches, vines, pine cones, Spanish moss, leaves, and other vegetative matter common to the location. Water is a good natural method to reduce thermal contrast. Ingenuity is a prime requirement for successful tone-down operations. Natural camouflage should always involve a careful consideration of the local area to ensure that camouflage techniques and materials conform to naturally occurring patterns.

6.4.3.3. **Artificial Camouflage.** To enhance effectiveness, designers should consider using artificial camouflage when siting and constructing facilities. It may be more significant when natural camouflage is insufficient to reduce the conspicuous nature for an area or important asset. Generally, employ artificial camouflage so it appears as realistic as possible. Examples of artificial camouflage include paints, stains, nets, textured matting/surfaces, and shields. This section only addresses camouflage coatings and nets; users should refer to UFC 3-340-01 for detailed information on the various types and uses of artificial camouflage.

6.4.3.3.1. Coatings. Various coatings offer CCD potential in the visual, thermal, and radar bands. Camouflage paints and stains have been in use for many years and can be effective when properly employed. Listed in **Table 6.1** are the advantages and disadvantages of using coatings. The primary uses of coatings are to reduce the brightness or color contrast between the target and background and to generate patterns that disrupt the shape of the target.

Table 6.1. Advantages and Disadvantages of Using Coatings.

Advantages of Using Coatings	Disadvantages of Using Coatings
Simple and fast to apply	Requires renewal of some coatings. May require change of colors according to season
Helps to preserve the surface	Standard coating effective only in the visual range
Eliminates operational or safety hazards on vertical surfaces	Seldom adequate as a single measure
Effective in visual and near IR bands. Limited effectiveness in thermal IR and radar bands	High cost for thermal and radar coatings
	Traction reduced on horizontal surfaces

6.4.3.3.2. Nets. The AF uses several variations of camouflage net and screen systems (commonly referred to as nets), including those listed in **Table 6.2**. The nets are lightweight or ultra-lightweight and the camouflage screen systems are radar transparent or radar scattering. Radar transparent versions (Type I) are for use over active radar antennas and radar scattering versions (Type II) are for use over everything else.

6.4.3.3.2.1. Nets and screen systems vary in color and size. Limited numbers of camouflage sets are available in mobility support packages; however, units can order additional sets through their local supply system. Camouflage sets provide an expedient means of concealing important targets and at a lower cost than more permanent CCD methods. The sets provide temporary camouflage to conceal stationary objects where natural cover and concealment are inadequate or absent. It is unlikely that bases will buy and store enough nets to cover all key base assets. Consequently, nets should be only one element of the base CCD plan.

6.4.3.3.2.2. Especially useful at austere bases, these camouflage sets are simple and easy to erect and are effective in the visual, radar, and thermal bands. In the visual band, users can make them resemble various surfaces. In the thermal band, they provide shadowing of the target and, since nets generally remain near air temperature, there is little thermal contrast with most backgrounds. In the radar band, radar scattering nets can disrupt the radar return signals. When employed at long-term or permanent installations, locally constructed support systems can hold nets in place. These support systems stay in place longer and can speed net setup on larger structures.

6.4.3.3.2.3. A locally constructed support system has another advantage. It can also support profile disrupters, dummy features, and local debris to improve the CCD effect.

Table 6.2. Camouflage Nets.

<table>
<tr><th>Lightweight Camouflage Screen System</th><th>Support System</th></tr>
<tr><td>Desert, Radar Transparent, Type I, National Stock Number (NSN) 1080-01-475-0694</td><td>Support, Camouflage Screening, System Type I, NSN 1080-00-108-1173</td></tr>
<tr><td>Woodland, Radar Scattering, Type II, NSN 1080-01-457-2956</td><td>Support, Camouflage Screening, System, Type II, Woodland/Desert, NSN 1080-00-179-6025</td></tr>
<tr><td>Snow, Radar Transparent, Type I, NSN 1080-00-103-1234</td><td>Support, Camouflage Screening, System, Snow, Type I, NSN 1080-00-556-4954</td></tr>
<tr><td>Snow, Radar Scattering, Type II, NSN 1080-00-103-1233</td><td>Support, Camouflage Screening, Snow, Type II, NSN 1080-01-179-6024</td></tr>
<tr><th>Ultra-Lightweight Camouflage Net System</th><th>Support System</th></tr>
<tr><td>Desert, Class 2, 40x40 NSN 1080-01-375-8729</td><td rowspan="3">MTU-99/G Pole, NSN 1080-01-338-4470

MTU-96/G Camouflage Net Support, (A-Frame), (NSN 1080-01-338-4472)</td></tr>
<tr><td>Woodland, Class 1, 70x70 (NSN 1080-01-375-8730)</td></tr>
<tr><td>Desert, Class 2, 70x70 (NSN1080-01-375-8731)</td></tr>
<tr><th>Lightweight Camouflage Net System</th><th>Support System</th></tr>
<tr><td>Green-Desert/Woodland, CVU-166/G (NSN 1080-01-338-4471)</td><td rowspan="2">MTU-96/G Support Set (NSN 1080-01-338-4470)</td></tr>
<tr><td>Snow (Partial), Camouflage Set, (NSN 1080-01-338-4469)</td></tr>
</table>

6.4.3.3.2.4. The lightweight camouflage screen systems are the traditional nets commonly used throughout the Services (**Figure 6.8**). However, the nets' garnish produces a foreign object damage hazard when used around aircraft. The nets come in three visual schemes (woodland, desert, and snow) and two radar schemes (transparent and scattering). Compared to the newer ultra-lightweight camouflage net (ULCAN), these nets are heavier and bulkier and have a shorter useful life. While not as capable as the ULCANs, these nets may be an option whenever available.

6.4.3.3.2.5. The ULCANs (**Figure 6.9**) work against both visual and radar sensors. They come in two sizes, 40 feet by 40 feet and 70 feet x 70 feet, and in two visual schemes, woodland and desert. For each visual scheme, one side is mono color, and the opposite side has a two-color pattern. Generally, personnel can set up the ULCANs more quickly around facilities, equipment, and aircraft than the traditional nets. For additional guidance and detailed procedures on camouflage nets and screen systems, users should refer to T.O. 11WA2-5-1, *Fiber Camouflage Net, Camouflage Net Support and Aluminum Support Pole*, AFH 10-222, Volume 10, and the applicable manufacturer's manual.

Figure 6.8. Traditional Camouflage Nets.

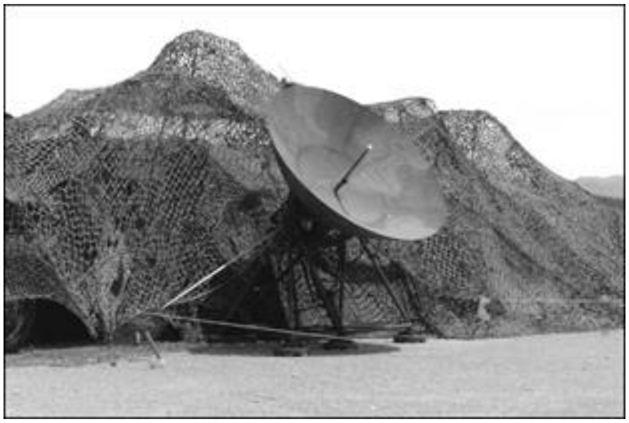


Figure 6.9. Ultra-Lightweight Camouflage Net.

6.4.3.4. CCD at Permanent Bases. This section highlights CCD design considerations for potential targets on permanent installations.

6.4.3.4.1. Runways/taxiways. Camouflage or concealment of runways and taxiways is difficult due to their large size and operational requirements (**Figure 6.10**). When designing camouflage for these areas, do not obscure markings essential to aircraft operations. Basic options for camouflage or concealment of runways and taxiways are tone-down, patterning, or shielding.

6.4.3.4.2. Parking areas. The methods used on runway/taxiway camouflage also apply to parking areas. Because of less stringent requirements, several other methods are also available. Camouflage coatings, textured mats, and other methods can be used more extensively due to less and slower traffic.

Figure 6.10. Uncamouflaged Taxiways.

6.4.3.4.3. Roads. It is difficult and costly to camouflage an entire road, but certain methods can break up geometric patterns formed by roads on an installation. Enemy pilots may be able to locate an installation or vital facility by the conspicuous characteristics of roads and intersections. A road that terminates at no logical position can be a dead giveaway to an otherwise well camouflaged position. Extending the access road past the camouflaged facility helps protect it from detection. Pattern painting various sections of the road, planting of trees, and construction of decoy roads can all be effective means of deception. For expedient methods, nets, screens, and textured mats can reduce the obvious features of a road.

6.4.3.4.4. Hardened aircraft shelters. The unique shape of aircraft shelters make them especially vulnerable to detection by enemy aircraft. Their shape often produces an easily recognizable shadow. The shelter opening appears cool during the day and warm at night to thermal sensors, and there are repeated radar signatures. Pilots recognize clusters of these shelters at long ranges because they are large and form geometric patterns with their connecting taxiways. Effective CCD for these large structures includes berming, local vegetation, tone-down, and camouflage nets and coatings.

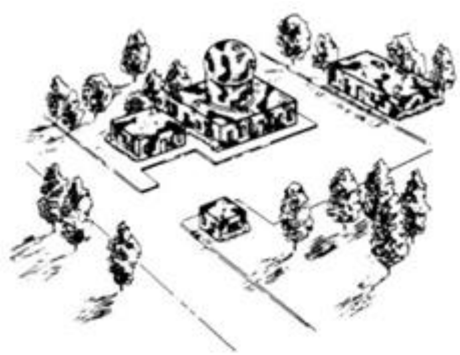
6.4.3.4.5. Conventional structures. Maintenance hangars, billets, administrative buildings, and terminal buildings normally are easy to identify because of their size, strong radar returns, and associated concrete or asphalt parking areas that surround them. Patterning with various coatings effective in visual and thermal bands is an effective way to break up the shape of these structures. Trees and other vegetation can disrupt shadows and hide portions of the structure.

6.4.3.4.6. Control towers. Control towers are difficult to camouflage, but protecting these facilities is essential if the air base is to continue operations. The height and the amount of glass required at the top of these structures make them especially easy to recognize. Patterning with coatings and disrupting the shape with nets help to blend the tower into its background. Screens and double glass can reduce glare and thermal signatures; so will glass coated with a glare reducing film.

6.4.3.4.7. Radar domes. These large bright spheres are one of the most conspicuous targets on a base. Besides being a critical target themselves, their location near runways and on the higher elevations of the area make them excellent orientation points. Pattern painting is the most effective means of reducing the brightness of the radar dome (**Figure 6.11**). If possible, use thermal camouflage paint for one of the colors. However, consult the manufacturer of the specific radar unit to ascertain that the camouflage measures do not degrade the radar operation.

6.4.3.4.8. Other towers and vertical structures. These include water towers, communications towers, and chimneys. These structures are conspicuous because of their long narrow shadows, characteristic shape, and contrast against the horizon when viewed from lower angles. Pilots often do not notice a tower until they see the long slender shadow on the ground. Planting trees and shrubs of various heights around the structure may be helpful in preventing detection by breaking up the shadows. Consider painting towers with a color that matches the vegetation.

Figure 6.11. Patterning on a Radar Dome.



6.4.3.5. CCD at Austere Bases. As with permanent bases, it is also difficult to conceal the existence of airfields and large facilities at austere contingency airbases. Any adversary will likely know the location and general base layout. However, CCD measures can hide or delay recognition of certain critical facilities, assets, and resources on the installation from the enemy. At bases located in areas with near featureless environments (i.e., mostly flat and devoid of tress and other vegetation), CCD will be challenging. At these locations, the recognizable features of most structures is their rectangular shape when viewed from ground level or the air (**Figure 6.12**). When viewed from the air, shadows are often easier to see than the actual object.

6.4.3.5.1. Facilities. Depending on the terrain features, facility placement and orientation could be key factors when determining and integrating CCD requirements at austere bases. In some circumstances, taking advantage of natural shadows and terrain features may be all that is required for good concealment. In other instances, facility location may help cut down on camouflage net requirements. From the air, shadows are often a conspicuous signature of base structures. If concealing shadows and forms is a concern, plan facility locations to make maximum use of land irregularities and shadows to disrupt structure shadows and forms.

6.4.3.5.1.1. Use shadow alteration techniques to create irregular shadows and break up the form. Consider physically concealing facility shadows and forms by digging the structure into the ground. Although it is not feasible at all austere locations, digging-in is one of the most effective techniques for concealment. It may be useable regardless of any additional camouflage techniques used. Digging-in reduces the effective height of a structure, thereby reducing the net requirements. The less the object extends above the surrounding surface, the shallower the angle of the camouflage nets with the ground; improving camouflage effectiveness.

6.4.3.5.1.2. Dug-in structures produce smaller shadows and thus, they require less effort and fewer nets to hide or disrupt their shadows. Facilities and equipment covered with camouflage nets also benefit from reduced profile and shadows when they are dug-in. Digging-in also affords protection against blast, shell fragments, and splinters and is particularly effective for sheltering. Construct dug-in shelters so that sleeping personnel are below the level of the ground surface. When used properly, camouflage nets can be very effective at blending facilities and other structures into the background.

6.4.3.5.1.3. The problem of concealment differs greatly between woodland and desert regions. From the ground, the desert may appear to afford reasonable cover, but from the air, the whole area appears as perfectly level and featureless, light colored plains, with scrub growth showing up as dots. A camouflage net, such as the woodland set that relies on concealment by casting irregular shadows to break up the form of an object, is of little use under these conditions. To be effective in desert areas, a camouflage net should be a "complete cover" and rely on its imitation of the ground surface, both in color and in texture for its effect.

6.4.3.5.1.4. Completely garnish nets with no voids. The object is to make a mound and keep the mound as low as possible. Because of the high reflectivity of the desert due to its flatness, light colored sand, and strong sunlight, use a very light sand colored net. Attach local debris and vegetation to the net for a better background match.

Figure 6.12. Aerial View of Austere Base Facilities.

6.4.3.5.2. Open storage areas. Open storage will probably be used for many supplies at austere bases. The size variety of items and the quantities involved makes complete concealment of outside storage areas difficult. However, consider taking definite measures to conceal open storage areas and supplies, including natural terrain features, earthworks (i.e., berming), local vegetation, camouflage nets, and shields.

6.4.3.5.3. Aircraft revetments. Several types of revetment options are available for use on austere bases in high threat areas (steel, precast concrete forms, soil-filled wire and fabric containers, etc.). These revetments equate to a large building for camouflage purposes. A revetment for a single tactical fighter aircraft is about the same size as a small hangar. Consider using methods previously addressed for other large or conventional structures.

6.4.3.5.4. Utility lines. If dispersing Basic Expeditionary Airfield Resources (BEAR) facilities during austere base beddown, some facilities could be located nearly two miles apart. These facilities may connect together by water, sewage, and waste utility systems. There will likely be several miles of utility lines, which, if left unconcealed on the ground, clearly point out each facility. Large cables, cable harnesses, and pipes between shelters and equipment have conspicuous signatures that may reveal the location of critical elements of a system, even though camouflage conceal the elements themselves. They are visible because of their long continuous form, or by the long straight shadow created by their form.

6.4.3.5.4.1. Bury utility lines whenever possible. Make the trenches for burying the lines as inconspicuous as possible. They should follow ground indentations, shadows, color, and texture breaks in the terrain, or place them along established roads or paths. All traces of the distribution trenches approaching camouflaged sites should blend with the surrounding soil. Cover the resultant earth spoil with local debris or vegetation if the excavated area has a different color or texture than the rest of the background. In a desert environment, the excavated earth, in many cases, is the same color and texture as the top surface soil, and all that is required is to smooth out the top surface.

6.4.3.5.5. Aircraft. Camouflage of aircraft involves consideration of the same factors previously discussed in the camouflage of other austere base equipment. The initial step is to examine the terrain, and locate and disperse the aircraft where possible to take advantage of the ground formations, colors, and patterns of the area. Locations that afford screening from slanting or indirect observation are valuable. Camouflage measures to conceal aircraft can range from natural field expedients to camouflage net systems that provide enough space for servicing (**Figure 6.13**).

Figure 6.13. Aircraft Draped With Camouflage Net.

6.4.3.5.5.1. Natural field expedients available in a desert environment are fewer than natural field expedients available in a woodland environment. The use of natural materials alone is rarely adequate for concealment in the desert. Net systems should be available for all aircraft. As in previous discussions, the color of the item needing camouflaged, in this case an aircraft should not be in contrast with the prevailing or dominant background. Hasty parking areas should be located on the shadow sides of folds in the terrain or on blotchy ground patterns where possible. However, hasty parking areas should provide quick access to taxiways and runways particularly for fighter aircraft.

6.4.3.5.5.2. Make aircraft parking areas as inconspicuous as possible using similar techniques prescribed for runways, taxiways, aprons, and hardstands to blend with the surrounding areas. If used for taxiways or parking, consider painting AM-2 matting to match the background.

6.4.3.5.6. Vehicles and heavy equipment. Much of the movement on an austere base is by vehicles, thus creating special concealment problems. Vehicle concealment is not for personnel safety alone, nor for the preservation of an individual vehicle or single piece of heavy equipment. If the enemy spots one vehicle, they will probably search for others in the area. This could help them determine the location of vital and otherwise well-concealed facilities and resources. In addition, the shadow areas of the vehicle itself can reveal the type of vehicle. The wheel cavities, the cargo area black hole, and the shadow area under the side and rear of a covered cargo truck, make them easily recognizable by their shadows.

6.4.3.5.6.1. Consider hiding vehicles from aerial observation by parking them in the shadow of larger objects. Washes, gullies or any other depressions lend themselves as excellent locations for vehicles because the banks absorb the shadow. From the air, it is much more difficult to see into shadows than from the ground. If possible, vehicles should have a camouflage net for concealment as part of their equipment. Digging V-trenches for vehicles and other equipment can reduce the number of camouflage nets required in addition to offering protection against the effect of nearby bomb blasts.

6.4.3.5.6.2. V-trenches covered with horizontal nets and local debris is practically indistinguishable from the background. **Figure 6.14** illustrate the technique of using V-trenches. Additional options include treating vehicle surfaces to minimize reflection of light. If not already painted with camouflage paint, consider having vehicles painted IAW T.O. 36-1-161, *Color, Marking, and Camouflage Painting of Military Vehicles, Construction Equipment and Materials Handling Equipment*. Besides vehicle concealment and camouflage, vehicle tracks may present an additional concern; shadows formed by vehicle track impressions across terrain are frequently more visible from the air than the actual tracks.

Figure 6.14. V-Trench Technique.

6.4.4. **Support of Decoy Deception.** Contrary to camouflage and concealment, using decoys is a job of display. The decoy environment should contain the activity and associated features of real operations. Support decoys with access roads, utility lines, communications lines, and other elements to present a realistic image to the enemy. CE personnel will likely be responsible for the construction and maintenance of these supporting facilities. Additionally, they may need to help in movement of decoys and other equipment to provide a simulation of activity normally associated with actual targets. Users should refer to AFH 10-222, Volume 10, for other potential CE activities supporting installation CCD measures.

6.5. Summary. The intent of CCD is to minimize the loss of operational capability during contingencies by reducing the effectiveness of attacking air and ground forces and reconnaissance assets. Utilizing the principles of hide, blend, disguise, and decoy to protect friendly assets and aim points, its main focus is force survivability and mission continuation. Although MAJCOMs and CCMDs direct CCD requirements, commanders incorporate responsibilities for accomplishing CCD tasks into base OPLANs. Base plans may also incorporate specific CCD task procedures, relevant to the threat to the installation and to its likely taskings. For additional CCD information, engineer planners should consult the references listed in **Table 6.3**

Table 6.3. Chapter 6 Quick References.

CCD Chapter References	
AFDA 3-13	*Information Operations*
AFH 10-222V10	*Civil Engineer Camouflage, Concealment & Deception (CCD) Measures*
AFI 10-704	*Military Deception Program* (S)
JP 3-13.4	*Military Deception*
T.O. 11C12-2-7-1	*Generator, Smoke, Mechanical A/E32U-13 and Control, Remote, Smoke Generator MXK-856/E32U-13*
T.O. 11WA2-5-1	*Fiber Camouflage Net, Camouflage Net Support and Aluminum Support Pole*
T.O. 36-1-161	*Color, Marking, and Camouflage Painting of Military Vehicles, Construction Equipment and Materials Handling Equipment*
UFC 3-340-01	*Design and Analysis of Hardened Structures to Conventional Weapons Effects*, 30 June 2002 (FOUO)
UFC 4-020-03FA	*Security Engineering: Final Design* (FOUO)

Chapter 7

BASE DEFENSE PREPARATIONS

7.1. General Information. Enemy forces may choose the time and place of an attack; however, base defenders have one major advantage—the opportunity to prepare defenses prior to an attack. Well-sited and constructed defensive structures are important elements of the AF Integrated Defense (ID) strategy. Although the ID strategy is wide-ranging with many elements and involve different AF competencies, the capabilities of CE units is fundamental to base defense preparations. Base defense forces implement ID measures under direction of the Defense Force Commander and staff. These measures can include anything from establishing hasty or deliberate fighting positions and clearing fields of fire, to placing reinforcing obstacles. However, major construction for defensive measures requires the specialized skills, heavy equipment, resources, and expert support provided by CE units. Commanders relay what base defense measures to accomplish and when. While many of the base defense preparations occur during peacetime, some may occur immediately prior to an attack, or whenever sufficient, time and resources are available.

7.2. Overview. The base defense preparations CE units perform encompass many of the areas previously addressed in this publication, including facility hardening, shelters, and CCD measures. Mostly, this chapter addresses base defense preparations related to protective and defensive structures requiring CE support and resources (**Figure 7.1**). The focus are those preparations associated with protective positions (e.g., bunkers, trenches, observation posts), obstacles, and AT barriers (e.g., vehicle barriers, berms, security fences, ECPs). Users should review AFI 31-101, *Integrated Defense* (FOUO), AFH 31-109, *Integrated Defense in Expeditionary Environments*, ATP 3-37.34, and other references addressed in this chapter for additional details on base defense measures and ID supporting capabilities and requirements.

Figure 7.1. CE Airmen Build Defensive Barrier on FOB Perimeter.

7.3. Fighting Bunkers. Fighting bunkers (enlarged fighting positions), are constructed for squad-size units who are required to remain in defensive positions for longer periods. These protective structures usually require CE support and resources to site and build. Fighting bunkers can offer excellent protection against direct fire and indirect fire effects. Personnel can build these structures aboveground or belowground using concrete, wood, steel, or other suitable material. If necessary for added protection, strengthen the structures with sandbags or other soil-filled containers.

7.3.1. When feasible, prefabrication of bunker assemblies can permit rapid construction and placement flexibility. Similar to field expedient shelters, a structural engineer should review the design of fighting bunkers prior to employment to ensure they are safe to occupy.

7.3.2. At some expeditionary deployment locations, personnel build expedient fighting bunkers nearly entirely with soil-filled wire and fabric containers like those shown in **Figure 7.2**. These contemporary bunkers offer good protection, takes less time to build, and uses a lightweight containment system and native soils as fill material. Regardless of the construction material used, fighting bunkers should provide protection from enemy fire while allowing occupants to employ weapons effectively against enemy targets. Estimated construction times and equipment requirements for various fighting bunkers is summarized in **Table 7.1**.

Figure 7.2. Soil-Filled Wire and Fabric Container Bunkers.

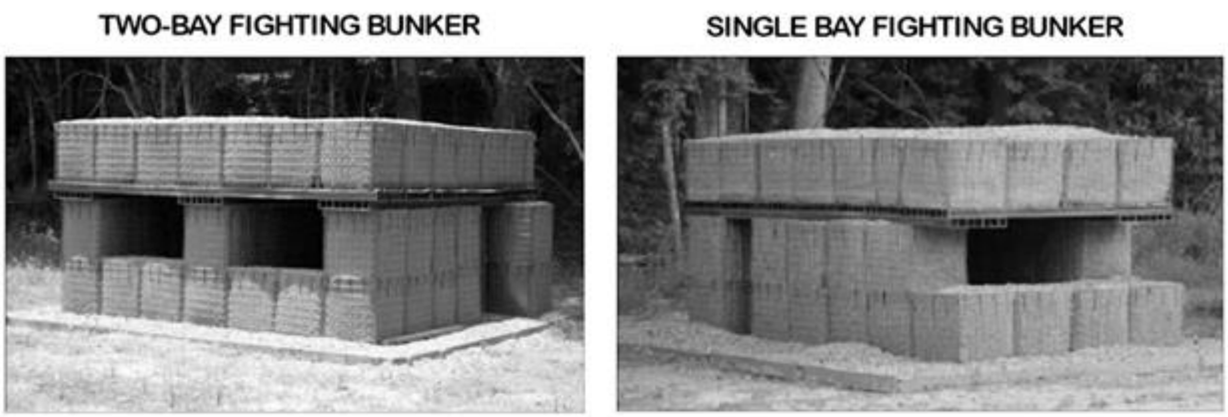


Table 7.1. Bunker Construction Equipment and Time Estimate.

Type of Fighting Bunker	Equipment Required*	Estimated Construction Time
Soil-filled Wire and Fabric Container (1-Bay) Bunker	Hand tools, front-end loader/backhoe	14 Man-hours
Soil-filled Wire and Fabric Container (2-Bay) Bunker	Hand tools, front-end loader/backhoe	26 Man-hours
Precast Concrete Slab Bunker	Hand tools, crane, backhoe	30 Man-hours
Wood Frame Bunker	Hand tools	32 Man-hours
Corrugated Metal Bunker	Hand tools, backhoe	48 Man-hours
*Does not address site preparation/transport equipment (e.g., bulldozers, rollers, trucks).		

7.4. Guard Towers and Observation Posts. These structures are important elements supporting base defense and overall installation FP measures. Similar to fighting bunkers, many of these structures require CE support and resources to site, build, or position. Typically, CE and SF personnel set up expedient guard towers and observation posts along the base perimeter, base boundary, or ECPs at expeditionary bases. These elevated structures permit observation over particular sectors of the perimeter or boundary to defend the base against enemy attackers.

7.4.1. CE heavy equipment operators should be prepared to clear, cover, and remove obstacles and sculpture the terrain on and immediately off base to provide base defenders with clear fields of fire to repel attackers. Depending on local security requirements, guard tower construction can range from simple, wooden designs to larger concrete structures weighing numerous tons. The hardiness of the construction and FP considerations usually determine what additional features are included with these structures. Items such as hardwired communications equipment, utilities, searchlights, blast and small arms protection are potential features.

7.4.2. Defenders can quickly deploy field expedient guard towers and observation posts if the structure is prefabricated in advance. Further information for observation post and guard tower construction is available in AFH 10-222, Volume 14, and GTA 90-01-011.

7.4.3. **Wooden Guard Tower.** Sometimes referred to as plywood perimeter bunkers, CE units sometimes build these structures using plywood and lumber (**Figure 7.3**). They can be quickly constructed using construction and barrier materiel (Class IV). Units have used these expedient towers extensively at contingency locations. If the tower is sufficiently robust and the threat warrants, additional protection in the form of sandbags, sand filled walls, barriers, etc., may be used as protection against blasts and threat weapons fire.

Figure 7.3. Engineer Personnel Erecting Plywood Perimeter Bunker.

7.4.4. **Precast Modular Concrete Guard Tower.** Concrete towers provide increased fortification over field expedient wooden towers. These precast, modular concrete structures support installation and base defense operations at overseas locations throughout the current theater of operations (**Figure 7.4**). They are manufactured locally or obtained commercially via contract methods and are usually transported and erected on site by engineer or contractor personnel.

7.4.5. **Observation Posts.** In addition to elevated structures, defenders use ground-level observation posts during expeditionary operations. As shown in **Figure 7.5** and **Figure 7.6**, contemporary designs for ground-level observation posts include the use of soil-filled wire and fabric containers and soil-filled metal containers as the main structure. **Table 7.2** approximates basic construction times and equipment requirements for these and other observation structures.

Figure 7.4. Engineers Erect Concrete Guard Tower.

Figure 7.5. Soil-Filled Wire and Fabric Container Bunker (Observation Post).

Figure 7.6. Soil-Filled Metal Container Bunker (Observation Post).

Table 7.2. Guard Tower/Posts Construction Equipment and Time Estimate.

Type of Structure	Equipment Required*	Estimated Construction Time
Precast Concrete Modular Guard Tower	Hand tools, crane	Varies (based on number of modular sections)
Soil-filled Wire and Fabric Container Observation Post (Small)	Hand tools, front-end loader/backhoe	22 Man-hours
Soil-filled Wire and Fabric Container Observation Post (Large)	Hand tools, front-end loader/backhoe	45 Man-hours
Wooden Guard Tower (Plywood Perimeter Bunker)	Hand tools, forklift, crane	48 Man-hours
Soil-filled Metal Container Bunker (Observation Post)	Hand tools, front-end loader	51 Man-hours
*Does not address site preparation/transport equipment (e.g., bulldozers, rollers, trucks).		

7.5. Trenches. Trenches provide protection and concealment when moving between fighting positions or in and out of the area. They are usually open excavations, but covered sections provide additional protection if the overhead cover does not interfere with the fire mission of occupying personnel. Depending on the threat and available time, base defenders may elect to fortify defensive areas and positions by excavating trenches to connect individual fighting positions and weapons positions. Digging trenches involves considerable time, effort, and materials and is only justifiable when occupying an area for a long time. In deeper trenches, some engineer advice or assistance is usually necessary in providing adequate drainage. If needed, trenches are usually included in the overall layout plan for the defense of an area. Consult AFH 10-222, Volume 14, for additional trench excavation preparations and procedures.

7.6. Obstacles. Imaginative employment of obstacles is a relatively low-cost way to influence the enemy's movement during an attack. Obstacles are also effective when used as the first line of defense against terrorists and saboteurs. Different obstacles can control the movements of vehicles and people. The same obstacles are generally not effective for both threats. However, defenders often place anti-personnel and anti-vehicular obstacles together in mutually supporting ways to control a combined threat.

7.6.1. **Natural Obstacles.** The location and characteristics of natural obstacles directly affect the details of the defense plan and positioning of forces. When feasible, upgrade or reinforce natural obstacles into obstacles that are more effective. Defenders should keep obstacles under observation and covered by direct and indirect fire.

7.6.2. **Manmade Obstacles.** Manmade obstacles are useable for offensive or defensive purposes. Manmade obstacles fall into two categories—nonexplosive and explosive. Nonexplosive obstacles may be cultural, constructed, or demolition. As the name indicates, nonexplosive obstacles do not contain explosives; however, engineers may use explosive demolition to create the obstacle. Conversely, an explosive obstacle refers to obstacles containing an explosive component, such as mines, booby traps, improvised explosive devices, UXOs, and other explosive ordnance hazards. Use of explosive obstacles is beyond the scope of this publication.

7.7. AT Barriers. Installations employ AT defensive measures to help reduce the vulnerability of personnel and resources to terrorist attacks. Installation commanders and their staffs identify appropriate AT defensive measures and requirements. CE units play an important role in the planning, design, and development of protective construction on the installation. Many of the obstacles used to counter a wartime ground threat can also protect against terrorist actions. This section highlights passive and active vehicle barriers CE personnel may be task to setup or maintain. For more specific information concerning AT barriers, see AFTTP 3-31.1, *Entry Control*, UFC 4-022-01, *Security Engineering: Entry Control Facilities/Access Control Points*, UFC 4-022-02, UFC 4-010-01, GTA 90-01-011, and AFH 10-222, Volumes 3 and 14.

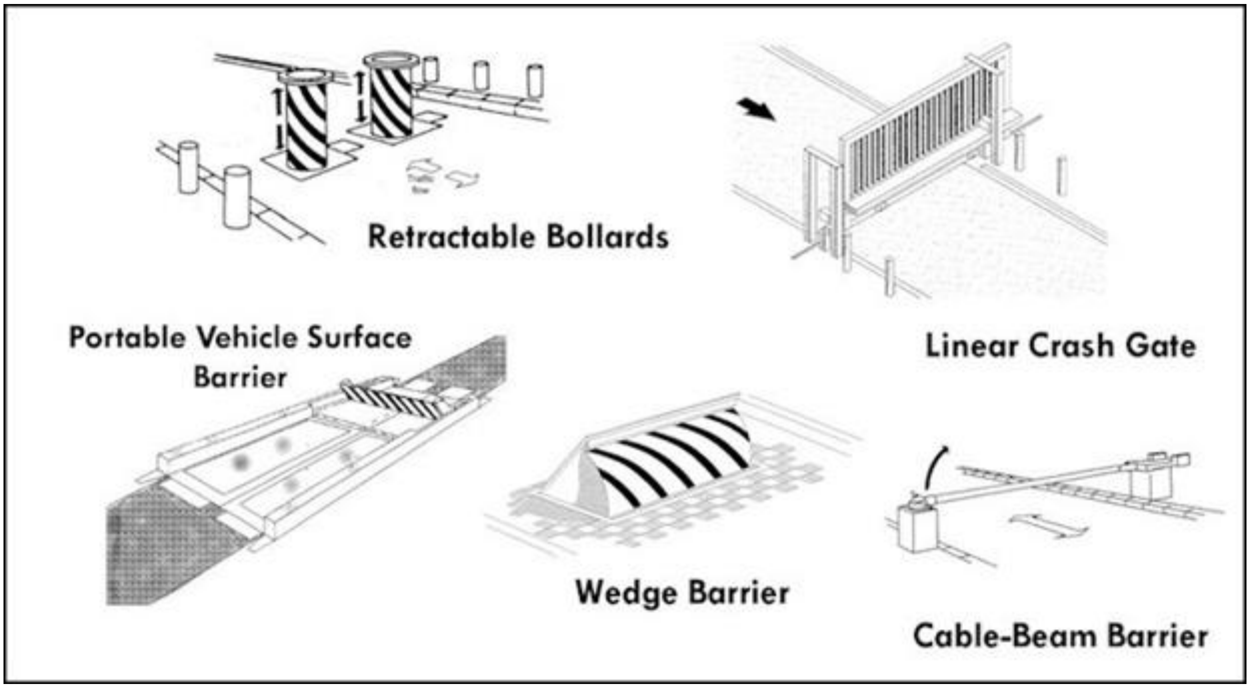
7.7.1. **Passive Vehicle Barriers.** Passive vehicle barriers include:

- 8- to 12-inch straight curbs
- Chain link or ornamental fence
- Decorative posts (4-inch diameter at 4-foot centers)
- Trees and shrubs
- Half-buried heavy-equipment tires
- Concrete barriers—Jersey, Texas, Alaska, and Interlocking T-wall barriers
- Reinforced concrete planters
- Concrete retaining walls
- Concrete-filled steel bollards
- Cable-reinforced chain link fences
- Shallow ditches
- Berms
- Sandbags
- Concrete-, rock-, or sand-filled 55-gallon drums connected with wire rope
- Dirt filled dump trucks (can be used around vulnerable facilities or block access routes or gates until other obstacles can be fabricated and installed)

7.7.2. **Active Vehicle Barriers.** Active barriers are more expensive to construct, but defenders can operate them within seconds. Listed below and illustrated in **Figure 7.7** are several examples of active barriers.

- Portable hydraulic barriers
- Wedge barriers
- Crash gates—sliding gate
- Cable-beam barrier
- Retractable bollards

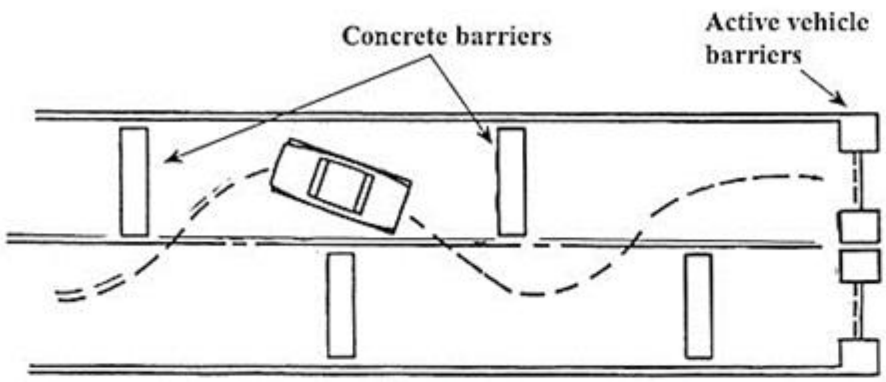
Figure 7.7. Example of Active Barriers.



7.7.3. **Speed-Control Obstacles.** Defenders often place obstacles to control vehicle approach speeds without blocking access. Such obstacles are common at ECPs. **Figure 7.8** illustrates how concrete barriers can control vehicle approach speeds. Examples of speed-control obstacles include:

- S-curves
- 90-degree bends
- Traffic circles
- Speed bumps
- Concrete obstacles

Figure 7.8. Vehicle Speed-Control Obstacles.



7.8. Summary. This chapter focused on base defensive and protective structures requiring CE support and resources to site or build. At permanent and enduring bases, CE units routinely create and improve (over time) protective structures to enhance FP around the base. However, at contingency locations, time and resources are usually not available to build and improve complex defensive structures over long periods. Commanders decide what protective measures and defensive structures are necessary and how best to use finite CE and SF resources. CE personnel should be prepared to assist SF build deliberate fighting positions and expedient obstacles when the threat warrants. As the base matures and more time becomes available, units can make improvements in base defensive structures. In any case, civil engineers should be prepared to employ the skills, tools, heavy equipment, and resources to site, build, and emplace required defensive and protective structures at contingency locations. Consult the references in **Table 7.3** for additional information on siting and constructing protective and defensive structures.

Table 7.3. Chapter 7 Quick Reference.

Base Defense Preparations Chapter References	
AFH 10-222V3	*Civil Engineer Guide to Expeditionary Force Protection*
AFH 10-222V14	*Civil Engineer Guide to Fighting Positions, Obstacles, and Revetments*
AFH 31-109	*Integrated Defense in Expeditionary Environments*
AFI 31-101	*Integrated Defense* (FOUO)
AFTTP 3-31.1	*Entry Control* (FOUO)
ATP 3-37.34	*Survivability Operations* (FOUO)
GTA 90-01-011	*Joint Forward Operations Base (JFOB) Force Protection Handbook, Sixth Edition* (FOUO)
UFC 4-010-01	*DOD Minimum Antiterrorism Standards for Buildings*
UFC 4-022-01	*Entry Control Facilities/Access Control Points*
UFC 4-022-02	*Selection and Application of Vehicle Barriers*

Chapter 8

BEDDOWN PREPARATIONS

8.1. General Information. Advance planning and preparation is necessary to beddown incoming military forces, disaster victims, or relief teams. Often, a beddown means providing facilities and utility service for deploying military units. Generally, AF beddowns consists of three support elements: aircraft, personnel, and infrastructure support. Aircraft support provides for maintenance shops, hangars, squadron operations, munitions storage, fuel storage, and other facilities directly supporting 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 serving the beddown site.

8.1.1. This chapter addresses basic CE planning and preparations necessary for an effective force beddown capability supporting contingency operations. It primarily focuses on CE responsibilities for providing the facilities and utilities to ensure minimum mission support. For additional planning factors, considerations, and references relating to force beddown for initial contingency locations, review AFPAM 10-219, Volume 5, *Bare Base Conceptual Planning*.

8.1.2. The activities and priorities for sheltering disaster victims, evacuees, and other displaced persons differ from a military force beddown. However, many of the concepts presented in this chapter may apply.

8.2. Beddown Concepts and Standards. Due to the unpredictable nature of most deployments, civil engineers should be ready to support beddowns for differing situations. Situations may include force beddown preceding war, supporting crisis response, limited contingency operations, or sheltering disaster victims, evacuees, or refugees. Because time is often limited, advance preparations or expedient methods are essential to accomplish the task. In many instances, both approaches are necessary. Generally, military beddowns at contingency locations follow three categories: initial, temporary, and semi-permanent. During the initial phase, essential facilities and systems are set up to support sustained aircraft operations. As incoming forces arrive and have a place to live and work, beddown efforts expand to include passive defense measures. When time and resources permit, personnel support facilities are improved.

8.2.1. **Engineer's Role.** Ideally, engineers at the gaining command or a subordinate unit plans beddowns in support of OPLAN taskings. They document requirements in the OPLAN, base support plan (BSP), expeditionary site plan (ESP), and other support plans. Expect the level of detail and quality in these plans to vary. For short-notice deployments and disaster recovery support, there may be little time for advance planning. Likely, civil engineers will have to make an existing plan work or develop a new plan on the spot.

8.2.1.1. Whether a plan exists or not, on-site civil engineers will obviously formulate beddown details. They should be able to develop requirements and sort out beddown priorities to get the critical efforts started quickly—sometimes before knowing all the details; and then site, layout, and erect or modify the facilities and utility systems. These are monumental tasks frequently accomplished by AF civil engineers. Beddown support is provided by in-place or deployed engineers or a combination of both. CE units have the capability to erect, modify, or construct facilities that AF units need at contingency locations.

8.2.1.2. In addition, civil engineers set up and operate utility systems that serve aircraft and personnel support facilities. CE personnel also have the knowledge, skill, and expertise to teach personnel from base units how to erect their own portable shelters.

8.2.2. **Advanced Echelon (ADVON) Team.** Civil engineers should be included in any ADVON team sent to a non-AF installation to prepare for the arrival of the main deployment force. ADVON engineers can start developing beddown details, gain a sense of the commander's priorities, and locate vehicles and supplies. CE personnel 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.

8.2.3. **Beddown Timing and Responsibilities.** Not all beddown facilities need to be ready for occupancy before deploying forces start arriving. Since forces flow into an installation over a number of days, sequence work to correspond with their arrival. The flow of AF forces into an installation is determined using the Force Module concept addressed in AFI 10-401, *Air Force Operations Planning and Execution*. Engineers usually deploy early, but are rarely among the first arrivals. Consequently, they are immediately in a catch-up mode of activity. As other units flow in, they should erect their own portable shelters.

8.2.3.1. Of course, CE units should layout shelter locations and provide units 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 CE personnel to complete all beddown tasks for the installation to be operationally ready in the required time. Following intermediate beddown efforts for a military deployment, users should be active in developing passive defense measures for their particular functions if it is required.

8.2.4. **CONUS versus Theater Beddown.** Force beddown will most often occur overseas. 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 AF civil engineers to have an effective force beddown capability. However, civil engineers do not ignore CONUS beddown requirements. Besides disaster relief support, some designated CONUS installations may need to beddown large numbers of personnel during periods of increased national readiness. These personnel may be awaiting movement overseas or be non-combatants returning from overseas.

8.2.4.1. Where OPLANs identify the need for an installation to prepare for incoming forces or evacuees, units develop beddown plans in the luxury of peacetime.

8.2.4.2. CONUS civil engineers have major advantages in conducting beddown operations at home base: familiarity with existing base facilities, good resource availability in the local area, standard materials, and no language barriers or differing customs. Additionally, CONUS civil engineers are not likely to be operating in hostile environments or potential theater of operations subject to enemy action.

8.2.4.3. Overseas, civil engineers face the task of bedding down incoming forces during wartime or before the outbreak of hostilities. In order to accomplish this task, in-place engineers normally require the support of augmenting forces in the form of RED HORSE Squadrons (RHS) or Prime Base Engineer Emergency Force (Prime BEEF) teams. The deployed personnel are not normally familiar with the beddown location and may require detailed information about installation facilities and capabilities. In addition, theater CE forces are far removed from CONUS supply points, making the engineers more dependent on local sources for new materials and innovative use of existing materials.

8.2.5. **Likely Beddown Locations.** Some of the more common beddown locations include a main US installation, bare base, and civilian community (during disaster relief). Beddown locations for military deployments can range from a Main Operating Base (MOB) with adequate existing facilities and utilities to an initial contingency location with little to no facilities (**Figure 8.1**).

Figure 8.1. Beddown at an Initial Contingency Location.

8.2.5.1. 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. Depending upon local conditions and the size of the deployed force, additional feeding, housing, and operational facilities may be necessary. The BSP/ESP should specify which existing facilities incoming forces will use, what modifications to those facilities will be required, and what additional facilities will be required.

8.2.5.1.1. Lacking a BSP/ESP, an installation should 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, *Base Support and Expeditionary (BAS&E) Site Planning*, provides guidance for preparing the installation-wide plan. Sound beddown plans should always have inputs on facility requirements from operations, aircraft maintenance, SF, services, and other functional areas.

8.2.5.2. Austere or Initial Contingency Locations. Since facilities for use by US forces may be nonexistent at austere or initial contingency locations, beddown of deploying forces requires a more extensive effort from civil engineers. Other than the runway, aircraft parking areas, and nearby source of water, units may have to start from scratch to provide basic services. These include erecting shelter for deployed forces and establishing basic utilities (i.e., water, electricity, heat, and sanitation) and other services as necessary. In some locations, additional airfield tasks may be required. Including, expanding aircraft parking areas, constructing revetments, developing POL facilities, erecting aircraft shelters and maintenance shops, and repairing or modifying the runway.

8.2.5.3. Civilian Communities. CE units could be task to set up tent cities in local communities for disaster victims or deployed disaster relief forces. As with an austere base environment, permanent facilities may be nonexistent or unavailable, especially following a disaster.

8.2.6. **Other Considerations.** The environment that civil engineers encounter at potential deployment locations can change at the last moment by unforeseen factors. For example, changes in the flying mission at the time of deployment could unexpectedly increase facility needs for 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.

8.2.7. **Sources of Equipment and Materiel.** Quality sources of equipment and materiel are essential if a force beddown is to proceed immediately. Although units should not ignore any sources, most materials should come from WRM assets, installation resources, and local area support. Be prepared to engage alternate sources for needed materiel.

8.2.7.1. WRM Assets. WRM provides wartime support through pre-stocking and prepositioning of items. There are many types of WRM assets, but for beddown operations, AF units primarily use BEAR (**Figure 8.2**). For an overview of BEAR assets consult AFH 10-222, Volume 1, *Civil Engineer Bare Base Development* and AFH 10-222, Volume 2, *Bare Base Assets*; for specific logistics and MISCAP information for BEAR unit type codes, refer to the Manpower and Equipment Force Packaging (MEFPAK) database (aka MEFPAK Tool).

Figure 8.2. BEAR Warehoused in United States Air Forces in Europe (USAFE) Facility.

8.2.7.2. Logistics Readiness Squadron (LRS). The LRS is the first place at a MOB civil engineers should check for needed force beddown resources. Even if beddown operations occur at a remote or austere base, the main supporting base may still provide assistance. For example, they may be able to send logistics personnel to the location to process requisitions back through the main supporting base. However, be aware logistics personnel may not be familiar with the common or technical names of the various beddown items. CE personnel can improve resupply by providing current NSNs of common engineer materials.

8.2.7.2.1. If the required materials are available on base, units can expedite beddown of incoming forces. However, if materials are not in stock, LRS may have to order items from logistics sources thousands of miles away, resulting in beddown delays.

8.2.7.3. Local Economy. A strong local economy is the second best source. Depending upon location, civilian vendors and contractors may be able to satisfy all materiel needs. The local economy should be the primary source for bulky materials like cement, crushed stone, select fill, asphalt, and lumber. This improves delivery times and reduces demand on shipping and other transportation assets. Local purchases require the services of a contracting officer, finance officer, and a knowledgeable CE representative to identify the proper materials. Additionally, in overseas locations, an interpreter and guide may be required.

8.2.7.3.1. The AF has specific guidelines on expenditure of funds, and only a contracting officer can make a purchase commitment for the government. In overseas locations, cultural differences can have an impact on purchase procedures. For example, in many foreign locations, local businesspersons work on a verbal, cash basis. Invoices, bills of sale, and written contracts are common in the CONUS. However, local vendors may consider them unnecessary or even an insult to their integrity. Prices, normally established by bargaining, will likely increase during times of crisis. Blindly imposing American methods can cause resentment.

8.2.7.3.2. Host government assistance combined with sensitivity to local customs is important.

8.2.7.4. HN BCE. At HN installations, check with the HN BCE for beddown support. As mentioned earlier, support plans normally outline resources available for deployed forces. In the absence of such agreements, tactful negotiations with host BCE may result in outstanding assistance. Equipment provided through these agreements will probably be of foreign manufacture, but should have capabilities similar to US equipment. Building materials may be of different size and quality than expected at CONUS locations, but CE ingenuity can overcome these problems without major delays to the beddown operation.

8.2.7.5. Non-Engineer Units. US non-engineer units and allied units on an airbase may have equipment that can be useful. For example, aircraft maintenance units have AGE carts, which have ducted heaters, generators, light systems, or hydraulic systems. Mobile elements of the tactical air control system possess portable shelters, generators, and other items the unit may loan to CE units. Operational demands may prevent such loans.

8.2.7.6. Local Military Engineer Organizations. Consider contacting any military engineer unit within a reasonable distance of the beddown location regarding equipment and materiel support. These include nearby HN engineer forces, US Army combat engineer battalions, and US Navy construction engineer (Seabee) battalions. Obtaining support from these sources will likely require reimbursement and possibly formal agreements. Less formal negotiations (bartering) between counterparts in each organization may result in mutually acceptable agreements that greatly expedite transfer of materials.

8.2.8. **Manpower.** Engineer labor for force beddown operations is likely to come from Prime BEEF teams, RHS, 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, RHSs 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 provide the continuing agile combat support for the site. In many locations, it is possible to contract support from local construction firms to supplement AF engineer capabilities. The contracting officer should contract for such support, which they can do quickly if the circumstances justify it.

8.2.9. **Construction Standards.** The Joint Chiefs of Staff established construction standards that outline the types of materials and construction techniques to use when constructing facilities in support of joint operations. According to JP 3-34, *Joint Engineer Operations,* the standards provide a framework to ensure efficient application of limited engineering assets and responsively support the commander's intent and executing the theater concept of operations. The construction standards for the contingency or short-term phase (0-2 years) are organic, initial, and temporary. Construction standards for the enduring phase (2 years and beyond) are semi-permanent and permanent. Typically, force beddown operations use the initial standard unless circumstances dictate otherwise.

8.2.9.1. The CCDR in coordination with Service components and the Services specifies the construction standards for facilities in the theater to optimize the engineer effort expended on any given facility while assuring that the facilities are adequate for health, safety, and mission accomplishment. This section focuses on engineer support for the initial and temporary construction standards during force beddowns. The organic construction standard refers to unit systems and equipment that requires no external engineer support. The semi-permanent and permanent construction standards are beyond the scope of this section.

8.2.9.2. Readers should consult JP 3-34, UFC 1-201-01, *Non-Permanent DOD Facilities in Support of Military Operations*, and CCMD guidance for specific theater and AOR contingency construction standards and requirements. **Attachment 3** provides hyperlinks to JPs, UFCs, and other useful references and reach-back resources.

8.3. Engineer Preparations. Good beddown preparation means understanding what facilities and utility service the incoming units need to perform their mission. These include, finding out what resources are available to satisfy those needs, using approved TTPs and common sense to site the facilities, and developing solutions to the inevitable problems. While the gaining MAJCOM usually prepares the overall beddown plan, the on-site engineer always has the task of adjusting such plans to make them work. Beddown preparations may include developing or fine-tuning facility use and site plans; obtaining and storing expedient beddown materials and equipment; arranging for temporary utility service, latrines, showers, and collection of sewage, garbage, and refuse; creating permanent beddown sites with utility service, drainage, and roads for extended periods. The following steps detail beddown preparation stages in a logical order, but in time-sensitive situations, some of these events should occur simultaneously.

8.3.1. **Gather Facts.** Civil engineers need to gather and digest a lot of information to develop a good beddown plan. A prime information resource is the AF GeoBase mapping framework and associated support environments. The geospatial data and imagery in GeoBase can quickly aid in both initial beddown planning and follow-on preparations, including actual or planned base layout and configuration of facilities and systems. When gathering facts base planners should, as a minimum:

- Understand the mission and OPLAN requirements; find out what forces have to be bedded down; learn their physical and functional requirements
- Know the threat; understand how the enemy can attack the base and how often
- Learn the details of any prior planning (usually in BSP or ESP)
- Gather site geographic data (topographic information, weather, flood data, etc.)
- Find out what facilities are available to the incoming forces
- Learn what utilities are available/loads they can support; where they can be tied into
- Determine where to get materials/equipment; what WRM is to be shipped in and when
- Learn the commander's priorities

8.3.2. **Determine Requirements.** Before force beddown operations begin or proceed very far, determine what minimum facilities and utilities are required. Work with the incoming units to find out their facility requirements and functional relationships, that is, which units they mostly interact with face-to-face. Calculate the gross requirements and determine how much can be satisfied by existing facilities. Units will likely have to satisfy the difference by expedient methods.

8.3.3. **Draft the Plan.** The beddown plan should identify the planned location for incoming units (including tent-city layout, if necessary), the work required to make existing or expedient facilities ready for them, who will perform the work, and in what priority. Using whatever time is available, draft a plan and brief the major points of the plan to the commander for his or her approval.

8.3.3.1. When an OPLAN tasking attaches your unit to a specific location, determine what beddown actions will be required. Find out what planning is already completed. If more planning is required, work with the gaining MAJCOM and do it in peacetime, before you have to deploy. When OPLAN taskings change, you should repeat the process.

8.3.3.2. Since the World political situation is not predictable, you may not have prior knowledge of your deployment location or the luxury of peacetime planning. Even then, the planning and preparation process is still valid. You just have to work with less information, make more assumptions, and establish communications with appropriate command-level staff because of the limited time available to you.

8.3.3.3. Try gathering information just as soon as you receive notification. You should start with the point of contact in the Task Order. Continue making preliminary plans on the airplane and adjust them when you arrive at the base.

8.4. Existing Facilities and Utilities Evaluation. Using known facility and utility system requirements; evaluate existing facilities and utility systems to see if they can accommodate the incoming forces or displaced civilians. This step should incorporate user input to ensure critical facility needs are satisfied. If well done, it minimizes resources needed for a beddown.

8.4.1. **Aircraft Facilities.** The determining factors regarding aircraft facilities are the flying mission the installation assumes and the existing facilities in place. The mission dictates the type aircraft deployed and the existing facilities drive what work the beddown teams should accomplish to make the base usable to those aircraft. Regardless of the final mission of the base, an early concern is to prepare the minimum facilities and utilities needed to receive airlifted personnel and materials. If not previously evaluated, an immediate assessment of airfield pavement capacities by qualified engineers is imperative. Also important is an evaluation of facilities that support aircraft operations such as POL dispensing and storage facilities, munitions storage areas, hangars, maintenance shops, revetments, and other critical structures. There is no time for extensive development of new structures. Innovation is essential in developing plans for effective sharing or modification of existing facilities.

8.4.2. **Personnel Facilities.** After determining what aircraft facilities are required, the engineer ADVON team should evaluate existing personnel facilities. This evaluation should include housing, DFACs, latrines, administrative offices, and other indirect support facilities. Using information about the expected size of the deployment force, evaluate existing structures to determine if they can support the increased numbers. Consider modifications that might enable use of facilities for another, more important function. For example, a warehouse might be equipped with partitions, utilities, and heat and used as administrative offices. A gymnasium or a school could be equipped with cots and used as billeting. Then consider using expedient structures to meet unsatisfied requirements of incoming forces. Determine what local assets and WRM are available to satisfy those shortfalls.

8.4.3. **CE Facilities.** Do not overlook CE unit needs. At a MOB, deployed engineers can probably share workspace with the in-place CE unit. At a contingency location or joint FOB, they may share some facilities and be forced to develop others. At an austere base, the unit may have to develop all facilities. The initial engineer work facility may be only a securable area to hold construction materials, equipment, and vehicles. A drive-through arrangement avoids the problem of backing large vehicles. An additional open work area may be necessary for prefabricating building components. Covered space is desirable for most CE shops, and fully enclosed space is required for administration and the CE control center.

8.4.4. **Options to Satisfy Facility Requirements.** There are many ways to satisfy contingency facility requirements. Always look for the solution that provides needed facilities in the least possible time. The following options range in order from most expedient to most time consuming.

8.4.4.1. Share or Convert Existing Facilities. The quickest way to provide a facility is to share or convert a like facility performing the same function. Sharing requires no CE 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. Converting a facility is not as quick as sharing, but it is still faster than constructing a new structure (See **paragraph 8.5**). **Note:** In converting a facility, the primary concern is function. Do not devote valuable time to cosmetic work to improve the appearance. Civil engineers can add amenities later when initial beddown activities are complete. Consider this note for all beddown work.

8.4.4.2. BEAR Assets. Shelters provided in BEAR equipment sets are quick to set up. Some hard-wall shelters require some extra training to erect. Most of these shelters are easily relocatable for changing mission requirements.

8.4.4.3. Trailers and Portable Buildings. Trailers and portable buildings (obtained from civilian sources), can be used for billeting, administrative offices, recreation facilities, and latrines. Portable buildings require some site work such as leveling and possibly steps. Their availability is location dependent.

8.4.4.4. Pre-engineered Buildings. Pre-engineered structures require significantly more time to set up since they normally require a foundation, assembly, interior finishing, joint sealing, and sometimes a separately built roof. If utilities are to enter through the floor, bury distribution lines, with precisely located stub-ups installed before the building is set. Some structures may have utility connections through the walls, allowing simultaneous completion of structure and utility work. Erecting these structures is too time consuming to satisfy initial beddown needs. However, they are good replacements for initial structures during longer deployments, or erected in peacetime to cover OPLAN taskings.

8.4.4.5. Conventional Construction. The slowest building type is conventional construction. In current wartime scenarios, conventional construction cannot meet initial beddown requirements because development could take many months, even using simple designs, prefabricated structures, and expedited methods. The current requirement for deployed units to reach their location and be operational in a matter of days dictates that conventional construction is not feasible for short-term operations.

8.5. Conversion of Existing Facilities. When possible, convert existing structures to beddown incoming forces. By using this approach, civil engineers are not as dependent on outside sources for materials. Additionally, this method requires less heavy equipment, thereby minimizing the need for a RHS or civilian contractor support. Consider the factors listed in **Table 8.2** and subsequent paragraphs when selecting structures for conversion.

8.5.1. **Identification of Candidate Facilities.** Some facilities are better suited to support beddown operations than others are. On MOBs and HN bases, there may be aircraft hangars, maintenance shops, POL facilities, and munitions storage structures. If these facilities have unused space by the host forces, see if portions are 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. Gymnasiums, theaters, schools, or chapels are candidates for conversion. If feeding facilities are inadequate, consider converting service clubs and snack bars with existing kitchens to provide food to incoming troops.

8.5.2. **Useful Life of the Converted Facility.** Before civil engineers devote extensive labor 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.

Table 8.1. Facility Conversion Factors.

Facility Size:
Certain aircraft and maintenance operations dictate facility size. 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.
Facility Location:
The importance of location may depend on the proposed function or use. 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.
Utilities Available at the Facility:
Rerouting utilities could be the most time consuming task when converting an existing facility. Therefore, first use structures not requiring 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.
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.
Construction Priority:
The degree of importance 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.

8.6. Selection of Beddown Site. When existing base facilities are not adequate to support the beddown of the deployed forces, erect temporary structures to accommodate the overflow. Good site selection for 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 you are doing it 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, most land areas may already be developed. At an initial contingency location or other less developed location, civil engineers usually have more latitude.

8.7. Site Preparation Tasks. Site preparation may require nothing or be extensive. The following paragraphs detail common site preparation tasks associated with a beddown.

8.7.1. **Earthwork.** Earthmoving operations are time consuming and require heavy equipment as well as specialized skills. Since time and equipment are usually in short supply, avoid large quantities of earthwork. Minimize earthwork by siting facilities to take advantage of prevailing grades that fall within required shelter erection criteria and that follow reasonable engineering practices (consistent with the contingency). When earthmoving is unavoidable, balance the movement if possible. That is, when there is a need for both cutting and filling during the project, consider using the excavated material for filling.

8.7.1.1. Balancing should be within the haul capabilities of available equipment, and excavated material should be suitable for use as fill. When haul distances become excessive, it is more practical to open a nearby borrow pit or to establish spoil areas.

8.7.2. **Clearing.** The need for clearing depends on the location of the site and its intended use. Minimize clearing when setting up tent cities in wooded areas by arranging the tents in a random pattern rather than in typical rows. The arrangement has the additional advantage of providing a degree of dispersal and camouflage. Some facilities, such as aircraft parking areas, radar facilities, and communications activities, require obstacle removal for proper operation. Users should provide clearance criteria for their equipment, especially when they find their equipment does not work correctly. In those cases, limit clearing to the minimum.

8.7.2.1. Find airfield clearances in UFC 3-260-01, *Airfield and Heliport Planning and Design*. When peacetime clearance standards are not yet met, wing commanders may waive or relax some clearance criteria if delays occur in flight operations supporting war or the build up to war.

8.7.3. **Utilities.** Normally, civil engineers establish utilities simultaneously with site development. However, it is sometimes necessary to establish site utilities prior to actual erection of expedient facilities. See **paragraph 8.9** for more information on beddown utilities.

8.7.4. **Roads and Streets.** When a tent city or other temporary facility is constructed, it requires supporting roads and streets. Before any effort is devoted to construction of new roads, evaluate the existing road network to determine if it can support the new facilities. Generally, civil engineers save time and effort by repairing or improving an existing road rather than constructing a new one. If new construction is required, consider developing interior roads and streets of the beddown area during the site preparation phase, because construction will be difficult once the structures are in place. Find additional information on road design, construction, and repair, in UFC 3-250-09FA, *Aggregate Surfaced Roads and Airfields Areas*, UFC 3-250-01, *Pavement Design for Roads and Parking Areas*, UFC 3-250-11, *Soil Stabilization for Pavements*, UFC 3-250-03, *Standard Practice Manual for Flexible Pavements*, UFC 3-250-04, *Standard Practice for Concrete Pavements*, and other criteria in the UFC-3-250-series.

8.8. Expedient Structures. When existing installation facilities are not adequate to support the beddown of the deployed forces, consider erecting temporary structures to provide the needed accommodations. Initial and temporary structures take many forms, and may be available from military logistics sources or acquired from commercial sources, including civilian suppliers in the local area. The following paragraphs highlight various types of expedient structures that can support the beddown of deployed forces and aircraft.

8.8.1. **BEAR Facilities.** When AF civil engineers talk of expedient beddown structures, they most often mean BEAR assets. The BEAR equipment sets are a simple, expedient way to provide facilities, equipment, and basic infrastructure to support a force beddown. Check AFH 10-222, Volumes 1 and 2 for a brief review of available BEAR facilities and other assets.

8.8.1.1. **Small and Medium Sized Shelters.** These fabric structures serve many purposes at a beddown location: billeting, administrative offices, maintenance shops, kitchens, showers, latrines, and others. They are readily available from WRM assets and are quick and easy to erect, requiring no specialized tools or critical skills. With proper training, users may erect these shelters. The shelters function in a variety of climates and can be equipped with air conditioning. When preparing facility layout, civil engineers will naturally try to use the most effective organization, however the situation will usually dictate the arrangement.

8.8.1.1.1. For example, civil engineers at a HN installation may find that the space provided by the HN severely limits layout options. At austere locations, where there are few existing structures to compete for space, facility layout options may be more flexible. Shelter layout may be conventional or dispersed patterns. The conventional layout is the normal arrangement for a tent city where shelters are in neatly organized rows—sometimes called "military" or non-dispersed layout (**Figure 8.3**). The conventional layout provides for the maximum use of limited space and works well when there is no enemy air threat.

8.8.1.1.2. This configuration is highly vulnerable to air attacks. When dictated by the threat, the dispersed layout is the better configuration for the tent city. This arrangement provides maximum flexibility in the use of available land space and natural camouflage. In a dispersed layout, arrange shelters in small clusters or even individually if the situation dictate. A disadvantage of the dispersed layout is the potential separation of related functional areas, resulting in reduced efficiency of operations. In addition, the dispersed layout generally makes it more difficult to provide utilities.

8.8.1.2. **BEAR Large Shelters.** Oversized shelters such as the Dome shelter (**Figure 8.4**) and Large Area Maintenance Shelter provide housing for small aircraft, vehicle maintenance, warehouses, and other activities requiring large spaces. RHSs or Prime BEEF teams (with support from the 65th Materiel Maintenance Group large structures team) erect these facilities.

Figure 8.3. Small Shelter Systems in Conventional Layout.

Figure 8.4. Dome Shelter.

8.8.2. **Non-BEAR Facilities.** Non-BEAR facilities come in all shapes and sizes and may be from various sources. They may be special field-deployable medical systems, COTS items, deployable assets from other Services, locally manufactured structures, or pre-designed facilities constructed from the ground up using Class IV construction materials. Whatever the source, Prime BEEF forces are building and supporting initial contingency locations and force beddowns around the world for AF, joint, combined, and multinational operations. See AFH 10-222, Volume 1 for a brief description and resources of these non-BEAR assets.

8.9. Beddown Utilities. Supporting utilities are essential to force beddown. Units need electricity 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, units may need to provide heating and air conditioning. The following paragraphs present general concepts for providing utilities during beddown operations.

8.9.1. **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. Specific information on contingency electrical systems is contained in AFPAM 10-219, Volume 5, AFPAM 10-219, Volume 6, *Planning and Design of Expeditionary Airbases*, and AFTTP 3-32.34, Volume 5, *Contingency Electrical Power Production and Distribution Systems*.

8.9.1.1. **Basic Construction Principle.** Avoid constructing new systems unless 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.

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

8.9.1.2.1. Commercial or Base Power. If available, commercial or base power is the best source. However, if it was damaged or destroyed during the contingency that prompted the need for beddown, they may not be the best option. Engineers can often restore commercial power service relatively quickly following a disaster. However, the surrounding civilian community's needs may be such that excess power is unavailable for use by the incoming forces. Power from a 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 existing distribution system's configuration influences where and how much power provides support to beddown facilities.

8.9.1.2.2. 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 plan for generator refueling. Weather can affect generator operations. To prevent problems during extreme cold weather, use special lubricants, check storage batteries frequently to prevent freezing, and rapidly remove moisture buildup on equipment. When operating in extreme heat, be sure to clean and flush cooling system at regular intervals and maintain the coolant at the proper level. It is also a good idea to shelter generators from the effects of solar radiation in hot climates such as in SWA (**Figure 8.5**). The actions listed in **Table 8.3** can help ensure reliable support from available generators.

Figure 8.5. Sheltered Generators.

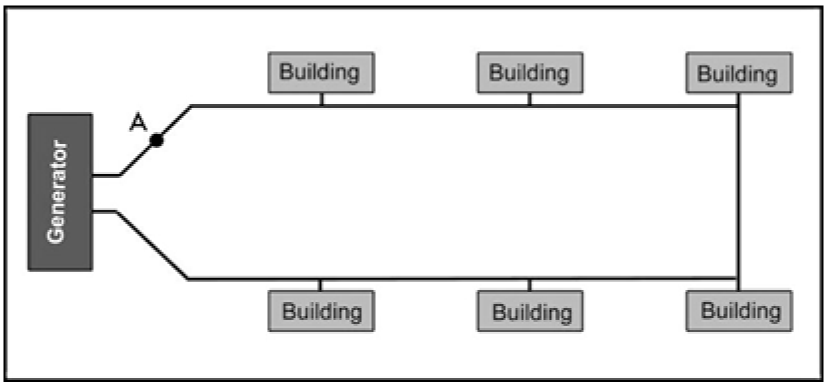
Table 8.2. Portable Generator Actions.

Inspection	. Inspect all generators prior to use to determine that all components are in place and operational . Replace or repair defective parts
Leveling	• For proper operation, be sure the generator is leveled before starting • Never operate a generator set at an angle greater than 15 degrees from horizontal
Placement	• Generators should be placed to minimize voltage losses to the facilities they serve (a good rule of thumb is to position low voltage generators no more than 900 feet from the facilities they serve) • Point the exhaust away from the facilities and take measures to reduce the noise levels, such as not placing them too close to facilities or constructing noise berms • When possible, position generators so prevailing winds help disperse exhaust and noise
Grounds	• Be sure generators are properly grounded to prevent unstable generator output
Air Conditioned Facilities	. For critical functions which require air conditioning for sensitive equipment, try to have one generator for the technical load and one for air conditioning (if one unit is lost for a short time, the other can still be on line; this generally minimizes total equipment down time)

8.9.1.3. **Power Distribution.** There are two general methods of arranging a power distribution system at initial contingency locations; or rather, the layout of the wires to the various facilities at the force beddown location. These methods are the loop and radial layout.

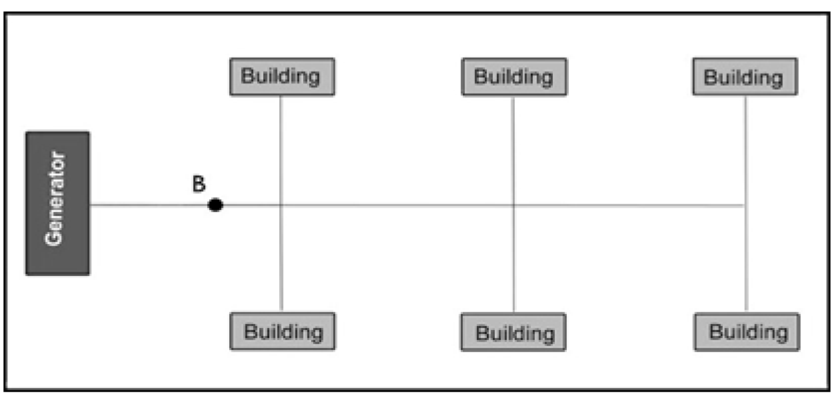
8.9.1.3.1. In a loop layout (**Figure 8.6**), the power to a facility is from more than one direction. This reduces the likelihood of complete loss of power to all facilities served by the loop. For example, in the following illustration, it is apparent that a break in the wires at point "A" will not cause complete loss of service since power distribution is still available through the lower section of the loop. The primary disadvantage of the loop system is that it requires more materiel and time to construct than the radial system. For this reason, units generally use the radial system for beddown operations.

Figure 8.6. Electrical Distribution, Loop Layout.



8.9.1.3.2. The radial layout (**Figure 8.7**) has one or more main circuits that run through an installation. Branch lines run from those main circuits to service the various facilities. The primary advantage of the radial system is that it requires considerably less materiel, labor, and time to construct. A primary disadvantage of the radial system is that disruption to electrical service is easier due to damage from disasters or enemy attacks. The following illustration indicates that a break of the wires at point "B" will result in a complete loss of power to all facilities at the installation.

Figure 8.7. Electrical Distribution, Radial Layout.



8.9.1.4. **Phases of Construction.** When planning electrical system installation, the following steps are applicable:

8.9.1.4.1. Collection of Data. Determine beddown power requirements. Review electrical power planning factors for the beddown and check out any existing electrical systems to determine their characteristics and excess capacities.

8.9.1.4.2. Planning and Design. In a preplanned beddown situation, exterior and interior electrical layout plans may already be available for both exterior and interior systems. Give those plans a quick check to see if anything major is missing. If layout plans are not available, take a little time to develop them to guide the electrical system set up.

8.9.1.4.3. Installation. Coordinate electrical layout efforts with those of other CE shops working in the same area. This ensures that the various beddown tasks complement rather than contradict each other. Be sure to follow safe electrical practices. Safety during installation and continued safety for people using the beddown location should be a major concern. Work crews, which install the electrical system at the beddown location, must be qualified and have the proper tools to accomplish the job. To provide increased safety for individuals using the beddown location:

- Bury or string electrical cables so they do not present a tripping hazard and they are protected from vehicle traffic
- String cables inside a tent or other expedient structure so as not to present an electrical hazard
- Place lights in expedient structures low enough for occupants to reach, but high enough that no one walks into them
- Tape or cap all unused connections
- Use only water tight or explosion proof fixtures in shower areas
- Make all electrical distribution systems and connections as simple as possible; complex designs require more time to install and are sure to cause more maintenance problems during operation

8.9.1.4.4. Testing. Inspect each installation closely to detect hazards and incorrect installations. After installing the wires and equipment, test each circuit to be sure it operates correctly. Properly installed wiring requires minimum maintenance.

8.9.2. **Water System.** Water is the most critical need of any beddown population. An adequate supply of potable water should be available for human use, e.g., drinking, cooking, and showering. Improperly treated water can spread diseases such as typhoid, dysentery, cholera, and common diarrhea. Non-potable water may be option for fire fighting, general decontamination, and construction. Water systems generally consist of four elements:

- Source
- Treatment
- Storage
- Distribution

8.9.2.1. **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 seawater, and rain collected in catchments. The value of any source depends on many factors, such as proximity to beddown location, quantity of water available versus the demand, amount of treatment required, time and effort needed to develop the source, and ability to pump or transport water from the source to point of use.

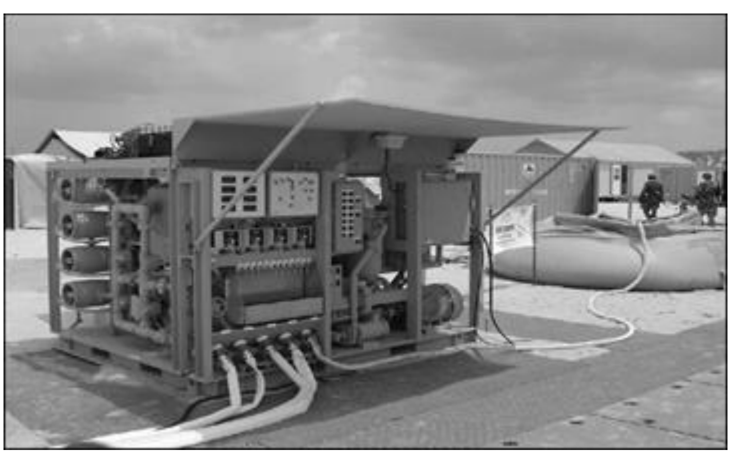
8.9.2.1.1. If you must use one of the alternate sources and everything else is equal, pick the one that appears to be the most sanitary. Be sure to treat before use any water taken from any source, except an existing water supply system approved by the AF medical team.

8.9.2.2. **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 local treatment of contaminated water sources is inadequate, civil engineers should at least set up the treatment and storage components of the water system contained in BEAR assets. Reverse-osmosis water purification units (ROWPU) in BEAR 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.

8.9.2.2.1. The AF primarily uses the 1500-gallons per hour (GPH) ROWPU (**Figure 8.8**), however a few legacy 600-GPH ROWPUs may still be in service. Until ROWPUs are set-up and operating, haul in potable water by truck or plane, or have individuals treat their own water. Mostly, individuals accomplish this by adding iodine purification tablets or calcium hypochlorite ampules to a canteen of water. When no other method is available, render the water safe by bringing it to a boil for at least 5 minutes. At higher elevations, boil the water for longer periods; consult AFMAN 48-138, *Sanitary Control and Surveillance of Field Water Supplies* for specific requirements.

8.9.2.2.2. 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 8.8. 1500-GPH ROWPU.



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

8.9.2.4. **Water Distribution.** Use the existing water distribution system whenever possible. Run temporary branch lines from permanent water mains using available pipes, water hoses or even a fire hose. Additionally, if sufficient water booster pumps are available, consider using them to provide pressure to an expedient water distribution system. BEAR assets have components sufficient to provide a complete, pressurized water distribution system.

8.9.2.4.1. For very short-term beddowns, it may not be practical to lay extensive distribution lines. If not, haul water to distribution points (water points) where users fill their own water cans and other containers. Use water trailers to distribute water to remote locations.

8.9.2.4.2. For additional information on water sources, treatment, and distribution at austere bases, refer to T.O. 40W4-20-1, *1500 Reverse Osmosis Water Purification Unit (ROWPU)*, T.O. 40W4-21-1, *Basic Expeditionary Airfield Resources (BEAR) Water System*, AFH 10-222 Volume 11, *Contingency Water System Installation and Operation*, and AFPAM 10-219, Volumes 5 and 6.

8.9.3. **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 to provide heat. BEAR systems provide field deployable environmental control units to heat and cool the shelters. However, the 130K portable heater is also available for extremely cold conditions. Ensure preparations address fuel distribution to 130K heaters; they should operate approximately 15 hours at -15^{o} F without refueling. See AFH 10-222, Volume 2 and AFPAM 10-219, Volumes 5 and 6, for additional details on expedient heating systems.

8.9.4. **Field Sanitation.** In any contingency situation, it is important to protect personnel 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.

8.9.4.1. **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 an important factor in the prevention of disease. The following facilities developed by civil engineers for force beddown contribute to effective personal hygiene.

8.9.4.1.1. Shower and Lavatory. Shower and lavatory areas are essential elements in providing for effective hygiene. Personnel should have a place to maintain body cleanliness. Consider the following planning factors when developing shower and lavatory areas:

- 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
- Heat expedient shower and lavatory areas
- Privacy screens at each entrance and exit (tent vestibules are sufficient)
- Benches for dressing and undressing; additionally, a means of hanging clothes and towels improves facility usefulness
- 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

8.9.4.1.2. 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 deployed Prime RIBS (Readiness in Base Services) team may operate a complete field laundry. Primary CE support to either type of operation should be in the form of electrical power, an adequate water supply, and proper drainage.

8.9.4.2. **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 should also be concerned with toxic wastes. When developing disposal methods, bioenvironmental engineers and the units generating the waste should be major players. Consult AFH 10-222, Volume 4, *Environmental Considerations for Overseas Contingency Operations*, for more information on managing waste and wastewater.

8.9.4.2.1. Human Waste. Proper disposal of human waste is another important element in the prevention of disease. Improper disposal can easily contaminate water supplies, 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 contingency locations. Commonly, unit will use BEAR assets at austere bases. When the situation dictates, use expedient waste disposal techniques (**Table 8.3**). More information on human waste methods and facilities is available in AFH 10-222, Volume 1, AFPAM 10-219, Volumes 5 and 7.

Table 8.3. Expedient Human 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

8.9.4.2.2. Liquid Waste. Proper disposal of liquid wastes from kitchen and bath sources prevents breeding grounds for harmful bacteria. On a MOB or contingency location, force beddown personnel should attempt to connect these facilities to existing sewers. If this is not possible, process kitchen liquid waste through a simply constructed grease trap to 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.

8.9.4.2.2.1. For details on constructing these expedient facilities, check AFPAM 10-219, Volumes 5 and 7.

8.9.4.2.3. 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 HN bases, large-scale garbage incinerators, sanitary landfills, or garbage collection contracts may exist. In less developed locations, units may have to develop improvised methods to dispose of garbage. In any case, CE units should build garbage collection points near food preparation facilities and arrange for periodic pickup.

8.9.4.2.3.1. Consider burying kitchen garbage for short-term beddown operations in small pits or trenches. A pit 4 feet square and 4 feet deep can handle one day's garbage for 100 personnel. Fill these pits no closer than 1 foot below ground surface, spray with insecticide, and mound 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.

8.9.4.2.3.2. For longer-term operations consider burying kitchen garbage in a continuous trench or combined with other solid waste in a sanitary landfill. The trench size depends on the size of the force supported and their length of stay. With this method, use dirt excavated while extending the trench to cover and mound the garbage already deposited.

8.9.4.2.3.3. Under temporary conditions, it may be possible to burn relatively small amounts of wet kitchen garbage in open incinerators. Units can improvise an open incinerator from numerous materials readily available at most beddown locations. For example, converting a 55-gallon drum makes an excellent barrel incinerator. When using a drum for an incinerator, ensure it is free of toxic, flammable, or combustible contents. Units should consult DODI 4715.19, *Use of Open-Air Burn Pits in Contingency Operations*, and DODI 4715.22, *Environmental Management Policy for Contingency Locations*, and CCMD guidance before disposing of any waste using an open burning method.

8.9.4.2.4. Solid Waste. Beddown sites generate a significant amount of solid waste. Because this waste also provides an excellent breeding ground for insects and rodents, it too should be disposed of properly. Burning dry combustible waste may be an option, 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. Often, units dispose of garbage and solid waste in a common sanitary landfill, covering each day's deposit with soil. Consider building collection points throughout the encampment and especially at locations convenient to the major waste producers.

8.9.4.2.4.1. 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.

8.9.4.2.5. 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 those base units generating toxic materials to minimize their use; collect the used materials, and temporarily store them. Involve base logistics and transportation units when transporting toxic wastes. In some circumstances, the installation may need to follow Environmental Protection Agency and Department of Transportation rules.

8.9.4.2.5.1. 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, develop a permanent and proper disposal method for those wastes. Burial is an option, but double seal waste materials when possible or place single-sealed containers in a lined pit. If possible, do not commingle toxic wastes with regular garbage and solid waste. Mark burial sites and identify the name and amount of each material.

8.9.4.2.5.2. 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 periodic service schedule for the oil-water separators.

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

8.9.4.3. **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, controlling the pest population may require extermination. If that becomes necessary, consult qualified CE pest management personnel or the medical public health specialists to determine proper procedures. Mostly, units control insects by spraying an insecticide in and around nesting and feeding areas and fogging or spraying throughout the installation. Consider controlling rodents with poisons or traps.

8.10. Learning from Beddown Lessons. Good preparations include learning from previous beddowns. Whenever possible, review CE lessons learned maintained at the Air Force Civil Engineer Center (AFCEC) Reach-Back Center (RBC). Contact the AFCEC RBC at 1-888-232-3721 (toll free), 1-850-283-6995 (comm), Defense Switched Network (DSN) 312-523-6995, or via email at **AFCEC.rbc@us.af.mil**. Additionally, consider reviewing the Joint Lessons Learned Information System at **https://www.jllis.mil/apps/** prior to deployment; it will likely contain essential information you can use before you deploy and once on site. No two beddowns are alike; there will be differences in mission, site conditions, and logistics. However, there are hard lessons, which apply to most beddowns that CE leaders have learned and offered to future leaders of CE deployments. Below are a few of these lessons; grouped in arbitrary categories and no special order.

8.10.1. **When You Deploy.**

8.10.1.1. Pack reference materials. Include one or two copies of reference materials in your Prime BEEF team kit. Consider putting copies in your personal mobility bags. Useful reference materials are the AFPAM 10-219, AFH 10-222, AFTTP 3-32, and UFC 3-260-series documents and the Air Force Institute of Technology, Contingency Engineer Command Course (WMGT 585) course materials.

8.10.1.2. Get your people licensed. You need a number of people qualified in many specialties to operate forklifts, front-end loaders, dump trucks, and backhoes.

8.10.2. **When You Arrive.**

8.10.2.1. Get a handle on your mission and priorities. Focus your efforts by quickly finding out what the commander wants. If the site commander is inexperienced and asks for your recommendation, have a proposal ready. Prepare for this in peacetime by learning all you can about beddown operations.

8.10.2.2. Contact the host BCE if there is one. Attempt to establish a good working relationship early. Set up your combined C2 structure and divide responsibilities.

8.10.2.3. Put the beddown plan together quickly. All units need a plan—whether formal or informal—to give focus to their efforts. Use available facilities to the maximum. It minimizes your beddown effort and usually gives you better facilities, faster. It will happen anyway when other units learn there are facilities available. A listing of facilities you can use should be available in the BSP or ESP. In any case, ask what is available when you arrive. Your challenge is to quickly develop an intelligent beddown plan that the commander can approve and support. Whenever possible, start with an existing plan and modify as needed.

8.10.2.4. Don't wait until the beddown plan is complete to start work. Use your intuition as to what will be most important and get your people working. As soon as you know what facilities are most important to the commander, start there with shelter erection and utility support.

8.10.2.5. Avoid redundant tasking by establishing a work schedule and work flow diagram at the earliest possible time. Make the plan flexible to allow for the inevitable changes that will occur. Create a visible work chart that show where the team members are working at any given time.

8.10.2.6. Establish your working hours around the mission, not the mission around your working hours. This should be obvious, but some civil engineers have lost sight of this.

8.10.3. **Setting up The Base.**

8.10.3.1. Accomplish the difficult mission requirements first to make the deployment site operational. Livability projects can be done later.

8.10.3.2. Hot meals, hot showers, and a place to sleep contribute most to troop morale. As soon as possible, start assembling or constructing latrines, dining, and shower facilities. Recreation facilities can be erected later.

8.10.3.3. You will rarely have all the materials needed to complete a task at the precise time when you need them. Be prepared to innovate and substitute in order to accomplish the job on time.

8.10.3.4. Maintain a neat job site. This helps you maintain tighter control of tools and materials. It also reduces safety hazards.

8.10.3.5. Request users erect their own facilities. Civil engineers should provide technical guidance when necessary to ensure the safety of all Airmen participating in beddown activities.

8.10.3.6. When moving shelter containers from the holding area, place the containers where the shelters will be erected. Place other items nearby to reduce the distance people have to manhandle items.

8.10.3.7. When considering flood levels and tides, look for features that indicate an area subject to flooding. Keep high/low tides in mind if you ever need to set up facilities/ equipment near the ocean or need to draw water from the ocean.

8.10.3.8. Grass helps control dust. You can minimize dust problems when you set up contingency shelters on grassy areas. Other considerations such as soil bearing pressure may rule out this option.

8.10.4. **Utility Systems.** Trained and qualified utility systems operators is critical when installing BEAR utility systems: electrical generation with 750-Kilowatt (kW) units, high voltage electrical distribution, and water treatment with ROWPUs.

8.10.5. **Vehicles.**

8.10.5.1. Vehicles during initial beddown operations will be limited so close coordination with the unit Vehicle Control Officer (VCO) and operations is critical. Other options include off-base rentals, which should be worked through the VCO, operations section and fleet management.

8.10.5.2. Vehicles coming out of deep storage will probably need servicing before they can be used. Rubber components such as belts and hoses will probably have to be replaced. The transportation unit should ensure vehicles are fully mission capable before issuing them to you.

8.10.6. **Logistics.**

8.10.6.1. Once the mission is known, coordinate with your WRM manager and Logistics Readiness personnel on flow of WRM assets. Your commander should report shortages in their daily/weekly situation report (SITREP) to the Command's Engineer Staff.

8.10.6.2. Know what supplies, equipment, and vehicles you have and where they are located, at all times.

8.10.6.3. Establish a central supply storage area that is secured to prevent pilfering. And establish some type of controlled access. Coordinate with LRS to ensure construction material is properly distributed and tracked for accountability.

8.10.6.4. With LRS personnel, set up a secure holding area for incoming BEAR equipment and facilities to ensure easy access and movement when needed. Coordinate closely with Aerial Port managers to track incoming BEAR assets for planning and installation priorities.

8.10.6.5. Minimize movement of materials. If helpful, set up temporary holding areas near the intended point of use, so items can be delivered there when first moved from the flightline or from the prepositioned areas.

8.10.6.6. Ideally, WRM assets are in good shape when they arrive, but in fact, you are likely to have problems with the electrical and mechanical systems. Good peacetime training does not diminish the problems, but your people can find them—and repair them—faster.

8.10.6.7. Thoroughly inspect WRM and BEAR assets for mechanical and electrical issues and repair as necessary.

8.10.7. **Taking Care of Your People.** There are many ways you need to look out for the well-being of your people when they are deployed. Here are just a few:

8.10.7.1. Review local conditions with public health (PH) or bioenvironmental (BEE) personnel if possible to establish proper mitigation measures. There is a tendency to surge at the beginning of a deployment, which could establish a dangerous precedent that is not sustainable. Consult AFTTP 3-42.2, *Health Service Support Casualty Prevention for Expeditionary Operations*, to determine what assistance PH and BEE personnel may provide.

8.10.7.2. Keep/enforce good sanitation. This applies to individuals in your unit and your part of the base. Not only does it keep you and your people healthier, but also it eliminates one morale detractor. Good sanitation may not make for good morale, but you can guarantee that bad sanitation induces morale problems and fosters disease.

8.10.7.3. Enforce drinking water and taking medications. The Army practices forced hydration. That is certainly one way to make certain you do not lose people from dehydration. Do not rule out the use of forced hydration. If you start getting casualties, have your supervisors make their people drink often—at least every 20 minutes in hot weather. The warm water may not be palatable, but it still keeps you healthy. If possible, cool it. You can enhance the taste of warm water by adding a drink flavoring. In some places, you need to take some medications routinely. Again, stress the importance.

8.10.8. **Working with Other Services/HN Forces.** During initial beddown operations, each Service has their own QoL standards they are accustomed too. As the contingency location transitions through its temporal standards, the goal is to standardize across the base to ensure consistency and QoL for all members.

8.10.9. **Leading the Team.**

8.10.9.1. Know your people and maintain span of control.

8.10.9.2. Be flexible.

8.10.9.3. Be positive.

8.10.9.4. Ensure work requirements are equally distributed.

8.10.9.5. Maintain morale of your team.

8.10.9.6. Maintain work areas in safe and clean environment.

8.10.9.7. Delegate tasks when appropriate.

8.10.9.8. Be engaged and maintain proper oversight.

8.10.9.9. Ensure a thorough post inspection of tasks.

8.10.10. **Sharing Your Lessons.** Ensure you submit your lessons learned to the Air Force Civil Engineer Center Readiness Directorate (AFCEC/CX) and indicate you are proposing them for the next update of this volume.

8.11. 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 respond to natural disasters and man-caused accidents. A good understanding of how to determine and satisfy beddown requirements is vital. Civil engineers have the responsibility of providing the facilities and utilities to ensure minimum mission support. The location, mission, and available resources dictate the challenges civil engineers will face. Having the required equipment, materials, and a qualified workforce is essential. Equipment and materials may come from various sources, including WRM assets or commercial vendors. Prime BEEF, RHSs, and contractors are the normal sources of qualified technicians. This, together with advance planning and good preparation ensures CE is ready to meet force beddown challenges head on. For additional information regarding CE preparations for beddown operations, consult the references listed in **Table 8**.

Table 8.4. Chapter 8 Quick Reference.

Beddown Preparations Chapter References	
AFH 10-222V1	*Civil Engineer Bare Base Development*
AFH 10-222V2	*Bare Base Assets*
AFH 10-222V4	*Environmental Considerations for Overseas Contingency Operations*
AFH 10-222V11	*Contingency Water System Installation and Operation*
AFI 10-401	*Air Force Operations Planning and Execution*
AFI 10-404	*Base Support and Expeditionary (BAS&E) Site Planning*
AFMAN 91-201	*Explosives Safety Standards*
AFMAN 48-138	*Sanitary Control and Surveillance of Field Water Supplies*
AFPAM 10-219V5	*Bare Base Conceptual Planning*
AFPAM 10-219V6	*Planning and Design of Expeditionary Airbases*
AFPAM 10-219V7	*Expedient Methods*
AFTTP 3-32.34V5	*Contingency Electrical Power Production and Distribution Systems*
AFTTP 3-32.41	*Contingency Firefighting Operations*
AFTTP 3-42.2	*Health Service Support Casualty Prevention for Expeditionary Operations*
DODI 4715.19	*Use of Open-Air Burn Pits in Contingency Operations*
DODI 4715.22	*Environmental Management Policy for Contingency Locations*
JP 3-34	*Joint Engineer Operations*
T.O. 40W4-20-1	*1500 Reverse Osmosis Water Purification Unit (ROWPU)*
T.O. 40W4-21-1	*Basic Expeditionary Airfield Resources (BEAR) Water System*
UFC 1-201-01	*Non-Permanent DOD Facilities in Support of Military Operations*
UFC 3-250-01	*Pavement Design for Roads and Parking Areas*
UFC 3-250-03	*Standard Practice Manual for Flexible Pavements*
UFC 3-250-04	*Standard Practice for Concrete Pavements*
UFC 3-250-09FA	*Aggregate Surfaced Roads and Airfields Areas*
UFC 3-250-11	*Soil Stabilization for Pavements*
UFC 3-260-01	*Airfield and Heliport Planning and Design*
UFC 4-010-01	*DOD Minimum Antiterrorism Standards for Buildings*

Chapter 9

UTILITIES ISOLATION, BACKUP, AND REDUNDANCY

9.1. General Information. The loss of utility service has an immediate impact 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 vary with the disrupted utility, the nature and extent of the disruption, and the affected activity's importance to the mission. As "owner" of the base utility systems, civil engineers can minimize utility service disruption and resulting mission impacts with good disaster and attack planning and preparations. As a minimum, CE units should ensure procedures and resources are in place to isolate all or portions of the base's utility systems, provide utility backup to mission-critical activities, and protect key components of utility systems from damage. When provided only limited utility service, the base should also develop demand reduction procedures.

9.2. Overview. Protecting important base utility services is not only a CE responsibility. Many preparations require installation-wide inputs and preplanned responses. This chapter presents recommendations for preparing base utilities for disasters and attacks, including 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. Also highlighted is the importance of installation-wide demand reduction procedures. Civil engineers address these utility preparations according to the following activities:

- Learn the systems
- Assess vulnerabilities
- Determine critical requirements
- Prepare systems
- Reduce demand

9.3. Learning the Systems. The first step when preparing utility systems for a disaster or attack is to learn all you can about the system: its sources, configuration, vulnerabilities, operating details, recurring problems, spare parts, and other basic utility data. To the extent possible, use GeoBase data layers and other Geospatial Information to aid in identifying and locating critical equipment and resources. Additional utility and installation data may also be in the Installation Development Plan (IDP), Component Plan, Area Development Plan, and Base Comprehensive Asset Management Plan, if available.

9.3.1. **GeoBase.** GeoBase is a program that provides commanders, planners, and personnel across the combat support spectrum a near real time operational picture of the installation and facilities required for mission success. It enables users to visualize mission assets in a shared, intuitive, cross-functional manner, allowing a reduction in the time required for making decisions. GeoBase provides access to common, accurate and current geospatial information for the installation. The geospatial information constitutes georeferenced imagery and vector data that represent real-world features and conditions, and includes statistical data and information derived from various other sources.

9.3.2. **Installation Plans.** According to AFI 32-7062, *Comprehensive Planning*, the IDP is a web-based, summary product of the Comprehensive Planning Process (CPP) that provides a condensed picture of an installation's capability to support the mission with its physical assets and delivery systems. It also provides a general assessment of the installation's infrastructure and characteristics and addresses key indicators relating to capacity and sustainability. Typically, the Base Community Planner and cross-functional teams throughout the installation (including CE) develop and maintain installation plans. This section focuses on utilities data available in base plans.

9.3.3. **Basic Utility Data.** This data is the "general" information available for all utility systems on the installation (see **paragraphs 9.7** through **9.13** for utility-specific information). Utilities information is in the IDP and may be included in the utilities annex of the CE CRP and other base plans. Basic utility data should provide the following:

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

9.3.3.2. 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.

9.3.3.3. Layout and Configuration of Distribution System. Describes key system components such as pumps, transformers, and lift stations. Identify interchangeable items. Explain the distribution systems' layout and the normal configuration of valves or switches. Geospatial information in IDP includes data sets and data layers depicting the installation's utility systems. Illustrated in **Table 9.1** are geospatial data layers in the IDP Data Set G, *Utilities* section.

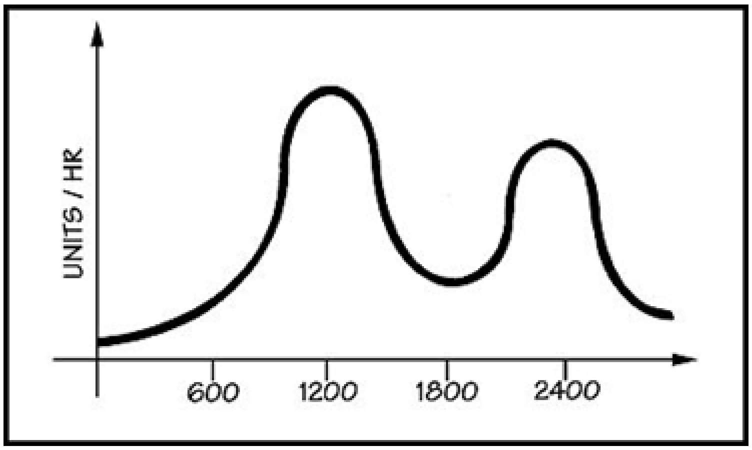
Table 9.1. IDP Geospatial Data Set G: Utilities.

Data Set	Detail
Water Distribution System	Wells, storage locations, and distribution lines six inches in diameter and above
Sanitary Sewerage System	Main trunk line and lift stations
Storm Drainage System	Main trunk line
Electrical Distribution System	Above and underground primary distribution lines and substations
Central Heating/Cooling System	Above-ground and underground distribution
Natural Gas Distribution System	Storage and primary/secondary distribution
Liquid Fuels System	Primary and secondary lines
Industrial Waste & Drain System	Lines, manholes, pumping stations, treatment plants, and outfalls

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

9.3.3.5. Consumption/Discharge. Record maximum, minimum, and average daily consumption (or discharge), and show daily variation in demand. Easily accomplish these using graphs such as illustrated in **Figure 9.1**.

Figure 9.1. Typical Demand (or Discharge).



9.3.3.6. 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.

9.3.3.7. Backup Capabilities. Describe alternate methods that the base, not just the CE unit, can employ to deliver full or limited utility service to users.

9.3.3.8. Hazards. Briefly describe any hazards to personnel resulting from damage to the distribution, production, or storage facilities associated with a utility system.

9.3.4. **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 to maintain for critical components and identify which components within the system (transformers, circuit breakers, and switches) are interchangeable. Check spare equipment lists against system requirements; record the condition and location of all spares. Collect the same information for generating plants and mobile generators. An annual review is particularly critical for those items stored as special levels.

9.4. Assessing Vulnerabilities. To determine what preparations deserve priority attention, identify which utility system components are most at risk from the likely threats. Underground elements of utility systems are inherently more survivable but can be harder to troubleshoot and repair. The CE unit possesses 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. Since the utility systems serving an installation are usually complex, using this iterative gaming process is time well spent. 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. Assessment results should be included in the utilities annex (P) to your CE CRP. Request help from SF; they can identify specific enemy ground threats and avenues of attack.

9.5. Determining Critical Requirements. You need another step to complete the data gathering and assessment phase of disaster and attack preparations. You should determine hard-core utility requirements—for individual users and the base. Civil engineers lead 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
- Calculate the minimum critical base-wide requirement

9.5.1. 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 undergoing repair; degrades C2 of the installation's forces, or jeopardizes lifesaving activities such as hospital operating rooms or shelters; that function/facility has a critical requirement. Loss of service causing only inconvenience is not a mission-critical impact. Neither is a loss that forces easily performed work-arounds; for example, going next door to drink water or to use the latrine.

9.5.2. Air conditioning in quarters or in a dorm is very nice, but it is usually a convenience. However, air conditioning for temperature-sensitive air traffic control or communications equipment is probably critical.

9.5.3. Installations can sort critical from non-critical utility requirements in different ways. Below are two examples; installations may also consider using a combination of the two:

9.5.3.1. Start with the facility priority list. If it accurately reflects mission priorities, you can use the list to identify facilities contributing 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 numbers of personnel, but it may overstate requirements since it does not challenge user inputs.

9.5.3.2. 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 that contains a critical function, and state what function performed. For example, "The unit needs 120/208V, 50 amps of power plus room lighting and air conditioning in room 12 of building 5505, so specialists can calibrate the F-15 internal navigation system with the test stand." Units should also defend their requirements in terms of mission impact.

9.5.3.2.1. They should specify what work-around solutions they should implement if they lose a utility. They should state the impact of working in that alternative situation by explaining how it affects the flying mission and how long it will take before loss of service critically affects 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.

9.5.3.2.2. Civil engineers 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.

9.5.4. 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. However, it is unrealistic to treat every unit—or even every section in the key units—as mission critical. Civil engineers can then work with the units to refine the detailed requirements and total the installation's critical requirements. If storage space in CE facilities is available, keep a copy of every unit's requirements and marked up facility drawings. This makes it easier to periodically validate and update requirements.

9.6. Basic Preparations for Utilities. Below are general CE preparations for critical utility systems. For utility preparations at austere beddown locations, review **Chapter 8** and consult AFH 10-222-, AFPAM 10-219-, and AFTTP 3-32-series for additional information.

9.6.1. Periodically, locate and operate cutoff valves and switches to ensure they are operational and control the desired systems.

9.6.2. Identify all available water sources (both on base and nearby off base) in the CE CRP as emergency backup and to support fire fighting and contamination control operations.

9.6.3. Consider redundancy when designing/redesigning critical utility systems or permitting reconfiguration for continued operations; for example, loop systems.

9.6.4. Maintain accurate utility distribution system drawings, showing the locations of all cutoff valves and switches in the CE UCC and ECC.

9.6.5. Electrical power should be continuous to essential base functions. The CE unit should have emergency-essential backup power sources when disruption of primary service to essential functions or facilities occur.

9.7. Electrical System Preparations. The installation electrical system is one of the most complex utility systems serving an installation. Its loss has an immediate impact on the installation mission. This review of electrical system preparations covers four areas:

- System information to collect and document in the CE CRP
- System isolation preparations
- Emergency backup preparations
- Physical protective measures

9.7.1. **System Information.** Good data collection should 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 describe your system adequately. Again, the IDP generally contains much of the basic layout and design data for on-base systems. The Infrastructure Support element chief should ensure the unit maintains system information in at least two separate locations. This includes schematics of substation equipment and layout, nameplate data, technical orders, manufacturer's literature on equipment, switch configurations, and other pertinent information.

9.7.1.1. Government-Owned Substation. With an off-base source, begin at the point of receipt—the main substation/switch station. Give a general description; including the location, number and size of supply feeders, voltages, and transformer capacities. State whether the conductors, transformers, or other feature limits the capacity. If there is more than one source, provide this same information for each receiving point.

9.7.1.2. 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 POC and record that information in the CE CRP.

9.7.1.3. Generating Plants. Fixed generating plants, 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:

- Location
- Total rated plant capacity (in kW)
- Firm plant capacity (in kW)
- Capacity of each generator (in kW)
- Make and model
- Type fuel required and amount stored on site (gallons)
- Daily fuel consumption (in gallons) during continuous use and the time interval (in days or hours) before resupply is required

9.7.1.4. Distribution System. Record the location, capacity, and type of cable, transformers, switch gear, etc., for 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.

9.7.1.5. Backup/Emergency Generators. Account for generators as either RPIE, Equipment Authorization Inventory Data (EAID), or 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:

- Type of generator and capacity (in kW)
- Run time when fully fueled (24 hours, 7 days, 14 days)
- Location
- Facility and activity for which authorized
- Type of fuel and quantity available on site
- Whether it is part of an uninterruptible power system, has an auto start capability, or is manually controlled
- Connection details (plug, split-bolt, etc.) and load transfer method at the facility where the unit is likely to be used

9.7.1.6. 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 and document all single points of failure for feeders serving critical mission loads. IAW AFI 32-1061, review outage reports for the past three years and identify any system elements or portions having recurring problems. Maintain this data in the utility service folder. These locations have a greater chance for causing problems.

9.7.1.6.1. 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.

9.7.1.7. Critical Facility Requirements. Make a list of critical facilities and activities. Ensure the locations of critical facilities are included in the IDP. Use IDP geospatial data sets and layers to preplan emergency switching and isolation procedures. Identify the specific power requirements for each key facility, such as voltage, load, frequency, and quality of power for special equipment. Remember, it is unlikely all requirements within a facility are critical.

9.7.2. **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 system damage and restore power to intact facilities in the damaged areas; create alternate paths to back feed critical loads; shut off power to all or portions of the system to protect it, personnel, and installation facilities from damage.

9.7.2.1. Utility system isolation is a common CE activity. Given warning prior to an attack or disaster, units can often complete preparations and procedures to protect system components and to sustain service to critical activities. Some activities should have power during or immediately after the active phase of an attack or natural disaster. An installation should consider the following actions:

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

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

9.7.2.1.3. 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 personnel cannot use their televisions or radios to get emergency instructions. Whether to shut off power and where to shut if off is an installation leadership decision. Civil engineers should offer recommendations.

9.7.2.2. Civil engineers should develop isolation procedures specifying 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 OIs and include those OIs in the CE CRP. Prepare supporting/execution checklists for shops and UCC. OIs and checklists should outline the sequence of actions and identify individual and coordinated tasks. If conditions permit, give users a warning you are about to cut off power. This gives them time to implement backup procedures.

9.7.2.3. The Operations section of each installation should have a single line diagram of the distribution system. Beginning with feeders to substation transformers, and indicating substation transformer configuration (delta-wye, delta-delta, wye-wye, etc.), circuits and their respective designations (number, color, name) and loading, switching scheme, device function number and the normal position (NO or NC, i.e. normally open or normally closed) of devices used to isolate faults. To facilitate communications between repair crews and the UCC, it is helpful to provide a simplified copy to the UCC.

9.7.2.3.1. Repair crews will likely advise the UCC of their planned procedures, the approximate time duration for isolating the fault, the customers who will have no commercial power until the fault is repaired, which customers will have backup power, and an estimated time for return to normal.

9.7.2.4. System modifications can increase isolation and back feed flexibility. Possibilities for isolating circuits and back feeding key facilities are only limited by the system layout and the funds available. Analyze the existing electrical system, and identify points where units can add switching capability. If any threat warrants the cost of the modification, do it. Plan such modifications with system backup capabilities in mind.

9.7.3. **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.

9.7.3.1. 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.

9.7.3.1.1. Follow procedures in AFI 32-1062, *Electrical Systems, Power Plants and Generators*, to get the generators authorized and delivered.

9.7.3.1.2. Identify all critical activities requiring backup power and list them in priority order. Logically, this should be the installation's 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. See AFI 32-1062 for a list of facilities authorized backup power.

9.7.3.1.3. 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 should be done automatically or can be done manually.

9.7.3.1.4. Develop an operating agreement with each user covering 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. Units may add this information to the back of the operating agreement. Then train the user's generator operators.

9.7.3.1.5. In the operating agreements, include procedures for servicing the generators. Most important is periodically refueling 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, civil engineers handle these responsibilities. Refer to AFI 32-1062 for specific requirements for fuel servicing and verification.

9.7.3.1.6. Add quick-connect/disconnect and double throw switchgear to facilities that 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 that 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 backup generators.

9.7.3.2. Exercise EAID generators annually while connected to the facility or system they primarily support IAW ETL 13-4, *Standby Generator Design, Maintenance, and Testing Criteria*. Historically, installations conducting large-scale tests of mission performance under commercial power-out conditions commonly report the conditions below as major LIMFACs:

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

9.7.3.2.2. 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.

9.7.3.2.3. Limited staffing 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.

9.7.4. **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. Consider using measures such as earth berms and revetments to protect power plants, substations, transformers, switch stations, generators, etc. Develop OIs that detail what to protect; how to protect it; where the resources are located to do the task, and who will do the work.

9.8. Water System Preparations. In the CONUS, AF 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 that supplement purchased water, while some isolated CONUS installations depend on wells as the primary source. At overseas locations, AF installations operate treatment plants where commercial sources are unavailable or below acceptable water quantity or quality requirements. When overseas water purchases are necessary, a “Purchase Water Agreement” should be negotiated spelling out the costs associated for the water purchased and “Water Rights” outlining the measures to plan, prepare and provide for an adequate water supply.

9.8.1. **System Information.** No matter how an installation gets its water, basic system information is still required. Find the layout and details of the installation water system in the IDP. Information should also be in the appropriate annex of the CE CRP (currently Annex P). 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. Below is the type of information to maintain.

9.8.1.1. Purchased Water. Usually, purchased water is 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 (tank, pool, basin, etc.). Sometimes, installations have a capability at the point of receipt to introduce additional chlorine or fluorine. For purchased water, record at least the following information:

- Capacity and minimum guaranteed quantity from source
- Pipe sizes and pressures
- Schematic of receiving point
- Pump data
- Description of chemical addition equipment
- Daily chemical requirements and stocks normally on hand
- Location, condition, and numbers of spares

9.8.1.2. Base Wells. Identify and record the following information for on-base wells:

- Location, depth, and capacity of wells plus pipe sizes and materials
- Well pump, control panel, and well point data
- Backup electrical power or other backup features
- Requirement, condition, and location of spares

9.8.1.3. Other Installation Sources. A few installations have other sources like rivers, lakes, and reservoirs. Collect the information outlined above, and record the quantity of water available from those sources. If applicable, address variations in quantity by season and during periods of drought.

9.8.1.4. Water Treatment. Frequently, the only treatment that is required for raw water drawn from deep wells (**Figure 9.2**) is disinfection. Treatment that is more extensive is required for shallow wells **(Figure 9.3)** or surface water sources **(Figure 9.4)**. The physical size and type of a treatment plant depends on the production requirement and the characteristics of the raw water source. Capture the information provided in the following paragraphs for water treatment plants:

9.8.1.4.1. Plant capacity.

9.8.1.4.2. Flow diagram through the plant. Include a process schematic that indicates backwash and bypass piping.

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

9.8.1.4.4. Main power supply to plant and backup power.

9.8.1.4.5. 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 normally takes to get the product in hand. Allow for disrupted supply and transportation in a contingency. If disinfectant is in pressurized cylinders, consider a 100 percent backup of dry powder disinfectant for contingency operations.

Figure 9.2. Example Deep Well Water Supply.

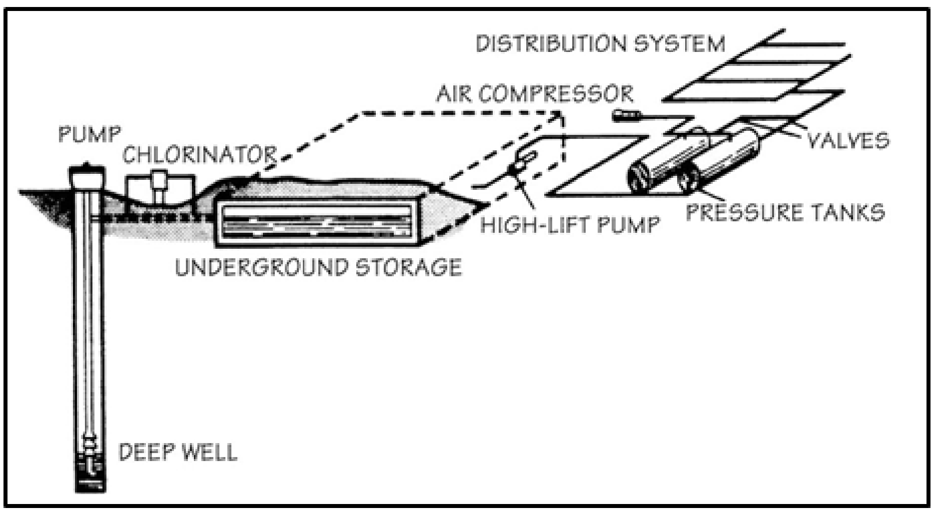


Figure 9.3. Example Shallow Well Water Supply.

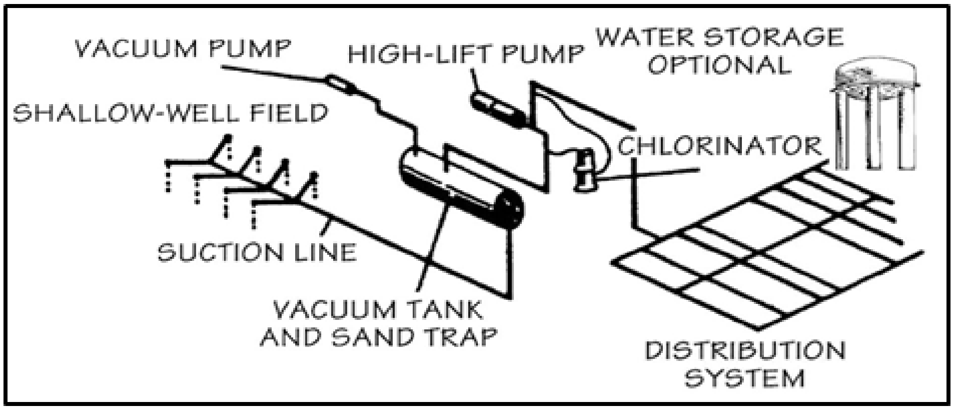
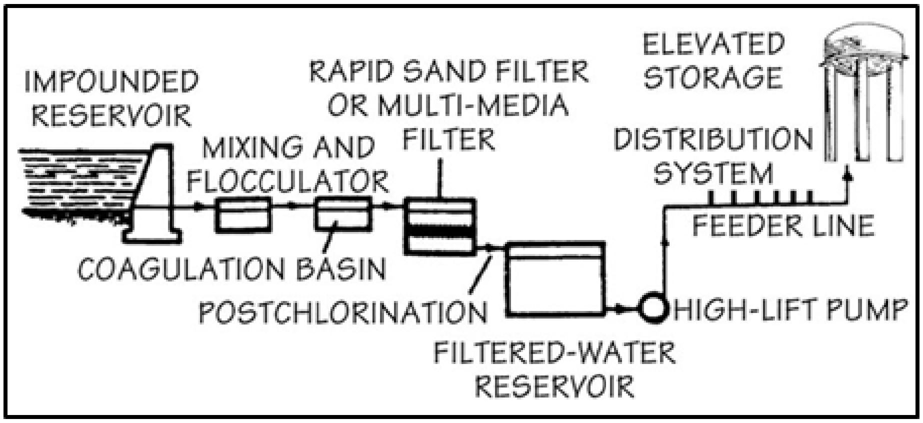


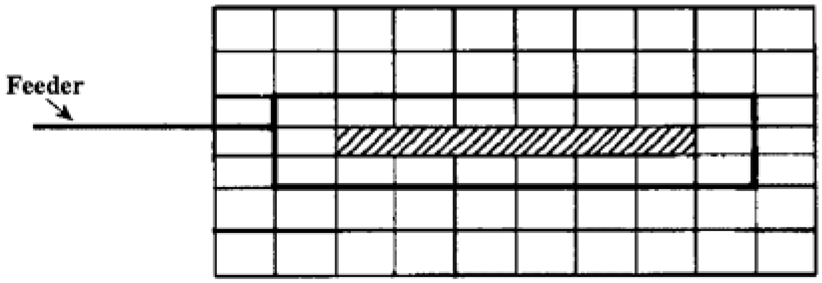
Figure 9.4. Example Surface Treated Water Supply.



9.8.1.5. Distribution System. Once rendered potable, introduce water into the distribution system. Lay out a loop distribution system (**Figure 9.5**) 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 elements in **Table 9.2**. As a minimum, record the information below for elements of the water distribution system:

- Location of water lines, including pipe sizes/materials and normal operating pressures
- Location, capacity, and type of storage reservoirs and tanks
- Location and data on motors, pumps, controls, valves, and other components
- Backup electrical power or other backup features for pumps and control circuits
- Requirement, condition, and location of spares

Figure 9.5. Typical Water Distribution System Pattern.



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

Table 9.2. Elements of Water Distribution System.

Element	Purpose
Distribution Mains	Pipelines that carry water from the source to the users
Arterial Mains	Distribution mains of large diameter that 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; used to gather consumption data and also for billing purposes to reimbursable customers (banks, Army Air Force Exchange Service, etc.); meters are not a priority for repairing or replacing in contingencies
Backflow Preventers	Devices that protect potable water from contamination
Fire Hydrants	Fire fighting

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

9.8.1.7. Vulnerability Assessment. Water treatment facilities and underground distribution lines are not especially vulnerable to enemy attack or natural disasters. However, be sure to annotate system maps pinpointing segments that are above grade and consider their vulnerability. Keep in mind that any above ground water tanks are very vulnerable to attack and natural disasters such as hurricanes, etc. Therefore, water systems designed with an operational above ground tank will likely be inoperable without the tank (due to it providing pressure to the system, etc.). Any water treatment plants located in low areas may also be vulnerable.

9.8.1.7.1. Floods could force these plants out of service if floodwaters enter the treatment structures. While there are targets that are more attractive, water treatment plants and storage tanks can be peacetime or wartime targets for terrorists using chemical or biological contaminants. Normally, water mains carry across ravines, streams, or drainage ditches, or on the underside of road bridges, or by structures erected only for 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.

9.8.1.7.2. At older installations look for long, dead-end runs. These may have once served large complexes and since demolished, but the mains are still in service to supply a single facility. Such segments will typically result in low chlorine residual and other vulnerabilities to consider when planning of isolation and flushing procedures.

9.8.1.8. Critical Facility Requirements. Plot the location of facilities or activities that 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 the fire protection requirements in Annex F of the CE CRP. Program for construction of additional storage capacity if the fire protection requirements exceed existing potable storage capacity.

9.8.2. **System Isolation.** Isolation enables an installation to provide continued water service while valving off redundant paths to avoid excessive loss of pressure and storage capacity if system interdiction (cut off or impeded) occur. Fire fighting 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.

9.8.2.1. Develop isolation procedures specifying 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. Accomplish this through the CAT or EOC. Do not 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 should suffice to direct on-the-spot response.

9.8.2.2. 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.

9.8.2.3. Locate and exercise valves periodically to make sure they work and personnel can easily find them. 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 that new personnel know where the valves are located.

9.8.3. **Redundant or Backup Water Systems.** If you cannot distribute potable water through the water system, the installation should look at hauling water. In recent operations in SWA, many units initially used bottle water. This dropped off as water treatment and distribution capabilities at austere bases picked up. Hauling water in bulk tanks is sometimes the installation's best alternative solution. With a moderate-size fleet, you may be able to haul enough water to satisfy more than human consumption needs. If water tank-trucks or trailers are unavailable, units may need to fabricate tanks to place on the bed of any vehicle that can handle the load. Examples include dump trucks, low boys, flat bed trailers, and 12-ton trucks.

9.8.3.1. For individual consumption, the installation should set up water distribution points. Such points do not have to be at fixed locations. It is advisable to pre-identify likely points that can best serve the installation population. If needed, construct distribution points in advance or expediently. Good drainage is necessary at every distribution point.

9.8.4. **Physical Protection.** Where topography permits, water treatment plants should not be located in areas subject to flooding. Protect treatment plants against flood threats by constructing permanent dikes in advance or by expediently building sandbag dikes. When preparing expedient measures, be sure to develop OIs that tell what to accomplish, where, by whom, and with what resources. It is also a good idea to create guidelines for starting and completing the preparations.

9.8.5. **Non-Potable Systems.** Normally, civil engineers would use non-potable systems for fire fighting and, on occasion, irrigation systems. They may either use the potable system as a source or derive their supply from sources that CE units could make potable, but choose not to treat. Deluge systems are usually located 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). The main reason for mentioning these systems is to make sure civil engineers inventory these supplies for emergency purposes.

9.8.5.1. In the case of deluge systems, engineers design the pumping facilities (equipped with backup power) into the system. Irrigation sources normally depend on electric power for pumping. In a power-out situation, that water is only available to fire fighting equipment, which has suction lift capability. System designs should positively separate all non-potable systems from potable systems using backflow prevention devices. This means you cannot easily inject that water into the installation distribution system even if you need it.

9.8.6. **Independent Systems.** Sometimes, units will use independent water systems to provide potable water to remotely located facilities. Two examples are ready alert crew quarters and offices in ammunition storage facilities. In most cases, independent systems need only a generator to ensure an uninterrupted supply of potable water. In extreme cases, potable water should be supplied over-the-road by tankers.

9.9. Central Heating System Preparations. A few AF installations have central heating plants, and some of those have more than one plant. The plants produce and circulate steam or hot water throughout the distribution system to points of use. Normally, at the point of use the steam or hot water gives up its heat to produce hot water and warm air. As steam gives up energy, the steam's temperature and pressure reduces until it condenses to water. A majority of this water, called condensate, returns to the plant in 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 replaced at the plant with treated water fed into the boiler. Civil engineers consider this process as Industrial Water Treatment, and refer to the product as make-up water. Hot water systems also have return lines.

9.9.1. **System Information.** Information on the installation's central heating systems is available in GeoBase data, the IDP, and included in the CE CRP.

9.9.1.1. Heating Plant Data. This information 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 system elements. For a plant, record the following data:

- Identification of each boiler—trade name, year built, year installed, type (water tube or fire tube), and size in total heat output (MBTU/hr.)
- Classification—high pressure (above 15 Pounds per Square Inch Gauge (PSIG) or high temperature hot water (HTHW) (above 160 PSIG or 350^{o}F)
- Type fuel and storage quantity
- Number of operating days possible with fuel amounts usually stored on base during winter
- Dual fuel capability (if applicable)
- Make-up water data—treatment process description, chemicals required for treatment and amount consumed, and normal stock levels
- The ratio of make-up water production capability to make-up water requirement
- Location, condition, and number of spares

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

9.9.1.3. 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 AF installation. However, 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. This is just one example. Still, installations can only achieve the full utility of redundant and backup opportunities if civil engineers assess and pre-identify the capabilities.

9.9.1.4. 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, civil engineers bury most distribution and condensate lines, 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 likely face two choices. Be forced to introduce untreated feed water (which will quickly destroy the boilers) or shut the boilers down.

9.9.1.5. 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 interruption occurs to the primary service path. Most steam and HTHW systems contain few alternatives for emergency back feed.

9.9.2. **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. Consider two factors when deciding to shut a system down.

9.9.2.1. 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 because of hostile action or accidental occurrence, operators cannot bring them back into full service for hours or even days.

9.9.2.2. Second, the potential of either system to contribute to secondary damage when interdicted is minor by comparison to electricity and gas. Thus, units should weigh the decision to shut down either type of system (as a precautionary action prior to attack or natural disaster) against the predictable effects of a long-term outage. Regardless, be sure to develop orderly and emergency shutdown procedures to protect the heating plant boilers should damage occur to the distribution or return system.

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

9.9.4. **Preparations for Other Plants.** Preparations for base-wide central heating plants are important. However, some AF installations have centralized cooling plants or combined heating/cooling plants installed in large buildings and facility groups. The proliferation of cooling plants and combined heating/cooling plants is due to on-going utility modernization efforts. The newer plants and systems are much more efficient than many existing systems and they create significant energy-saving opportunities. Similar to base-wide heating plants, contingency preparations for smaller, facility group plants can be equally important.

9.9.4.1. For example, an interruption in cooling service to facilities with vital computer operations can be extremely critical during an emergency since most computer systems do not operate very long without adequate cooling. Typical preparations may include:

- Incorporating protection in original design and installation

- Providing expedient protection for key system components for imminent threats
- Installing and documenting the location of isolation and shut-off valves and switches

9.10. 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, civil engineers should be prepared to isolate and back up this system.

9.10.1. **Engineering Facts.** Although, civil engineers routinely put gas distribution systems in the ground, portions of the system often extends above grade to manifold, valve, adjust pressure, and provide service. Below are some general engineering facts for gas distribution systems:

9.10.1.1. Commonly, distribution systems supply gas in three pressure ranges (**Table 9.3**).The lowest pressures are at the points of service and consumption. Where gas enters a building, it normally has pressure regulated at 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 adjustable to specific pressure ranges. Although this range is broad, the hazards of natural gas operations increase when system pressures vary significantly from the adjusted pressure.

9.10.1.2. 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 adjusted appliances accommodate a new low pressure, be sure to readjust appliances when the pressure is again increased. Pressures more than 50 percent above the appliance adjustment may cause carbon deposits, incomplete combustion, or flames blowing off the burners.

Table 9.3. Gas Pressure Ranges.

Pressure Level	Distribution Pressure Range
High Pressure (Greater than 50 Pounds per Square Inch (PSI))	This pressure range is not found in base distribution systems, but it may exist (up to 1200 psi) in transmission pipelines that cross AF 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 PSI

9.10.1.3. 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.

9.10.1.4. Because most natural gases are odorless, producers introduce unpleasant odors into the gas so personnel can readily detect its presence in the atmosphere. In the unlikely event, 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 sulfur compounds or sulfides with odors described as rotten, sour, putrid, meaty, metallic, and sulfurous.

9.10.1.5. Use only components designed and certified for gas service in gas distribution systems. Although 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.

9.10.2. **System Information.** Find most data for gas distribution systems and the central heating system in the IDP. Portions of the system data may also be included in the CE CRP.

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

- Amount of gas the supplier can provide
- Name and phone number of supplier's POC
- Location, description, and schematic of the receiving point
- Pipe sizes/materials and normal operating pressures

9.10.2.2. Distribution System. Gas system maps should 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. Record the following information on the map and amplify it in Annex P of the CE CRP.

9.10.2.2.1. 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).

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

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

9.10.2.2.4. 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 the installation, the base can often depend on the entity providing the service 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. **Note:** Focus the majority of the inventory investment in items such as low-pressure plugs, caps, connectors, valves, regulators, petcocks, sealants, and tubing.

9.10.2.3. 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 is available to an installation, or (2) the facility requiring gas service is remotely located from the central system. Service provided via a high-pressure tank where the gas remains in the liquid state. The gas leaves the tank via a valve and pressure regulator and flows by pipe to the point of use at low pressure.

9.10.2.3.1. Be sure to collect the following information:

- Location of independent systems, type of gas, and size of tank
- How long a full tank can support the facility
- Which systems are used to back up critical facility requirements

9.10.2.4. Transmission Pipelines. Transmission pipelines cross some AF property. While it does not happen often, such pipelines have ruptured or leaked. Be sure you have a POC who can quickly stop the flow of gas if such problems arise.

9.10.2.5. Critical Facility Requirements. If a critical function needs gas service, 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.

9.10.3. **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 is helpful. The only reasonable isolation procedure for individual gas systems is to turn the supply off at the tank.

9.10.3.1. It is simple to cut off gas service to an entire system or to any portion of the system with separate valves. In contrast, restoration of service to a segment of the system is both labor intensive and time-consuming. For example, engineers have to valve-off each individual facility at its service point prior to reintroducing pressure to the segment. Once the service main is pressurized, bring each facility back on line separately by first securing all appliances within the facility. Finally, place each individual appliance within the facility back into service by relighting and adjusting the pilot or checking electric/electronic pilots for proper operation.

9.10.3.2. 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; place all valves in the system in the “OFF” position. The best way to accomplish this is 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 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.

9.10.3.3. Consider the time and labor required to restore service before deciding to shut down or completely isolate the system for a threat that is not potentially explosive or incendiary. Units may need the time and labor for other recovery operations.

9.10.4. **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. Storage is invariably aboveground, as providers resupply individual container systems on a full-for-empty basis.

9.10.5. **Physical Protection.** When buried, the ground cover provides good protection for the gas system; there is little else to do reasonably to increase the system's protection. However, you can berm aboveground tanks positioned at facilities with critical gas requirements.

9.11. Liquid Fuel System Preparations. This may be the most important utility on the installation—certainly one with a flying mission. It is also unique among utilities because civil engineers "own" and maintain permanently installed systems, but the LRS operates it.

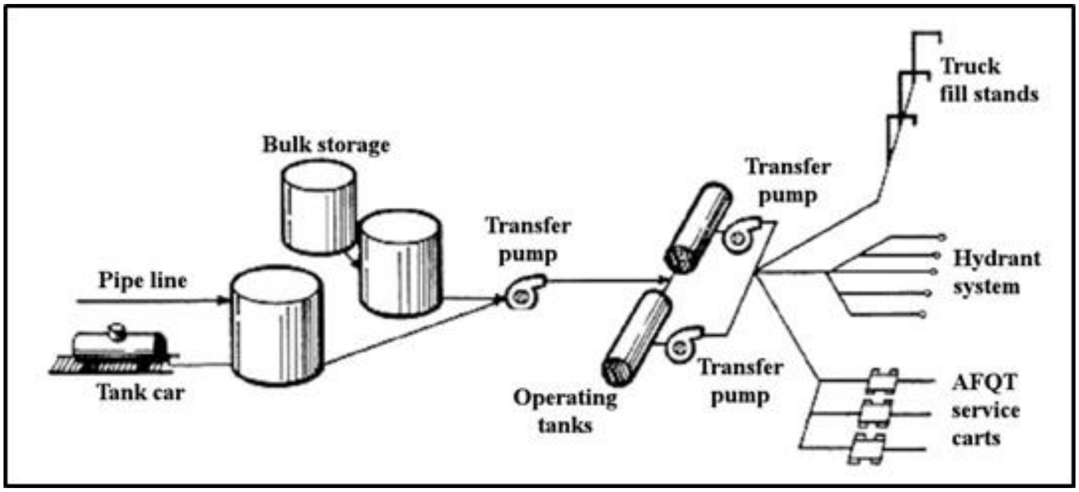
9.11.1. **System Information.** The IDP lays out the installation liquid fuels systems. Between the IDP and the information in the CE CRP, you should have the following information on storage, distribution, and vulnerability.

9.11.1.1. Storage and Distribution. Normally, installations receive bulk fuel products by either rail, barge or pipeline. The fuel is typically stored in a tank farm close to the point of receipt (**Figure 9.6**). If the tanks are some distance from the flight line where units dispenses most of the fuel, an underground pipeline system is often used to transport fuel to smaller tanks commonly called ready tanks. The fuel pumps from the ready tanks to a hydrant system or fuel specialists may move the fuel using refueling vehicles to aircraft, motor vehicles, and other users. The hazard presented by the different fuel products varies significantly.

9.11.1.1.1. Be sure to keep data concerning tank contents and transport line contents current. The fuels management officer should advise the BCE whenever there are changes to the fuel storage and distribution system. Record the following liquid fuels system information:

- Location, description, and schematic of the receiving points, pump stations, and hydrant systems
- Pipe sizes/materials and normal operating pressures
- Capacity and type of storage tanks
- Requirement, condition, and location of spares

Figure 9.6. Typical POL System.



9.11.1.2. 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 the system is important, most components are underground or are hardened at installations in Pacific Air Forces and USAFE. Power to run the system is a potentially vulnerable element.

9.11.2. **System Isolation.** Develop procedures so responding CE water and fuels systems maintenance or LRS fuels management personnel can cut off the flow of product to prevent or contain secondary damage, if system damage occur. 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 different system parts.

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

9.12. 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 that CE units should make. Sewage collection and treatment systems are designed for minimum operation and maintenance cost. Therefore, the majority of the system operation flows by gravity.

9.12.1. **Engineering Data.** To permit proper operation of gravity sewers, engineers maintain flow velocities in the pipe at greater than 2 feet/second and less than 8 feet/second. The amount 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).

9.12.1.1. Install lift stations where the collected wastes no longer flow with sufficient velocity to avoid settling of solids and stagnant conditions. Consider using lift stations when gravity-fed piping gets too deep for standard construction means, and thus needs elevating to a higher level. Lift stations can 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.

9.12.1.2. 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 pumps the wastewater either to a sewage treatment plant or to a regional collection system. All lift stations should have a source of alternate or backup power. Installations with operational Energy Monitoring and Control Systems may have a remote sensing capability installed to monitor continuous performance at lift stations.

9.12.1.2.1. 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 washed or blown into the system.

9.12.2. **System Information.** Data on the sanitary sewage collection and disposal system is in the IDP and recorded in the CE CRP (currently Annex P).

9.12.2.1. Collection System. Data for the collection system will likely 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. Consider recording the data elements concerning the system.

9.12.2.1.1. Gravity Flow Lines. It is only necessary to ensure 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.

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

9.12.2.1.3. 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.

9.12.2.2. 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.

9.12.2.2.1. As a final resort, when plant holding and equalization tanks are insufficient to contain the flow from the system, plants routinely have a bypass capability, which allows discharge of untreated effluent directly into a receiving body of water, or land application area.

9.12.2.2.2. Address any information concerning holding capacity and bypass discharge alternatives for a treatment plant in Annex P of the CE CRP. Therefore, decision-makers can make an informed decision to exercise one or more of these options in a contingency.

9.12.2.3. Regional Connections. Where regional connections to sewage collection and treatment systems exist, it has been AF 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 near 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.

9.12.3. **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 if damage occur to lines, force mains, or lift stations. Look for and identify alternate paths or means to route sewage 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.

9.12.4. **System Isolation and Backup.** There is 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.

9.13. Airfield Lighting System Preparation. Airfield lighting is a mission-critical support element of air operations. System information, operational and backup procedures, and repair considerations should be prepared in advance and included in the CE CRP.

9.13.1. **System Information.** The IDP and some component plans related to infrastructure should contain significant information related to airfield lighting systems. Gathered information may include the following:

9.13.1.1. 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 regulators control system elements.

9.13.1.2. Distribution System. Show the location of the distribution cables and control cables. Specify the lamp types and voltage.

9.13.1.3. Backup Sources. Show all locations for light controls. Identify where backup systems 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.

9.13.1.4. 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.

9.13.2. **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.

9.13.3. **Physical Protection.** Specify how the installation will protect vulnerable system elements. Give brief details on when to do the work and who is to do it.

9.13.4. **Repair Considerations.** List the location, type, and number of spare controllers and other items such as extra cable, lights, lenses, and bulbs.

9.14. Demand Reduction Preparation. While it does not happen often, there can be circumstances when an installation should quickly reduce utility consumption. 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 affecting mission-critical functions.

9.14.1. Achieve demand reduction 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 they can suspend. For many units, the temporary loss of utility service is annoying or potentially 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.

9.14.1.1. Civil engineers can help occupants in critical facilities by running separate circuits or lines to just the building's critical areas. Then building occupants can cut off all circuits except for the key circuit. Voluntary reductions are the least intrusive to the mission, but often ignored when new personnel—not involved in making the original plans—arrive on base.

9.14.1.2. 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 do not run out, which only worsens the problem.

9.14.2. When voluntary reductions do not 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 that 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 for service restoration, if necessary.

9.14.3. Develop a demand reduction plan in 10 percent increments. Identify specific actions which users should 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 specific CE unit actions for each increment (i.e., which circuits to cut, valves to turn, in what sequence, etc.).

9.15. Summary. The goal 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. These advanced measures include, preparing your OIs and execution checklists; documenting the procedures in the CE CRP so there is always a place to turn should the unit need information on the systems, and using execution checklists and practicing procedures periodically so each person in their respective utility shop can effectively respond to the unexpected. For more information on utility isolation, backup, and physical protection, consult the references listed in **Table 9.4**.

Table 9.4. Chapter 9 Quick Reference.

Utilities Isolation, Backup, and Redundancy Chapter References	
AFH 10-222V1	*Civil Engineer Bare Base Development*
AFH 10-222V11	*Contingency Water System Installation and Operation*
AFI 32-1062	*Electrical Systems, Power Plants and Generators*
AFI 32-7062	*Comprehensive Planning*
AFPAM 10-219V1	*Contingency and Disaster Planning*
AFPAM 10-219V3	*Civil Engineer Contingency Response and Recovery Procedures*
AFPAM 10-219V5	*Bare Base Conceptual Planning*
AFPAM 10-219V6	*Planning and Design of Expeditionary Airbases*
AFTTP 3-32.34V5	Contingency Electrical Power Production and Distribution Systems
ETL 13-4	*Standby Generator Design, Maintenance, and Testing Criteria*

Chapter 10

DISPERSAL

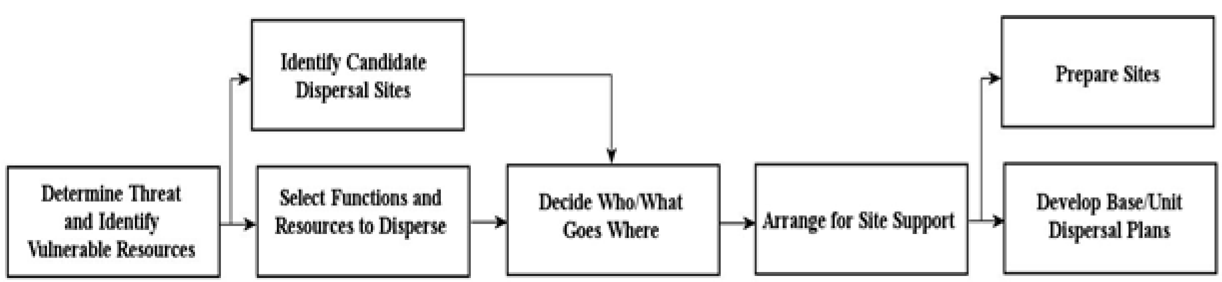
10.1. General Information. Dispersal is the separation or relocation of resources away from a potential threat, active hazard, or pending disaster, to increase survivability. It is a passive defense measure that can only be as effective as the operational environment, terrain limits, and available resources will permit. Dispersal has a role in the CONUS and OCONUS, from austere to enduring bases. When possible, incorporate dispersal into everyday installation operations through intelligent facility siting. In fact, planners routinely incorporate dispersal into base comprehensive planning and when siting new construction.

10.1.1. Engineers have been incorporating permanent dispersal, to varying degrees, for years at overseas bases. This chapter examines expedient measures for protecting important base assets from a pending disaster or wartime threat by temporarily relocating them. Temporary dispersal has one big advantage over other protective measures. If you have only limited warning, it is the quickest and easiest to do. As with all protective measures, the more warning you have the more effective and complete it can be. Of course, when moving assets out of harm's way, dispersal may move them away from operators, maintainers, and potential clients.

10.1.2. Because dispersal is an installation-wide effort, all units should provide inputs to each step. The following paragraphs address basic temporary dispersal preparations. Refer to AFI 10-404, BSP/ESP, IEMP 10-2, and the unit CE CRP for additional information regarding dispersal methods and procedures.

10.2. Planning and Preparing for Dispersal. Effective temporary dispersal depends upon the circumstance dictating dispersal and the location of dispersed resources. 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 addressed in the following paragraphs and illustrated in **Figure 10.1**, seven steps are involved in planning and preparing for resource dispersal.

Figure 10.1. Dispersal Planning and Preparation Flowchart.

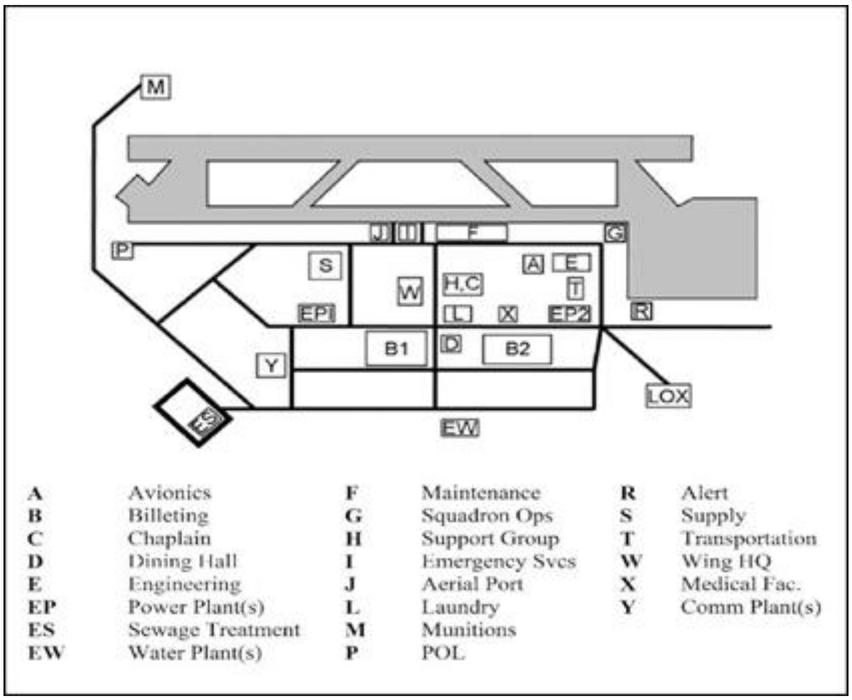


10.2.1. **Determine the Threats and Identify Vulnerable Resources.** As used here, a threat can be manmade, a natural disaster, or an enemy attack. Each installation should decide what threats it faces and which resources are vulnerable for each threat.

10.2.2. **Identify Which Resources and Functions to Disperse.** Usually, these are the high-value or critical mission and support assets not protected by other measures. Each unit should identify key resources to disperse for each threat and outline their planned dispersal priority. 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 adequate shelter is not available for everyone. Key elements of the installation should be located to properly conceal and protect them from ground attack. No two bases have exactly the same requirements; therefore, each base should carefully evaluate needs and assign dispersal priorities.

10.2.2.1. Base planners should consider the factors in the following paragraphs and the actual base layout pattern when determining which resources and functions to disperse. **Figure 10.2** illustrates a conceptual base layout pattern.

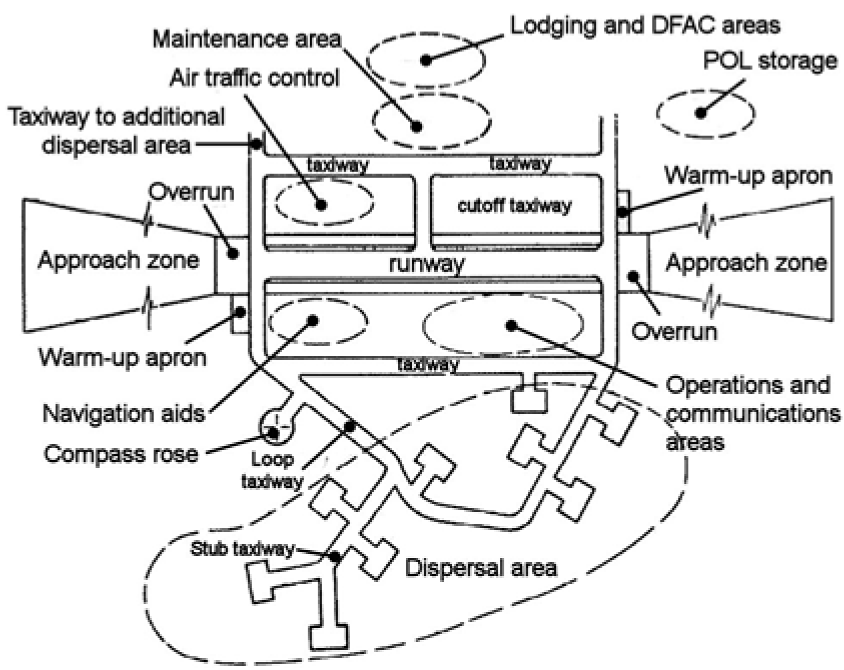
Figure 10.2. Conceptual Base Layout Pattern.



10.2.2.2. Aircraft. When aircraft are not sheltered or behind revetments, random dispersal of parked aircraft increases their survivability during an attack. When attacked by aircraft dropping general purpose bombs, the survivability rate increases two to four times when aircraft usually parked at 50-foot separations are dispersed to irregular parking with minimum separations of 300 feet. The additional separation can eliminate sympathetic explosions during an airfield attack. Dispersing aircraft also limits the possibility of an attacking aircraft destroying multiple aircraft on the ground with a single pass, thus creating vulnerabilities for enemy aircraft making repeated attacks to destroy dispersed aircraft.

10.2.2.2.1. An aircraft dispersal plan should consider operational requirements, maintenance, installation security, existing parking areas, and the availability of real estate for additional aircraft parking. At some installations, airfield pavements already incorporate dispersed aircraft parking areas (**Figure 10.3**). Other locations may require the construction of additional airfield pavements (taxiways and hardstands) to accommodate ground dispersal of aircraft.

Figure 10.3. Conceptual Airfield Layout with Dispersed Aircraft Parking.



10.2.2.3. Generators. Base power generating plants should be located in a minimum of two separate areas (see **Figure 10.2**). 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.

10.2.2.4. Munitions. Maximum separation between explosives and other resources reduces accidental or deliberate detonation of stored munitions. Consider dispersing explosives into small compatible groups. Ammunition should not be located near an installation perimeter where small arms fire can easily damage exposed ammunition. Consider splitting key storage or other munitions operations into sub-operations. See AFMAN 91-201 for specific explosives storage and safety requirements.

10.2.2.5. POL. Fuel should not be stored on the perimeter of an area where it is vulnerable to small arms fire.

10.2.2.6. Vehicles and Heavy Equipment. Avoid pooling motor vehicles. Consider parking motor vehicles under or beside trees, next to earthen embankments, or behind buildings to provide partial concealment as well as dispersal. The "harder" the structure—the better, but not if structures are likely to be targeted by the enemy.

10.2.3. **Select Candidate Dispersal Sites.** Survey and identify dispersal 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 dispersal sites as part of the CE CRP. When planned for use during hostile attacks, locate dispersal sites away from high-threat areas of the installation and provide concealment and protection from attacking forces.

10.2.3.1. 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 that need the least amount of advance preparation. Sites with in-place facilities, utilities, and communications are ideal if they are not visible and considered as targets in their own right. Avoid recommending sites where radio contact with the base is not possible. Ideally, each site should have pavement for parking vehicles or the soil should be capable of supporting fully loaded, wheeled vehicles during wet weather.

10.2.3.2. Adequate security is required for sites with mission-critical or high-value items. Some examples of areas to consider as possible dispersal locations include:

10.2.3.3. Aircraft Hangars. Commanders often relocate base aircraft to other installations under certain conditions, such as a hurricane evacuation or flying unit deployment. At such times, you may be able to use empty hangar facilities for dispersal and protection of some equipment. If hangar doors operate electrically, ensure there are alternative procedures to open them during power outages. Keep in mind hangars may be prime targets during wartime.

10.2.3.4. 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. Make alternate communications arrangements if hardened structures interfere with radio communications. In peacetime, munitions bunkers can shield vehicles and equipment from the effects of high winds if units place the vehicles and equipment close enough to the bunker.

10.2.3.5. Base Housing. When expecting hostilities in overseas areas, military dependents should be relocated stateside, time permitting. Vacant base housing units can then be potential dispersal areas for personnel as well as beddown facilities for incoming forces.

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

10.2.3.7. Recreation Halls/Gymnasiums. The installation can also use large base structures such as recreation halls and gymnasiums during emergencies as temporary dispersal points for personnel. Carefully evaluate these facilities to ensure they provide adequate protection from the anticipated threat.

10.2.4. **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.

10.2.4.1. Consider dispersing Airfield Damage Assessment Teams (ADAT) to locations with quick access to airfield pavements; their quick reaction will be critical to implementation of the ADR process. Also, disperse ADR equipment and materials to at least three separate sites. When selecting dispersed shelters for damage assessment response teams (DART), ensure each team is able to maintain communications with the UCC either by landline or by 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 should the enemy attack one or more shelters.

10.2.4.2. If there is a choice of shelters for the DARTs, choose shelters closest to the UCC. This eases reassembly of teams and subsequent flow of information to the teams from the UCC. Try not to overload a dispersal site.

10.2.5. **Arrange for Support Needed at Each Site.** Depending on circumstances, dispersal sites may need certain services, facilities, utilities, and communications. 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. Consider forming work details from each dispersed unit to provide services such as obtaining water, digging latrines, erecting tents, removing refuse, and operating the CCA.

10.2.5.1. 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 should determine its own priorities for providing this support. As a minimum, consider the following items and provide for them in dispersal plans.

10.2.5.2. 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.

10.2.5.3. 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, arrange to have these items pulled from the unit's mobility gear storage, 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.

10.2.5.4. Food. Individuals should carry enough 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.

10.2.5.5. Water. Individuals should disperse with full canteens or bottled water. Water should 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.

10.2.5.6. Electrical Power. Arrange for generator power and limited distribution for the few dispersed functions needing power.

10.2.5.7. Fuel Storage and Dispensing Points (vehicle/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. Potentially, that same truck can also 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 should be stored away from shelters and other resources to minimize the explosive hazard.

10.2.5.8. Sanitation (Latrines and Refuse Collection). Each site should 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.

10.2.5.9. Vehicle Maintenance. If necessary, request 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 T.O.s for special equipment.

10.2.5.10. Communications. Normally, units do not disperse skilled personnel with critical equipment and valuable materials to an area and leave them to operate on their own. To use these forces effectively, command personnel should maintain communications with dispersal sites. Keep dispersed forces informed of conditions at the base and so they are ready to respond. If a dispersal site is permanently established, consider installing a landline 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, consider using a radio network.

10.2.5.10.1. If necessary, use other communications measures including runners, signal flags, and signal lights. Most communication methods are acceptable, so long as the message received is the same as the one sent. If signals are used, their meanings should be prearranged and simple. If necessary, use intermediate locations to relay messages; another dispersal site closer to the main base could serve this function.

10.2.5.10.2. When making plans, the base should decide who maintains contact with dispersed forces: the CAT, the EOC, or UCCs for their own personnel. For multiple on-base sites, UCCs can usually perform a better job. At off-base sites with multiple organizations, the CAT or the EOC may elect to maintain communications and provide direction.

10.2.5.11. Transportation. Make decisions on how to move personnel, vehicles, and equipment. 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. For long-term dispersal, consider setting up a base shuttle to run scheduled routes.

10.2.5.12. 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 should be set up, manned, and operated. Consider assigning responsibility for these tasks 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, up to three CCA teams may be required. Decide who will set up the CCA and who will supervise the CCA teams. See AFMAN 10-2503 for guidance on CCA set up. Plans should specify who will obtain, store, and maintain CCA equipment and materials.

10.2.5.13. Security. At on-base sites, units should expect to provide security for their own assets. This does not mean guarding the assets on a full-time basis; each installation and situation is different. CE units should work out details with SF. 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.

10.2.5.13.1. Resources available from base SF, US Army units, or host nation SF determine the level of protection available to dispersed assets. CE units and other units at the dispersal site may need to assist SF.

10.2.6. **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 to disperse and how dispersal is accomplished.

10.2.6.1. 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 C2 structure. When dispersing more than one unit 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 C2 structure, especially for off-base sites, to control the initial chaos and to direct site operations during extended stays. It is reasonable to expect the senior ranking person will be in charge.

10.2.6.1.1. 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, and hardening, and CCA operations. Do not advertise locations of wartime off-base dispersal sites. Keeping them a secret may be impossible, but do not draw attention to them. Have enough alternate sites so you can keep an enemy guessing where you might be. Avoid using planned locations when exercising dispersal plans. Use less favorable sites.

10.2.6.1.2. If dispersal plans are to another installation or location far from the home base, convoys or other mass transportation efforts may have to be scheduled.

10.2.6.2. 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 which shop 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. Personnel may drive powered equipment to dispersal sites on base; transport other equipment by truck or similar vehicle, and personnel may physically carry smaller pieces of equipment and materials. To the greatest extent possible, disperse resources by teams.

10.2.6.2.1. 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 units move the most important assets first.

10.2.6.2.2. 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.

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

10.2.6.2.4. 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.

10.2.6.2.5. When dispersed, use available natural and manmade 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.

10.2.7. **Prepare Dispersal Sites.** This is the last step. With good site selection and limited site support, units can minimize advance preparations. Units should make good use of their time after dispersal by making improvements to shelters and other facilities at their dispersal sites. In the case of wartime dispersal, improve dispersal sites by employing CCD measures, supplemental protection, and hardening.

10.3. Hasty Planning and Preparations. Ideally, units can accomplish dispersal planning during the leisure of peacetime, but they cannot foresee every contingency. 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 to use to keep all unit personnel informed. Ensure all personnel understand how to accomplish the dispersal when dispatched. Ideally, each vehicle group traveling between the installation and a dispersal site should have at least one working radio.

10.4. CONUS CE Dispersal Guidance. A CONUS BCE’s primary use of dispersal measures is for natural disasters—to get personnel and priority assets out of harm’s way. Some installations support relocation or dispersal associated with survival, recovery, and reconstitution operations.

10.4.1. **On-Base Dispersal.** When establishing CONUS on-base dispersal sites, identify resources for pre-positioning at the locations to save time during dispersal. Materials not having 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 dispersal force vehicles can continue to operate if damage or destruction of main fuel storage facilities occur. If personnel relocate to the dispersal site for an extended period, utilities, billeting, and food service will be required.

10.4.2. **Dispersal to Other Military Installations.** If the CE unit is required to disperse resources to another installation during an emergency, the unit considers numerous details. Transportation arrangements are a primary concern. When reasonable distances are involved, a truck convoy may constitute the best method. Qualified personnel should supervise convoy loading and movement. 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 overload with military and civilian traffic.

10.4.2.1. Try to follow sound convoy procedures. 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. Assess communications capabilities to ensure the installation can maintain contact with the dispersing force throughout the movement and subsequent stay at the dispersal site.

10.4.3. **Dispersal to Civilian Locations.** If a situation arises where this type of dispersal becomes necessary under peacetime conditions, the BCE establishes close coordination with local property owners and civilian government officials. Units obtain property owner approval and CE personnel should carefully document any property damage caused from 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.

10.4.3.1. Consider dispersal to civilian locations only after careful consideration of on base and other military base alternatives.

10.5. Overseas CE Dispersal Guidance. An overseas BCE uses dispersal for many of the same reasons as a CONUS BCE. However, in addition to dispersal in the face of a natural disaster, the overseas BCE considers dispersal to protect resources from WMD attacks. Forces at a base overseas may disperse to a remote location on base, to another contingency location, or to a civilian location.

10.5.1. **On-Base Dispersal Locations.** Overseas civil engineers, like their CONUS counterparts, should select locations on the main base providing optimum protection against any foreseeable disaster. An area of difference is protection against WMD attacks. Overseas installations are more vulnerable to WMD attacks than CONUS locations; therefore, give emphasis to selecting multiple dispersal sites removed from likely installation target areas. Dispersal locations located away from prime target areas such as runways, C2 centers, POL facilities, and munitions storage areas, contribute to the preservation of resources during an attack.

10.5.1.1. After identifying these sites, develop physical protection methods (i.e., contamination, blast, and splinter) for each location as further resource protection. FES should be located in close proximity to the operational infrastructure and given special consideration for dispersal locations, concealment, and physical protection.

10.5.2. **Dispersal to Allied Installation.** An allied installation is sometimes used to beddown augmenting forces. Close coordination with the host installation agencies is a primary requirement during any dispersal to an allied base. An important aspect of dispersal to allied base is the cultural, procedural, and language differences CE personnel should overcome.

10.5.3. **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 should 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 host government representatives.

10.5.3.1. It is probably best to leave negotiations with foreign property owners to members of the host government.

10.5.4. Sometimes, temporary dispersal may not be the chosen course of action in response to an attack or peacetime disaster. If the situation warrants, an evacuation may be ordered. Units often accomplish personnel evacuation to prevent injury. They also conduct limited area evacuations for accidents, criminal activity, terrorist attacks, and other localized incidents. Conversely, base evacuations are large-scale relocations typically implemented for natural disasters and non-combatant evacuation operations prior to an enemy attack.

10.5.4.1. Since specific CE preparations and execution tasks for limited area and base evacuations are different for each installation, mission, situation, and location, personnel should follow instructions in the BSP/ESP, IEMP 10-2 and CE CRP.

10.6. Summary. As you can see, temporary dispersal can be an expedient and relatively inexpensive method to protect personnel and other important installation assets from the effects of a disaster or enemy attack. Even though some advance warning is required for mobilization, with good preparations, units can efficiently initiate and complete dispersal actions whenever the order is given. For additional information on dispersal information and preparations addressed in this chapter, consult the references listed in **Table 10.1**.

Table 10.1. Chapter 10 Quick Reference.

Dispersal Chapter References	
AFI 10-404	*Base Support and Expeditionary (BAS&E) Site Planning*
AFMAN 10-2503	*Operations in a Chemical, Biological, Radiological, Nuclear, and High-Yield Explosive (CBRNE) Environment*
AFMAN 91-201	*Explosive Safety Standards*

Chapter 11

BASE DENIAL PREPARATIONS

11.1. General Information. According to JP 3-34, base denial is the removal of resources from a threatened area, rendering resources unusable by fire or explosives, removal of parts, contamination (other than by nuclear, biological, or chemical means), immobilizing, and partially or totally destroying military equipment, supplies or infrastructure. Enemy action may force implementation of base denial, or it may be a voluntary, preplanned event. Regardless, Prime BEEF forces should be prepared to inflict damage to a base and deny its use.

11.1.1. In CE contingency response planning, base denial is an overseas theater task. It can become a CE task when the GCC directs base evacuation and the destruction of selected air base systems, military equipment, and supplies. The BCE usually prepares in advance, a list of candidate targets in preparation for base denial operations. Denial of air base infrastructure, for the large part, will likely be a CE unit responsibility. If available, EOD personnel can 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.

11.1.2. For MOB civil engineers, denial responsibilities usually include all militarily significant CE supplies and equipment, base facilities and utilities, and the airfield pavement system. For HN bases and initial contingency locations, civil engineers normally consider only AF organic equipment since real property facilities and utility systems are a HN responsibility. This chapter provides a brief review of conventional base denial preparations and methods at deployed locations, it does not address denial operations at captured locations or specially identified targets—these types of missions are normally RHS tasks and will generally have a narrower scope of activity.

11.2. 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 most US Airmen. However, modern warfare and the forward locations of many air bases now make the requirement for base denial a possibility. Engineer forces should 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. Base denial actions are not haphazard events—they require considerable preplanning and everyone's support to carry them out effectively.

11.2.1. If planning to accomplish destruction using explosive demolition, ensure the responsible unit has forecasted, obtained, and properly stored the suitable types and amounts of explosives.

11.2.2. The GCC describes the policy and extent to which units will carry out denial operations. Denial of key installations and facilities is desirable in most situations. However, theater planners integrates selected denial targets into the overall strategic and tactical concepts of the theater operations plan and executes IAW war objectives. Actual denial activities should not start until directed by the installation commander who carefully considers the possible negative impacts of allowing the enemy use of the air base. Commander also consider possible future use of the air base by US forces.

11.2.3. Taking it with you when you leave (evacuation) is the preferred method of denial. Units should use this option when conditions permit; if not, deny abandoned assets to the enemy.

11.2.4. Targets for base denial can come in many forms and one should 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. 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 labor 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.

11.2.4.1. Targets for base denial could include heavy equipment, fuel supplies, key buildings, utility substations, airfield pavements, and classified materials, to name a few. In addition, 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:

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

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

11.2.5. After choosing installation targets meeting the above criteria, place them in a priority sequence for denial actions. This priority listing is important since time will probably be limited for base denial activities, and units should perform the most crucial actions first (i.e., those actions that cause the greatest degree of resource denial). The priority listing should 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, be sure to avoid destroying fuel stores before fully servicing evacuation vehicles.

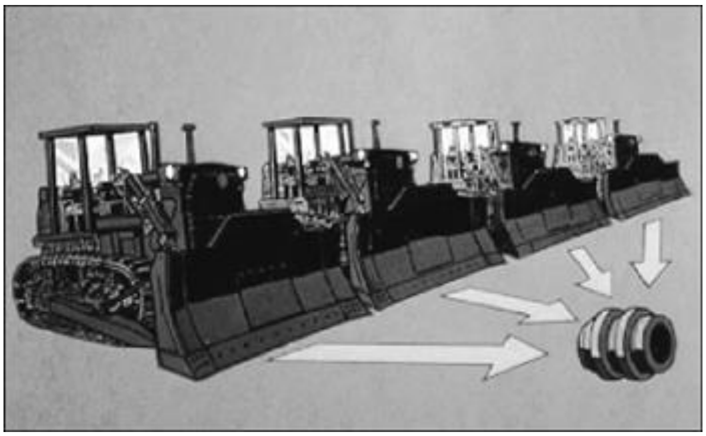
11.2.5.1. Also, recognize that traffic routes used by other denial teams could be blocked, or power could be cut off to those facilities used to marshal and prepare equipment and supplies for evacuation.

11.3. Conventional Base Denial Preparations. 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, prepare to use procedures that give the most rapid results with the least amount of effort.

11.3.1. **Item Evacuation.** Always consider 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 base's inventory. Further, it provides transportation for personnel and a means of relocating critical supplies away from the air base. Since time will always constrain evacuation operations, and the fact that many agencies could be potentially involved in the process, base denial should follow a thoroughly developed and well-rehearsed plan. Most evacuation efforts should be started early in the process and follow a preplanned schedule because of the logistics involved (fueling, marshalling, loading, etc.).

11.3.2. **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 (e.g., engines) that renders the item or equipment completely 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 11.1**). Lastly, do not forget to pick up any similar spares from bench stocks and supply points.

Figure 11.1. Remove Like Components to Prevent Cannibalization.



11.3.3. **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 trained in the use of explosive materials for demolition purposes, such as EOD and RED HORSE personnel.

11.3.3.1. Although part of the installation's CE complement, these personnel may be heavily tasked supporting other installation agencies and only able to provide limited help in the CE portion of base denial efforts. The use of conventional, non-explosive methods of base denial remains the BCE's primary means of accomplishing the base denial mission. As part of the installation denial plan, be sure to identify and prioritize any items or facilities requiring denial by explosive demolition. This allows denial teams to pre-develop a plan that addresses safety and logistics of acquiring the required explosives.

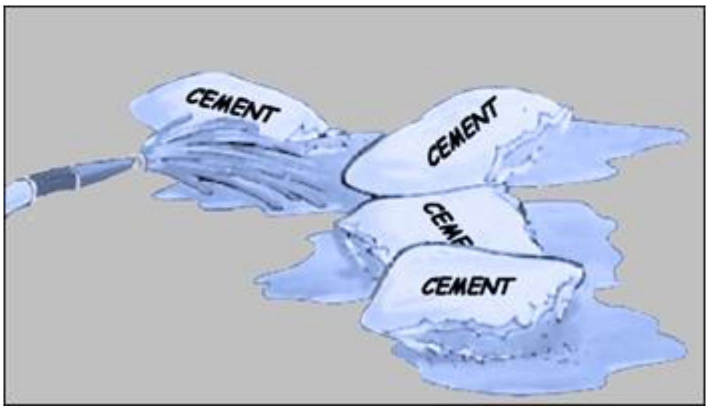
11.3.3.2. Fire. Destruction by fire is a good destruction technique for a wide range of materials and equipment. Denial teams may use heat in a selective fashion to deform or warp items that will not burn, bringing about dysfunction. Relatively thin gauge ferrous metals are often excellent candidates for this procedure. Even though fire seems from outward appearances to be an ideal way of destroying facilities, this is not always the case.

11.3.3.2.1. Modern building codes have brought about the development of a large variety of highly fire-resistant building materials. Some less combustible materials may require thorough saturation with fuel in order to ensure ignition. As a result, it is always a good approach to consult the fire department when considering any destruction by fire.

11.3.3.2.2. A final possible negative point to consider when selecting fire as a destruction method is the smoke normally generated from large burning activities can serve to announce withdrawal intentions to an enemy.

11.3.3.3. Water Soaking. Water can also be an effective means to damage many valuable assets. Unlike burning, a great advantage of using water is you can do it quietly without revealing telltale signs of withdrawal intentions to an enemy. It is an excellent way of destroying electrical components; however, use extreme caution to avoid electrocution when dealing with energized circuits. Using water is also an option to contaminate a number of substances such as petroleum fuels. In addition, denial teams can easily ruin many dry construction materials, such as cement, by simply drenching them with water (**Figure 11.2**).

Figure 11.2. Using Water to Ruin Bags of Cement.



11.3.3.4. Mechanical Destruction. This is another means to destroy assets without revealing withdrawal intentions to an enemy. Sledgehammers, axes, and wrecking bars are common tools of choice for this destruction technique.

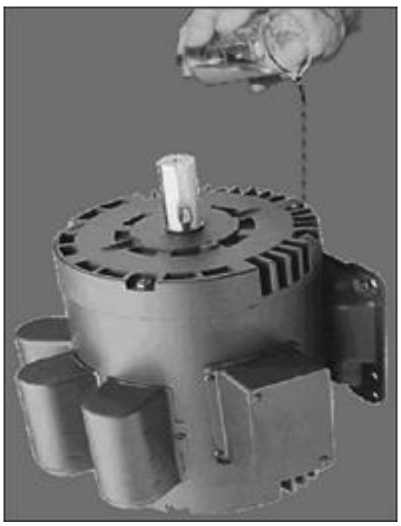
11.3.3.4.1. More often than not, denial teams will conduct mechanical destruction in a very selective manner rather than on a random basis. Key components of an item of equipment such as control devices and gauges are usually places of emphasis. A cutting torch can also be a useful tool when used judiciously. 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.

11.3.3.4.2. Although less common, methods of large-scale, mechanical destruction can at times prove to be highly effective as well. Especially in situations when large quantities of equipment or materials should be destroyed or rendered inoperable expediently. In such situations, consider using heavy equipment to crush items on a massive scale. In addition, burial may also be an excellent way of denying a resource to an enemy, yet still allow its recovery by friendly forces at a future time.

11.3.3.4.3. On the average MOB, numerous systems and equipment items require lubricants or coolants for proper operation. Denial teams can make reciprocating engines dysfunctional by simply draining vital fluids and allowing the engines to run until they overheat and seize-up. Similarly, you can quickly ruin electrical distribution transformers by draining their cooling oil while leaving the system energized. Lastly, the use of caustic substances such as sulfuric and nitric acid may provide yet another useful means of denial by destruction, particularly when applied to electrical motors and electrical components (**Figure 11.3**).

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

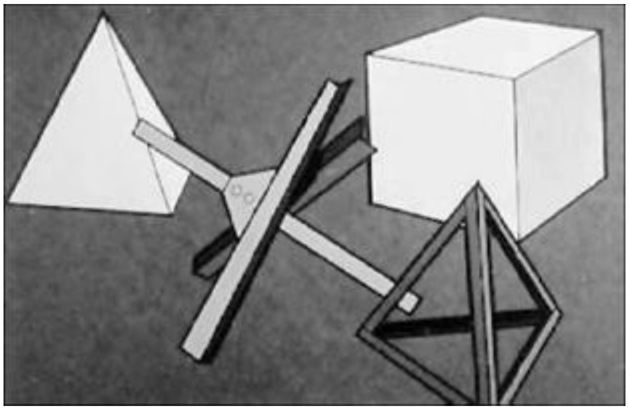
Figure 11.3. Caustic Fluid Destruction.



11.3.4. **Obstacles.** Thus far, this section has addressed evacuation, component removal, and destruction as denial methods. Using obstacles is another way to deny the use of certain facilities and resources by an enemy. Obstacles may be either natural or artificial. Due to the layout of most air bases, the construction of artificial obstacles such as those illustrated in **Figure 11.4** could be your primary focus. Barbed wire entanglements are also effective personnel obstacles. 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.

11.3.4.1. See **paragraph 7.8** for a review of other constructed obstacles. Check with SF 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 11.4. Typical Obstacles.



11.4. Summary. The execution of base denial measures may be a response to enemy action, or it may be a voluntary, preplanned event. In either case, base denial is a way to prevent or hinder enemy occupation and use of the airfield complex, its ancillary facilities, and residual resources. CE base denial teams at overseas theater bases prepare to implement denial measures according to denial plans and command direction. For specific CE base denial responsibilities and procedures, refer to AFPAM 10-219, Volume 3.

JOHN B. COOPER, Lieutenant General, USAF
DCS/Logistics, Engineering and Force Protection

Attachment 1

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Prescribed Forms

No prescribed forms are implemented in this publication.

Abbreviations and Acronyms

ADAT—Airfield Damage Assessment Team

ADR—Airfield Damage Repair

ADVON—Advanced Echelon

AF—Air Force

AFCEC—Air Force Civil Engineer Center

AFDA—Air Force Doctrine Annex

AFH—Air Force Handbook

AFI—Air Force Instruction

AFIMS—Air Force Incident Management System

AFMAN—Air Force Manual

AFPAM—Air Force Pamphlet

AFPD—Air Force Policy Directive

AFRIMS—Air Force Records Information Management System

AFS—Air Force Specialty

AFTTP—Air Fore Tactics, Techniques, and Procedures

AGE—Aerospace Ground Equipment

AL—Air Lock

AT—Antiterrorism

ATP—Army Techniques Publications

BCE—Base Civil Engineer

BDOC—Base Defense Operations Center

BEAR—Basic Expeditionary Airfield Resources

BSP—Base Support Plan

BTU—British Thermal Unit

C2—Command and Control

CAT—Crisis Action Team

CBRN—Chemical, Biological, Radiological, and Nuclear

CCA—Contamination Control Area

CCD—Camouflage, Concealment, and Deception

CCDR—Combatant Commander

CCMD—Combatant Command

CE—Civil Engineer

CFR—Code of Federal Regulations

CIP—Common Installation Picture

CO2—Carbon Dioxide

COLPRO—Collective Protection

COMSEC—Communications Security

CONUS—Continental United States

COP—Common Operational Picture

COTS—Commercial Off-the-Shelf

CPP—Comprehensive Planning Process

CRP—Contingency Response Plan

DART—Damage Assessment Response Team

DBT—Design Basis Threat

DFAC—Dining Facilities

DOD—Department of Defense

DRF—Disaster Response Force

EAID—Equipment Authorization Inventory Data

ECC—Emergency Communications Center

ECP—Entry Control Point

EM—Emergency Management

EOC—Emergency Operations Center

EOD—Explosive Ordnance Disposal

ESF—Emergency Support Function

ESP—Expeditionary Site Plans

ET—Effective Temperature

ETL—Engineering Technical Letter

FAX—Facsimile

FES—Fire Emergency Services

FEMA—Federal Emergency Management Agency

FOB—Forward Operating Base

FOUO—For Official Use Only

FP—Force Protection

FPCON—Force Protection Condition

FU—Filter Unit

GCC—Geographic Combatant Commander

GPH—Gallons per Hour

GTA—Graphic Training Aid

HAZMAT—Hazardous Material

HN—Host Nation

HTHW—High Temperature Hot Water

HURCON—Hurricane Condition

IAW—In Accordance With

IC—Incident Commander

ID—Integrated Defense

IDP—Installation Development Plan

IEMP—Installation Emergency Management Plan

IPE—Individual Protective Equipment

IR—Infrared

JP—Joint Publication

kW—Kilowatt

LNG—Liquefied Natural Gas

LPG—Liquefied Petroleum Gas

LRS—Logistics Readiness Squadron

MAOS—Minimum Airfield Operating Surface

MAJCOM—Major Command

MBTU—One Million British Thermal Units

MILDEC—Military Deception

MISCAP—Mission Capability

MOB—Main Operating Base

MOPP—Mission-Oriented Protective Posture

NATO—North Atlantic Treaty Organization

NBC—Nuclear, Biological, and Chemical

NSN—National Stock Number

OI—Operating Instruction

OCONUS—Outside Continental United States

OPLAN—Operation Plan

OPR—Office of Primary Responsibility

OSHA—Occupational Safety and Health Administration

POC—Point of Contact

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

RHS—RED HORSE Squadron

ROWPU—Reverse Osmosis Water Purification Unit

RPIE—Real Property Installed Equipment

R&EM—Readiness and Emergency Management

SF—Security Forces

SMT—Shelter Management Team

STANAG—Standardization Agreement (used in NATO)

SWA—Southwest Asia

TFA—Toxic-Free Area

T.O.—Technical Order

UCC—Unit Control Center

UFC—Unified Facilities Criteria

ULCAN—Ultra-Lightweight Camouflage Net

US—United States

USAF—United States Air Force

USAFE—United States Air Forces in Europe

UXO—Unexploded Explosive Ordnance

WMD—Weapons of Mass Destruction

WRM—War Reserve Materiel

Terms

Airbase 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 Center (AFCEC)—Headquartered at Joint Base San Antonio-Lackland, AFCEC is a 1,900-person primary subordinate unit, assigned to Air Force Materiel Command and attached to the Air Force Installation and Mission Support Center, responsible for providing responsive, flexible full-spectrum installation engineering services. AFCEC missions include facility investment planning, design and construction, operations support, real property management, readiness, energy support, environmental compliance and restoration, and audit assertions, acquisition and program management. The unit conducts its operations at more than 75 locations worldwide.

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.

Base—A locality from which operations are projected or supported, or an area or locality containing installations which provide logistic or other support.

Base Defense—The local military measures, both normal and emergency, required to nullify or reduce the effectiveness of enemy attacks on, or sabotage of, a base, to ensure that the maximum capacity of its facilities is available to US forces. (JP 1-02)

Base Defense Forces—Troops assigned or attached to a base for the primary purpose of base defense and security as well as augmentees and selectively armed personnel available to the base commander for base defense from units performing primary missions other than base defense.

Base Defense Operations Center—A command and control facility, with responsibilities similar to a base cluster operations center, established by the base commander to serve as the focal point for base security and defense. It plans, directs, integrates, coordinates, and controls all base defense efforts. Also called BDOC.

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—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.

Base Support Plan (BSP)—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 In-Garrison Expeditionary Site Plan (BSP). All plans formerly called BSP will be re-designated BSPs. The term BSP describes all plans developed to meet deliberate planning requirements, contingency planning requirements, and any other site planning requirements.

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.

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. The CBRN Control Center manages SMTs, Contamination Control Area, and Contamination Control Team operations and supports installation warning and reporting and operations with United States, joint service, coalition and host nation forces.

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

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.

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.

Common Installation Picture—A high-fidelity base map for an installation, including facilities and infrastructure that are typically viewed for reference by all functional communities. Also called CIP.

Common Operational Picture—A single identical display of relevant information shared by more than one command that facilitates collaborative planning and assists all echelons to achieve situational awareness. Also called COP.

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.

Comprehensive Planning Process (CPP)—The ongoing, iterative, participatory process addressing the full range of issues affecting or affected by an installation's development. Through this process, goals and objectives are defined, issues are identified, information is gathered, alternative solutions are developed, and a sound decision-making process is employed to select a preferred alternative for implementation (AFI 32-7062).

Construction and Barrier Materiel (Class IV)—A supply category that includes materials that support fortification, obstacle and barrier construction, and construction materiel for base development and general engineering. (DODD 5101.12E)

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.

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

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

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.

Denial Measure—An action to hinder or deny the enemy the use of territory, personnel, or facilities to include destruction, removal, contamination, or erection of obstructions. (JP 1-02)

Design Basis Threat.—The threat against which buildings and other structures must be protected and upon which the protective system's design is based. Also called DBT.

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), Base Defense Operations Center (BDOC), and Medical dispatch (when applicable).

Emergency Operations Center (EOC)—The physical location at which the coordination of information and resources to support incident management (on-scene operations) 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 (e.g., fire, law enforcement, medical services), by jurisdiction (e.g., Federal, State, regional, tribal, city, county), or by some combination thereof. (NIMS)

Emergency Support Function (ESF)—A grouping of government and certain private-sector capabilities into an organizational structure to provide the support, resources, program implementation, and services that are most likely to be needed to save lives, protect property and the environment, restore essential services and critical infrastructure, and help victims and communities return to normal, when feasible, following domestic incidents. Also called ESFs. (JP 1-02)

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. (JP 3-34)

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.

Geospatial Information—Information that identifies the geographic location and characteristics of natural or constructed features and boundaries on the Earth, including: statistical data and information derived from, among other things, remote sensing, mapping, and surveying technologies; and mapping, charting, geodetic data and related products. (JP 2-03)

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.

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—An occurrence, caused by either human action or natural phenomena, that requires action to prevent or minimize loss of life, or damage, loss of, or other risks to property, information, and/or natural resources.

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.

Initial Contingency Location—A contingency location occupied by a force in immediate response to a named or unnamed contingency operation and characterized by austere infrastructure and limited services with little or no external support except through Service organic capabilities. (DODD 3000.10)

Installation Development Plan (IDP)—The document that provides the installation commander and other decision-makers a condensed picture of an installation's capability to support the mission with its physical assets and delivery systems. It is a general assessment of the installation’s infrastructure and attributes for the purpose of gauging development potential (AFI 32-7062). The Installation Development Plan is a combined plan that integrates all the installation’s Area Development Plans, Illustrative Plans, and Regulating Plans into one consolidated plan. The IDP also includes installation-wide network plans for streets, sidewalks, parks and open spaces, and primary utilities (UFC 2-100-01).

Integrated Defense—The integration of multidisciplinary active and passive, offensive and defensive capabilities, employed to mitigate potential risks and defeat adversary threats to Air Force operations. (AFI 31-101)

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.

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.

Protection Factor—The relationship between the amount of nuclear fallout radiation which would be received by a completely unprotected person compared to the amount which would be received by a person in a shelter. Example: A shelter with a protection factor of 40 means that a person inside the shelter would be exposed to a radiation dose rate one-fortieth of which they would be exposed in the same location if unprotected.

Readiness—The ability of military forces to fight and meet the demands of assigned missions.

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.

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.)

Splinter-Protected—Protected using steel bin revetments, sandbags, earth berms, concrete revetments, or other expedient methods.

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).

Theater—The geographical area for which a commander of a geographic combatant command has been assigned responsibility.

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 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 UCC. This attachment offers samples for six charts: personnel, generator, vehicle, special equipment, critical supplies and spares, and installation damage status. Develop charts that fit your needs.

A2.2. Personnel Status. A "Key Personnel" chart (**Table A2.1**) shows at a glance who is currently filling what position. Some may find it desirable to modify the chart to show who fills each position during the second shift or use a second chart. The personnel status chart (**Table A2.2**) shows the strength of the unit at a glance. Often, CE UCCs account for unit strength by AFS, shop, or team.

Table A2.1. Key Personnel Chart (Notional Data).

KEY PERSONNEL				
POSITION	NAME	GRADE	AFS	REMARKS
DART 1 Lead	*James B. Federico*	*SMSgt*	*3E371*	*Call Sign DART-1, Ext. 3-5556*
Electrician Lead	*Calvin L. King*	*MSgt*	*3E071*	*Call Sign Sparky-1, Ext. 3-5507*

Table A2.2. Personnel Status Chart.

PERSONNEL STATUS							
SHOP/TEAM	NUMBER ASSIGNED	TDY/ LEAVE	DECEASED	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*	*R&EM*	*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-17Air 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 UFC 1-201-02, *Assessment of Existing Facilities for Use in Military Operations*, and 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 done according to procedures in IEMP 10-2 and CE CRP; however, the installation commander normally determines specific facility repair priorities.

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

ENGINEER REACHBACK AND OTHER USEFUL LINKS

Table A3.1. Useful Organizational and Product Links.

Useful Links
Air Force Civil Engineer Center (AFCEC): www.afcec.af.mil/
AF Publications and Forms: www.e-publishing.af.mil/
AF Design Guides (AFDG): www.wbdg.org/ccb/browse_cat.php?o=33&c=129
AF Engineering Technical Letters (ETL): www.wbdg.org/ccb/browse_cat.php?o=33&c=125
Whole Building Design Guide (WBDG): www.wbdg.org/
Unified Facilities Criteria (UFC): www.wbdg.org/ccb/browse_cat.php?o=29&c=4
Construction Criteria Base (CCB)/(WBDG): www.wbdg.org/ccb
USACE Protective Design Center (PDC): pdc.usace.army.mil/
USACE Reachback Operations Center (UROC): https://uroc.usace.army.mil
Army Publications and Forms: www.apd.army.mil/ProductMap.asp
Army ATP Publications: http://armypubs.army.mil/ProductMaps/PubForm/ATP.aspx
Navy Doctrine Library System: https://ndls.nwdc.navy.mil
USACE Afghanistan Engineer District Design Library: www.aed.usace.army.mil/Design.asp
DOD Issuances: www.dtic.mil/whs/directives/
Joint Publications: www.dtic.mil/doctrine/new_pubs/jointpub.htm
Code of Federal Regulations (CFR): www.ecfr.gov/cgi-bin/ECFR?page=browse
FEMA Documents Library: https://www.fema.gov/media-library/resources-documents