AIR FORCE TACTICS, TECHNIQUES, AND PROCEDURES 3-32.34 VOLUME 1

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CIVIL ENGINEER BARE BASE DEVELOPMENT

DEPARTMENT OF THE AIR FORCE

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BY ORDER OF THE SECRETARY OF THE AIR FORCE

AIR FORCE TACTICS, TECHNIQUES, AND PROCEDURES 3-32.34V1

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Tactical Doctrine

CIVIL ENGINEER BARE BASE DEVELOPMENT

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This Air Force Tactics, Techniques, and Procedures (AFTTP) describe civil engineer concepts and approaches to bare base development in support of Air Force Instruction (AFI) 10-210, *Prime Base Engineer Emergency Force (BEEF) Program*, and AFI 10-209, *RED HORSE Program*. This publication applies to the Regular Air Force, the Air Force Reserve, and the Air National Guard. This publication does not apply to the United States Space Force. Refer recommended changes and questions about this publication to the Office of Primary Responsibility using the Department of the Air Force (DAF) Form 847, *Recommendation for Change of Publication*; route DAF Forms 847 from the field through the appropriate functional chain of command and Major Command publications/ forms managers. Ensure all records generated as a result of processes prescribed in this publication adhere to AFI 33-322, *Records Management and Information Governance Program* and are disposed in accordance with the Air Force Records Disposition Schedule, which is located in the Air Force Records Information Management System. 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 DAF.

APPLICATION: This publication previews techniques and procedures for establishing and developing contingency locations using Air Force civil engineer distinctive skills and capabilities-based equipment configurations. This AFTTP is nondirective and does not replace technical orders and manuals, or any applicable mandatory procedures or instructions. Personnel should adhere to applicable technical, safety, and policy requirements when performing tasks addressed in this publication.

SCOPE: The data presented here addresses civil engineer tasks associated with development of airfields, facilities, utilities, base defense, and other key infrastructure and services at remote, austere, or bare base locations. For this document, "bare base" means "an installation having minimum essential facilities to house, sustain, and support operations to include, if required, a stabilized runway, taxiways, and aircraft parking areas. A bare base should also have a source of water that can be made potable. Typically, Air Force beddowns at contingency locations rely on the use of Basic Expeditionary Airfield Resources (BEAR), or other mobile assets. Prime Base Engineer Emergency Force (Prime BEEF) team leaders, supervisors, and other members may find the information and procedures addressed here useful when organizing, managing, and executing base development operations. Users of this publication are assumed to have a basic knowledge of BEAR assets and their use—readers without this fundamental knowledge should review AFPAM 10-219, Volume 6, *Planning and Design of Expeditionary Airbases*.

Chapter 1

INTRODUCTION

1.1. General Information. During bare base development, a main goal of Air Force civil engineers is to quickly set up infrastructure and services to support deployed aircraft operations and other contingency operations and missions. Civil engineer (CE) forces may accomplish this mission using standard techniques, procedures, and assets; however, depending on location and constraints, the use of expedient methods, adaptive techniques, and innovative procedures may be necessary for mission accomplishment. Operating locations could include main operating bases or "hubs," forward operating bases (e.g., commercial airports, allied military airfields, abandoned or captured airfields, remote airstrips), or austere, dispersed locations and sites with a suitable segment of road or highway. Regardless of location or type of mission supported, efficient planning and use of resources is essential for CE combat support teams.

1.2. Specialized Teams. During the initial stages of base development at contingency locations, CE work crews focus their efforts on areas that help bring about an initial operational capability, including airfields, facilities, structures, and services. These initial efforts evolve into base sustainment, and if later required, base recovery, transition, and closure. Generally, CE bare base development involve Prime BEEF and RED HORSE forces, however other teams with specialized skills and equipment may be employed, including contractor support. While other teams are mentioned, our primary focus here is Prime BEEF and RED HORSE operations.

1.2.1. Prime BEEF. Prime BEEF forces provide a wide range of engineer support to establish, operate, sustain, recover, and reconstitute installations. The type and number of Prime BEEF teams needed at any contingency location depends on the planned size and type of mission force, airfield or base layout, site conditions, and other criteria that dictate the degree of engineering effort needed to prepare and sustain the location.

1.2.1.1. Prime BEEF teams have tailored personnel and equipment packages or unit type codes (UTC) with specific civil engineering capabilities to support wartime and other contingency missions in overseas theater(s) of operation. Find UTC details in the CE Supplement to the Air Force War and Mobilization Plan, Volume 1(WMP-1), on the Air Force Civil Engineer Center (AFCEC) Expeditionary Engineering Division (AFCEC/CXX) SharePoint at https://usaf.dps.mil/sites/13072/sitepages/publications.aspx.

1.2.1.2. Although Prime BEEF teams are generally organized around specialties and abilities, multiskilling is inherently critical because many tasks will require more than one skill for accomplishment, and many more are not solely Air Force Specialty unique. For example, tasks such as camouflage and concealment, dispersal site construction, hardening, revetment erection, facility erection, etc., may require more workers than is provided by any one Air Force Specialty. Regardless of task and team makeup, remember to remain flexible and keep a mission perspective.

1.2.1.3. The bare base development skills and knowledge possessed by Prime BEEF team members is substantial and provides a tremendous capability, but for some requirements, specialized skills and equipment may be necessary. In those situations, RED HORSE teams, Airfield Pavement Evaluation teams, Civil Engineer Maintenance, Inspection, and Repair teams, specialized teams from the 635th Materiel Maintenance Group, and other teams deploy to locations requiring their expertise. Below is a brief review of these specialized teams.

1.2.2. RED HORSE. RED HORSE Squadrons (RHS) provide a highly mobile, self-sufficient, heavy construction engineer force capable of rapid response and independent operations. Core capabilities include heavy construction and the ability to operate in austere, CBRN, or high threat environments. They can perform major vertical and horizontal construction and have specialized bare base taskings. For a detailed list of RED HORSE special capabilities see CE Supplement to WMP-1 on the AFCEC Expeditionary Engineering SharePoint at https://usaf.dps.mil/sites/13072/sitepages/publications.aspx. Some RED HORSE specialized capabilities are listed below:

- Expedient Facility Erection (**Figure 1.1**)
- Quarry Operations
- Explosive Demolition
- Concrete Batch Plant Operations
- Asphalt Batch Plant Operations
- Concrete Mobile Operations
- Material Testing
- Concrete and Asphalt Paving
- Water-Well Drilling

Figure 1.1. RED HORSE Team Constructing K-Span Warehouse Facility.

1.2.3. Civil Engineer Maintenance, Inspection, and Repair Team (CEMIRT). Provides specialized teams that can rapidly deploy within 24 hours to a Theater of Operation for contingency support of equipment failures beyond the repair capabilities of the in-place engineer forces. **Table 1.1** lists these specialized capabilities.

Table 1.1. CEMIRT Specialized Capabilities.

Four 7-Person Teams (Provide intermediate and expeditionary depot-level)
Maintenance and repair of diesel-driven power generators.
Maintenance and repair of electrical distribution and control systems.
Maintenance and repair of fixed or mobile aircraft arresting systems.
Emergency troubleshoot, maintenance, and repair of bare based and real property-installed electrical power generation and distribution equipment.

1.2.4. Airfield Pavement Evaluation Team. Provides specialized teams that conduct full-spectrum pavement evaluations to support operational and beddown decisions for sustained aircraft operations at enroute or contingency locations. Provides the structural load-bearing capacity of airfield pavements in terms of acceptable aircraft, allowable gross loads, and pass levels. Determines the friction characteristics of runways to quantify the aircraft hydroplaning potential. Provides proof testing of trim pad anchors.

1.2.5. 635th Materiel Maintenance Group. Responsible for storage, inspection, repair, deployment, and accountability (excluding in-theater accountability) of Basic Expeditionary Airfield Resources (BEAR) assets belonging to the 635th Supply Chain Operations Wing and is tasked to respond worldwide for deployment, setup, operations, maintenance, teardown, and reconstitution of BEAR assets supporting combat-related and other contingencies, and natural disasters. The 635th Materiel Maintenance Group provides three types of enabling teams to assist in erection and teardown of BEAR assets; **Table 1.2** lists these specialized teams.

Table 1.2. 635th Materiel Maintenance Group Teams and Capabilities.

Technical Supervision Team
Provides technical oversight and training teams to assist Prime BEEF or RED HORSE (or joint equivalent) personnel to erect/repackage/redeploy BEAR. Provides initial accountability, control, and supply support of BEAR equipment sets. Provides support for operational beddown requirements throughout the Theater of Operation.
Large Structure Erection Support Team
Provides a team composed of aircraft maintenance and civil engineer structures Air Force specialties. Provides technical oversight and training to assist the lead Prime BEEF or RED HORSE (or joint equivalent) in erecting or disassembly/reconstitution of BEAR large structures (**Figure 1.2**). Provides capability to erect BEAR Aircraft Hangars, Large Area Maintenance Shelters and Dome Shelters. Provides capability to repair/sustain BEAR assets.
Accountability Support Team
Provides one supply specialist (Air Force Specialty 2S0X1). Provides supervision and assistance with accountability of BEAR equipment and mobility readiness spares package assets. Performs supply “Reachback” actions to sustain the BEAR equipment.

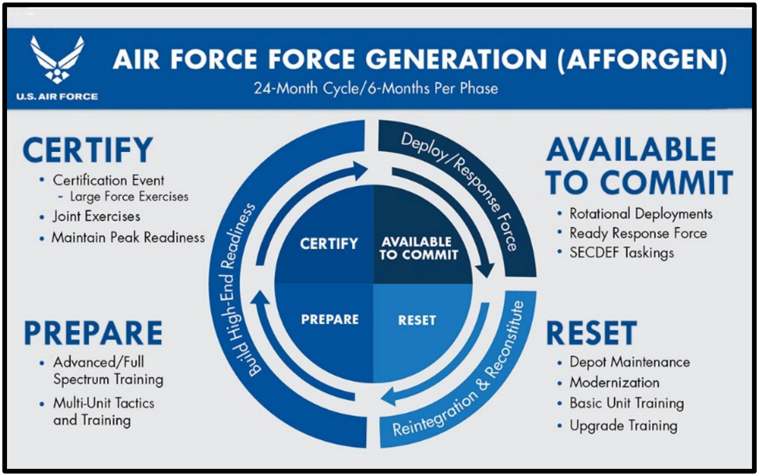
Figure 1.2. 635th Materiel Maintenance Group Assembles Large Area Maintenance Shelter.

1.3. Force Generation and Presentation. The Air Force generates and presents Airmen and airpower to support the Joint Force using the Air Force Force Generation (AFFORGEN) model (**Figure 1.3**) and Force Elements addressed in Department of the Air Force Instruction (DAFI) 10-401, *Operations Planning and Execution*.

1.3.1. Phases of Readiness. AFFORGEN establishes a 24-month rotational cycle with 6-month phases. There are four rotational phases of readiness in the AFFORGEN cycle:

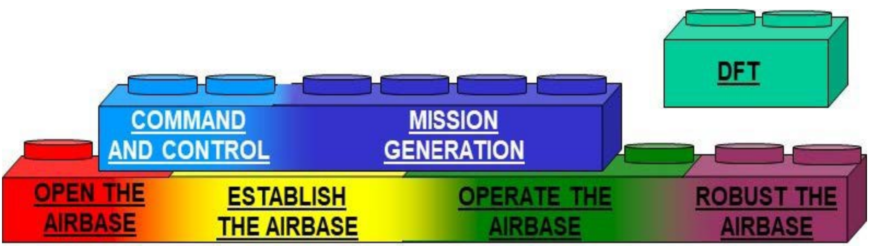
- Reset (for reintegration and reconstitution)
- Prepare (for training towards peak readiness)
- Certify (for certification)
- Available to Commit (for deployment)

Figure 1.3. AFFORGEN Model.



1.3.2. Force Elements. Under AFFORGEN, a Force Element (FE) is an integrated set of UTCs the Air Force uses to offer operational capability to Joint Force Commanders. Joint Force Commanders request AFFORGEN Force Elements (**Figure 1.4**) through the Global Force Management process. Below is a brief overview of each AFFORGEN Force Element:

Figure 1.4. AFFORGEN Force Elements.



1.3.2.1. Open the Airbase FE. Provides capabilities to open an airbase, regardless of follow-on mission. It arrives first and assesses an airbase for establishment of minimum airfield operating parameters. It consists of the initial capabilities for command and control (C2), force protection, cargo and passenger handling, logistics, airfield operations, force accountability, finance and contracting, host nation support, reception, and beddown of follow-on forces. The Open the Airbase FE sourcing will be based on the specific conditions and requirements of individual austere airfields. CE personnel, including RED HORSE and those assigned to Contingency Response Groups, airfield assessment teams, and other small units responsible for specific initial assessment and repair tasks will likely deploy with the Open the Airbase FE. Then, after completing their tasks, redeploy home to reconstitute or forward deploy to open a different site.

1.3.2.2. Command and Control (C2) FE. Provides the capabilities to establish an Air Expeditionary Wing C2 structure to include initial wing, operations, maintenance, mission support, and medical group commanders and staffs. It enables C2 of all Air Expeditionary Wing forces, including MG FEs, from AEW locations. Prime BEEF units tasked to beddown and sustain forces at a given site typically deploy a command and control cadre with the Command and Control FE, with the remainder of the tasked Prime BEEF forces deploying with the Establish the Airbase and later FEs.

1.3.2.3. Establish the Airbase (EAB) FE. Provides sufficient forces to bring an airbase to IOC status. It contains capabilities to support most missions or weapon systems and will integrate with Open the Airbase and C2 FEs as required. The EAB FE provides the airfield's earliest capability to enable and sustain mission generation. Air Force civil engineers have a significant role when tasked to establish or develop contingency locations supporting Air Force missions and operations. Refer to **Attachment 3** for a notional timeline of civil engineer bare base development tasks.

1.3.2.4. Mission Generation (MG) FE. Provides combat, combat support (those that are specifically identified on the aviation/operational UTC's mission capability statement), and combat service support capability. There are multiple types of MG FEs: Air Superiority, Global Precision Attack, Suppression of Enemy Air Defenses, Long Range Strike, High-Altitude Intelligence, Surveillance, and Reconnaissance, Air Refueling, Intra-Theater Airlift, and Combat Search and Rescue.

1.3.2.5. Operate the Airbase (OAB) FE. Enhances combat support and combat service support capabilities beyond what the EAB FE provides and brings an airbase to full operating capability. OAB enhances force protection, communications, cargo handling, and quality of life activities such as Chaplain Corps, services, health care, and reach-back capabilities.

1.3.2.6. Robust the Airbase (RAB) FE. Provides additional combat support and combat service support to increase the robustness of the capabilities already in place through previous FEs. It supports multiple MG FEs through additive capability. This FE is intended to enable the largest-scale enduring expeditionary operating locations.

1.3.2.7. Demand Force Teams (DFT). Teams composed primarily of UTCs from units or capabilities that operate independently, including unique, highly specific, combat, combat support, or combat service support capabilities. Example DFT capabilities include but are not limited to the Expeditionary Medical Support System, RED HORSE, and Tactical Air Control Party.

1.4. Agile Combat Employment (ACE). ACE is a proactive and reactive scheme of maneuver executed within threat timelines to increase survivability while generating combat power. ACE is a way of generating, projecting, sustaining, and preserving airpower that shifts operations from large, centralized, and often vulnerable infrastructures (e.g., main operating bases (MOB)) to networks of smaller-footprint dispersed locations to increase force survivability, complicate adversary planning, and provide more options to joint force commanders for power projection. For more information, see Air Force Doctrine Note (AFDN) 1-21, *Agile Combat Employment*.

1.4.1. ACE uses tailored force packages with unit-assigned multi-capable Airmen. These tailored force packages provide mission generation (MG), command and control, and base operating support (BOS) as the mission dictates. Multi-capable Airmen should have diverse foundational skills that enable them to operate in a contested, degraded, and operationally limited environment with minimal support.

1.4.2. The Base Operating Support-Integrator (BOS-I) team provides combat support and combat service support to open, establish, operate, and robust an airbase. BOS-I force packages provide capabilities including Rapid Airfield Damage Repair (RADR), UXO Removal, Air Rapid Response Kit Employment, Power Generation, Integrated Defense and Force Protection/Counter small Unmanned Aerial Systems (sUAS), Intelligence Preparation of the Battlespace, and Health Service Support.

1.4.3. CE forces are part of the BOS-I team. Whether at a main operating base or dispersed location, CE forces use their wide-ranging capabilities along with expedient facilities and utilities to help establish and maintain supporting infrastructure for Air Force forces deploying to the fight. CE forces could also be tasked to provide support to joint/combined forces at other sites or dispersed locations. For example, Prime BEEF forces have been tasked to build Army tactical operations centers (**Figure 1.5**), troop billets, latrines, showers, and other structures.

1.5. Planning Information and Resources. Air Force Pamphlet (AFPAM) 10-219V5, *Bare Base Conceptual Planning*, describes CE's role in planning and establishing contingency locations. It lists CE tasks related to bare base development, with emphasis on the use of BEAR assets to support force beddown and contingency operations. AFPAM 10-219V6, *Planning and Design of Expeditionary Airbases*, has information on airbase planning and resources. It focuses on designing, establishing, and sustaining expeditionary airbases. Other publications in AFPAM 10-219 Series and Air Force Tactics, Techniques and Procedures (AFTTP) 3-32 Series provide information on CE contingency planning, expedient methods, expeditionary airfield resource, and CE base response and recovery. See **Attachment 1** for additional references related to base development and force beddown operations at overseas contingency locations. The Air Force Civil Engineer Reachback Center is available for information not found in this publication or the references in Attachment 1. Contact the Reachback Center at 850-283-6995, Toll Free at 888-232-3721, Defense Switched Network 523-6995, or Email at AFCEC.RBC@us.af.mil. **Attachment 2** provides links to engineer Reachback resources and other useful sites.

Figure 1.5. Prime BEEF Building Army Tactical Operations Center.

1.6. General Safety Hazards and Protection Guidelines. Whether constructing a beddown location from the ground up or upgrading existing facilities and infrastructure, civil engineering operations with heavy equipment, power production equipment, fuel systems, mechanical systems, high-pressure subsystems, water and waste systems, and others makes for a hodgepodge of job safety hazards. Things like flammable fuels, high voltages, dangerous chemicals, harmful solvents and adhesives infectious black and gray water, dust, and rotating, cutting, and crushing equipment associated with these operations are significant hazards. Following safety protocols will be critical to avoid injury or death. Always be vigilant to prevent unsafe acts and conditions. Compliance with technical order warnings and cautions is essential and personnel should wear appropriate personal protective equipment.

1.6.1. Personal Protective Equipment (PPE). No matter how effective PPE can be, it does not protect or benefit anyone unless it is available and properly worn. One of the most important responsibilities of a supervisor is to ensure their people understand the importance of wearing the necessary protective equipment for the working environment. In addition, individuals should properly use, inspect, and care for PPE assigned to them. Personal protective equipment is mandated in specific equipment T.O.s, TTPs, and local guidance. **Attachment 4** lists PPE for selected civil engineer activities according to DAFMAN 91-203, *Air Force Occupational Safety, Fire, and Health Standards*. For certain electrical tasks, additional Arc Flash PPE is required. Arc Flash warning labels (**Figure 1.6**) should be present on switchgear, switchboards, panelboards, disconnect switches, industrial control panels, meter socket enclosures, and motor control centers. Personnel should comply with AFMAN 32-1065, *Grounding & Electrical Systems,* any time lethal voltages are involved. See UFC 3-560-01, *O&M, Electrical Safety*, and NFPA 70, *National Electric Code* for additional information.

Figure 1.6. Common Arc Flash Warning Label.

1.6.2. Basic Safety Standards and Requirements. In addition to wearing required PPE, personnel should understand applicable safety standards and requirements in technical guidance before performing operations or using equipment. When technical guidance is followed, personnel can usually avoid unsafe acts and conditions. Guidance comes in many different forms, including instructions; technical orders (T.O.); technical manuals; commercial manuals; tactics, techniques, and procedures; handbooks; unified facilities criteria (UFC); and official on-line resources. Depending on the project or task, the guidance and instructions provided in these sources could be the difference between success and failure. **Attachment 5** lists basic safety rules for specific civil engineering operations and equipment according to DAFMAN 91-203.

Chapter 2

SITE PLANNING AND STAGES OF DEVELOPMENT

2.1. Expeditionary Site Plans. When time and conditions permit, deploying units develop preliminary Expeditionary Site Plans before their forces arrive to establish the airbase. These site plans may cut across all functional areas and support Combatant Command wartime operations plans, as well as Major Command supporting plans. As indicated in AFI 10-404, *Base Support and Expeditionary (BAS&E) Site Planning*, Expeditionary Site Plans are chiefly associated with locations without a permanent Air Force presence and may contain only the minimum data necessary to make initial beddown decisions. Sometimes, planners must develop Expeditionary Site Plans in short periods to meet contingency needs without full staffing or coordination. This suggests even when accomplishing an Expeditionary Site Plan beforehand, it may be lacking sufficient details to satisfy the needs of every tasked function, and significant planning may still be required to accomplish an efficient beddown for the incoming mission. Regardless, Prime BEEF team leaders should learn as much information as possible about factors affecting the beddown location before deploying—use every available resource at your disposal to help ensure mission success.

2.2. General Planning Resources. Site planning resources and tools include those listed in **Table 2.1**. GeoBase and planning tools provides valuable information about potential or actual beddown locations, including site surveys, site mapping data and location imagery, facility and utility layout data; others provide planning resources and theater construction standards. The list is not all-inclusive, and other data and resources may be available when planning development and beddown operations at expeditionary bare bases. Whether or not a site plan exists, or whether all data is available or not, on-site civil engineers will strive to develop requirements and sort out beddown priorities to get the critical efforts started quickly—sometimes before all details are known; and then site, layout, and erect or modify the facilities and utility systems as needed. For questions, information, and assistance contact the Air Force Civil Engineer Reachback Center and other resources using the links in **Attachment 2**.

Table 2.1. Bare Base/Beddown Planning Information.

Base Support & Expeditionary Planning Tool
A versatile, web-enabled application delivering the capability to collect and centrally store military value data to support beddown planning. It enables rapid assessment for potential beddown locations around the world. Contains access to imaging and command surveys and reports, including previous airfield, pavements, threat, and initial beddown assessments. For access to this application, contact your local installation Logistics Plans office, Major Command A4R, or AFIMSC/XZ point of contact.
GeoBase
GeoBase is the name of the Air Force Installation Geospatial Information and Services Program. The GeoBase Program supports the AF civil engineer mission by providing accurate, current, and timely satellite and aerial imagery and map data representing real-world features and conditions for bases, installations, ranges, and property. It enables the management of natural and built infrastructure to support military readiness regarding facility construction, contingency planning, sustainment, and modernization.
BEAR Planning and Power Distribution Tool (PPDT)
The BEAR PPDT is a software application for planning deployment and beddown of BEAR. The application calculates the type and number of BEAR UTCs required based on a series of questions to the user. In addition, users may view BEAR UTC Planning Factors within the tool. The PPDT is available on the AFCEC Expeditionary SharePoint at https://usaf.dps.mil/sites/13072/SitePages/BEAR.aspx?RootFolder=%2Fsites%2F13072%2FDocuments%2FBEAR%5FUTC%5FPlanning%5FTool&FolderCTID=0x010100E5E4E56DC154E54FAACD842CA1B37C78&View=%7B771D76AB%2DB1A7%2D40A9%2D9935%2DE3DDA03CE191%7D.
Geospatial Expeditionary Planning Tool
Geospatial Expeditionary Planning Tool is an advanced expeditionary base-planning tool that combines camp and aircraft parking planning capabilities.

CE Site Planning Playbook
Provides an overview of the siting process and provides Installation Planners with an understanding of fundamental activities that make up the siting process. Locate CE Playbooks at https://www.ceplaybooks.com.
CCR 415-1, Construction in the USCENTCOM Area of Responsibility
Establishes standards for facility design, development, security, sustainment, survivability, and safety with affordable working and living environments for personnel in the USCENTCOM Area of Responsibility.
AE PAM 420-100, Standards for Forward Operating Sites
Addresses base camp facilities standards for contingency operations in the USEUCOM Area of Responsibility. The pamphlet outlines standards for base camp construction, maintenance, housing, master planning, service member support, unit facilities, and utilities for all bases.
USPACOMINST 0611.2, Engineer Support Planning
Addresses construction planning factors and standards in the USPACOM Area of Responsibility, including initial and temporary construction standards for short-duration contingencies and sustained operations.
GTA 90-01-011, Deployed Forces Protection Handbook (JFOB7)
Provides insights and best practices, and lessons learned for contingency locations and operating sites with respect to mass casualty threats including rockets, artillery, and mortars; direct-fire munitions; and both vehicle- and person-borne improvised explosive devices.
Joint Construction Management System (JCMS)
Provides contingency construction information to military engineers. The JCMS is an automated construction planning, design, management, and reporting system primarily used to support outside the continental United States requirements.

2.3. Equipment Resources and Other Assets. Efficient beddown operations at a bare base or initial contingency location requires the appropriate types and quantities of systems and materiel to establish the site for the operational mission. BEAR mobile assets and other base beddown materiel are essential resources for establishing and sustaining initial and temporary contingency locations.

2.3.1. BEAR Assets. BEAR assets are flexible, modular, and scalable to meet an array of beddown missions. They consist of personnel shelters, aircraft shelters, food service facilities and equipment, hygiene facilities, power and water production and distribution equipment, heating, air conditioning, and refrigeration equipment, vehicles, runway lighting, vehicle maintenance equipment, and civil engineering equipment and associated spares. When combined, these systems and equipment make-up the infrastructure needed to establish an airbase in a deployed environment. Organized into capability-based configurations, BEAR assets allow Air Force and Combatant Commanders to employ only those capabilities required to meet the mission, thereby reducing the overall logistics footprint of BEAR sets. **Note:** Some BEAR assets may not remain in their current UTC configuration due to potential changes in War Reserve Materiel related to ACE requirements.

2.3.1.1. BEAR capabilities, in the form of UTCs, are critical to employment planning for austere locations up to main operating bases. Important considerations include specific missions, locations, and population requirements. Built with the end-user in mind, BEAR synchronizes to other combat support UTCs to arrive as needed to enhance the incremental buildup of an operating location. A critical enabler of the FE construct, BEAR plays a key role in Open, Establish, and Operate the Airbase FEs.

2.3.1.2. BEAR UTCs supporting the Open the Base FE are associated with initial beddown forces and Contingency Response Groups. Postured UTCs include those designed to provide basic hygiene, billeting, power, lighting, water, and Meals Ready-to-Eat for the initial cadre.

2.3.1.3. A significant portion of BEAR UTCs supports the Establish the Airbase FE. These UTCs synchronizes with other combat support capabilities to provide shelters, billeting, messing, lighting, and power capabilities that arrive on or about C-day and are designed to provide an initial operational capability within the first few days of arrival. Those UTCs supporting the Operate the Base FE include engineering, structural and fuels facilities necessary to complete the deployed location layout and support quality of life activities, such as Chaplain and the Tactical Field Exchange.

2.3.1.4. For the Mission Generation FE, BEAR UTCs support both Combat Air Forces and Mobility Air Forces, and contain maintenance shelters, lighting, and aircraft supporting structures. Mission Generation UTCs are tasked in response to numbers of aircraft being supported.

2.3.1.5. The importance of BEAR (including legacy equipment sets) and non-BEAR assets to bare base development is readily apparent. The proper flow of these assets is critical to establishing the airbase and generating the mission. Obtaining non-essential assets early in the logistics flow merely congests off-load areas, increases the potential for loss or damage to items, and does little to provide immediate mission capability. The capabilities-based configuration of BEAR assets should remedy many of these problems. However, as users and installers of much of the base equipment, and in planning for contingency beddown operations, civil engineers have a vested interest in, and responsibility for influencing the flow of BEAR assets. The theater logistics staff, with input from the CE staff, usually determine selection and time phasing of BEAR and other assets for a given site. Base-level engineers can influence the process by working with their unit-level logistics plans office and the theater CE staff. While engineer planners can influence the planned flow of equipment, the real-time availability of transportation assets is a significant factor. Understanding the pressures applied to limited airlift resources available to support all the Services' deployment requirements, the Air Force designed and configured BEAR assets with transportation flexibility in mind. Therefore, BEAR packaging is in a multi-modal configuration for both air and surface transportation. Anticipate nearly one-third of all BEAR configurations will be for air shipment.

2.3.2. Non-BEAR Assets. Non-BEAR assets also play an essential role. Items like non-BEAR support equipment and vehicles, expeditionary medical, communications, and Force Support facilities, fuels mobility support equipment, Air Force Contract Augmentation Program and locally contracted resources, and the Army's Force Provider assets are just a few examples. Any of these resources can be part of the asset mix needed for successful development of a contingency base. Although our engineer workforce has a long tradition of innovative and flexible use of available resources to satisfy command and mission requirements, we continue to apply lessons learned and use the ever-changing tools that improve our processes and product. For Prime BEEF forces, this includes employment of non-BEAR assets we may encounter at expeditionary operating locations.

2.4. Bare Base Development Stages and Tasks. The systematic establishment of a bare base follows a pattern comprised of four stages. They are initial, intermediate, follow-on and sustainment. However, CE teams accomplish bare base development tasks according to the commander's priority for the stages. **Table 2.2** is an example of how units may prioritize base development tasks. During the initial and intermediate stages, most tasks will fall in the upper two priorities. In the follow-on stage, tasks will shift more toward the lower priorities on the list. In any case, some of the tasks in the various stages will overlap because of their scope or labor requirements. **Note:** Any of the four stages or associated base development tasks could be reordered or truncated due to the operational environment or application of ACE scheme of maneuver. For example, many base development tasks beyond the initial stage may not be necessary for beddown operations at dispersed sites or locations. In addition, tasks from any stage may be accelerated or not accomplished at all due to constraints of the operational environment.

Table 2.2. Bare Base Development Priorities.

Priority	Task
1	Operational requirements
2	Utility systems and services

3	Transportation network
4	Essential support facilities
5	Other support facilities

2.4.1. Initial Stage. During the initial stage of bare base development, engineer efforts should be concentrated on accomplishing those tasks that are necessary to meet the combat sortie generation (or other mission) requirements of the Combatant Commander. These tasks (not in sequential order) may include:

2.4.1.1. Establishing and developing water points.

2.4.1.2. Inspecting airfield pavements for serviceability and accomplishing expedient repairs and marking, if required (**Figure 2.1**).

Figure 2.1. Contingency Base Airfield Repairs.

2.4.1.3. Hauling water from water points to purification site.

2.4.1.4. Establishing expedient field latrines.

2.4.1.5. Establishing basic water treatment plant (facility/purification storage).

2.4.1.6. Verifying arresting barrier serviceability or installing MAAS.

2.4.1.7. Verifying airfield lighting serviceability or installing Emergency Airfield Lighting System.

2.4.1.8. Providing site preparation support for navigational aids, fuels, cryogenics, C2, and other mission critical facilities.

2.4.1.9. Provide engineer assistance for fuel systems.

2.4.1.10. Providing mission-essential power to critical facilities using mobile generators (up to 100 kW in size).

2.4.1.11. Setting up emergency security/area lighting.

2.4.1.12. Performing EOD inspection of the entire installation.

2.4.1.13. Preparing a site plan for the entire installation to include facility group, road/drainage systems, and utility system locations.

2.4.1.14. Laying out facility groups and roads.

2.4.1.15. Starting layout and trenching for utility systems.

2.4.1.16. Grading primary roads and access ways to major facility group areas.

2.4.1.17. Establishing basic base defense network.

2.4.1.18. Establishing a munitions holding area.

2.4.1.19. Establishing engineer supply points for receiving, sorting, and releasing BEAR assets.

2.4.1.20. Setting up engineer command and control center and billeting/dining area.

2.4.1.21. Establishing a "taxi/bus" service to move work crews to and from work areas (vehicles will be in short supply).

2.4.1.22. Establishing alerting system and contamination control areas.

2.4.1.23. Establishing fire and emergency services (see AFTTP 3-32.41, *Contingency Firefighting Operations*, for specific requirements).

2.4.1.24. Establishing 24/7 support for the airfield (sweeping and maintenance of airfield lights, MAAS, etc.).

2.4.1.25. Establishing CBRN monitoring points.

2.4.1.26. Performing Environmental Condition Study (ref: DODI 4715.22, *Environmental Management Policy for Contingency Locations*, and AFH 10-222V4, *Environmental Considerations for Overseas Contingency Operations*).

2.4.2. Intermediate Stage. During the intermediate stage of a bare base development, place emphasis on erecting all BEAR facilities and placing utility systems in service. Some engineer workers are usually devoted to system operations and maintenance. The thrust in this stage is to provide the ability for all base agencies and functions to establish basic operating capability within the first ten days of deployment. Engineer tasks (not in priority order) may include:

2.4.2.1. Establishing fully functioning water plant(s).

2.4.2.2. Installing over-the-ground pipeline and pumps from water source to treatment plant.

2.4.2.3. Laying out "flexible hose" water distribution system for initial water supply to latrines, kitchens and storage bladders.

2.4.2.4. Connecting facilities and systems requiring water to the flexible hose distribution system.

2.4.2.5. Establishing a waste collection capability using sewage collection trailers.

2.4.2.6. Installing field latrines and shower/shave units.

2.4.2.7. Starting aboveground layout/connection of hardwall water distribution system once basic softwall distribution system is in service.

2.4.2.8. Leveling sites and constructing berms/dikes for POL storage areas.

2.4.2.9. Grading road network throughout installation; paying particular attention to drainage around roads.

2.4.2.10. Clearing hazards in airfield clearance zones, if necessary.

2.4.2.11. Constructing expedient berms for munitions storage area.

2.4.2.12. Expanding aircraft parking surfaces, if necessary.

2.4.2.13. Installing static grounds at fueling points, arming pads, hot cargo pads, maintenance areas, etc.

2.4.2.14. Setting up power plant(s) using Prime Power generators.

2.4.2.15. Laying out and burying the high-voltage distribution cabling and connecting the primary and secondary distribution centers.

2.4.2.16. Connecting base facilities (as erected) to power system.

2.4.2.17. Placing tactical power generators into service as backup power to mission essential facilities once provided primary power.

2.4.2.18. Installing grounding systems at munitions areas and on electrical components, etc.

2.4.2.19. Erecting engineer maintenance and shop facilities.

2.4.2.20. Providing technical guidance to other base organizations on facility erection.

2.4.2.21. Constructing evaporation ponds/stabilization lagoons as necessary.

2.4.2.22. Starting sanitary landfill operation, if required.

2.4.2.23. Installing heaters in facilities.

2.4.2.24. Assisting other base organizations in moving BEAR assets from holding areas to site locations.

2.4.2.25. Increasing engineer supply point operations to include storage of BEAR shipping containers and engineer related BEAR equipment.

2.4.2.26. Establishing hazardous waste control areas.

2.4.2.27. Laying out and begin constructing aircraft revetments.

2.4.2.28. Clearing perimeter areas and expanding the base defense network.

2.4.3. Follow-On Stage. During the follow-on stage, final installation of BEAR assets takes place and survivability enhancements to the base are considered. Strive to complete most of these tasks within the first 30 days. Engineer tasks (not in sequential order) for this stage may include:

2.4.3.1. Burying of the “hardwall” water distribution system.

2.4.3.2. Installing environmental control units in facilities.

2.4.3.3. Constructing aircraft and vehicle wash racks.

2.4.3.4. Installing the BEAR sewage collection system.

2.4.3.5. Connecting showers and latrines to the sewage collection system.

2.4.3.6. Connecting all facilities requiring water to the hardwall system.

2.4.3.7. Retrieving and repacking the "softwall" water distribution system.

2.4.3.8. Burying electrical distribution cables that were originally on the ground surface.

2.4.3.9. Building fixed defensive fighting positions around the base perimeter.

2.4.3.10. Building and placing obstacles supporting base defense requirements.

2.4.3.11. Modifying host-nation-provided facilities for United States use.

2.4.3.12. Constructing basic personnel shelters for survivability purposes.

2.4.3.13. Preparing an emergency disposal range for EOD use in munitions destruction.

2.4.3.14. Performing camouflage, concealment, and deception activities with available resources (primarily netting).

2.4.3.15. Hardening critical facilities/utility nodes with revetments, sandbags and berms.

2.4.3.16. Siting and developing dispersal locations.

2.4.4. Sustainment Stage. When the sustainment stage begins, most BEAR support work is completed and the engineer's focus shifts to operations, maintenance and upgrade activities. The extent of many of these activities will be predicated on the anticipated duration of the deployment—this is a command decision that should be made early in bare base planning. Typical engineer tasks during this period include:

2.4.4.1. Providing maintenance and repair support to BEAR assets and in-place facilities used by the United States.

2.4.4.2. Providing essential services such as utility plant operation, refuse collection, airfield sweeping, Fire and Emergency Services, environmental protection, hazardous waste management, etc.

2.4.4.3. Upgrading roads using soil cement, asphalt paving or crushed stone.

2.4.4.4. Constructing flooring in non-critical facilities.

2.4.4.5. Establishing material stocks for potential base recovery efforts.

2.4.4.6. Developing contingency response plans for base recovery and natural disasters and writing accompanying checklists.

2.4.4.7. Establishing supply and services contracts with local vendors, as security considerations allow, for such things as refuse collection/disposal, sewage disposal, water supply, etc.

2.4.4.8. Developing contingency training and exercise programs.

2.4.4.9. Providing quality of life improvements such as increased square footage, additional air conditioning, hot water, etc.

2.4.4.10. Constructing basic recreational facilities.

2.4.4.11. Providing more utility support to outlying/heavily populated areas.

2.4.4.12. Improving personnel protective shelters.

2.4.4.13. Increasing hardening features of base facilities.

2.4.4.14. Increasing security measures such as area lighting and fencing.
2.4.4.15. Replacing temporary pavement surfaces or repairs with permanent fixes.

2.4.4.16. Constructing protective structures such as sun shades and wind breaks (**Figure 2.2**).

2.4.4.17. Constructing permanent berms for munitions storage areas.

Figure 2.2. Raising Aircraft Sun Shade On Contingency Base.

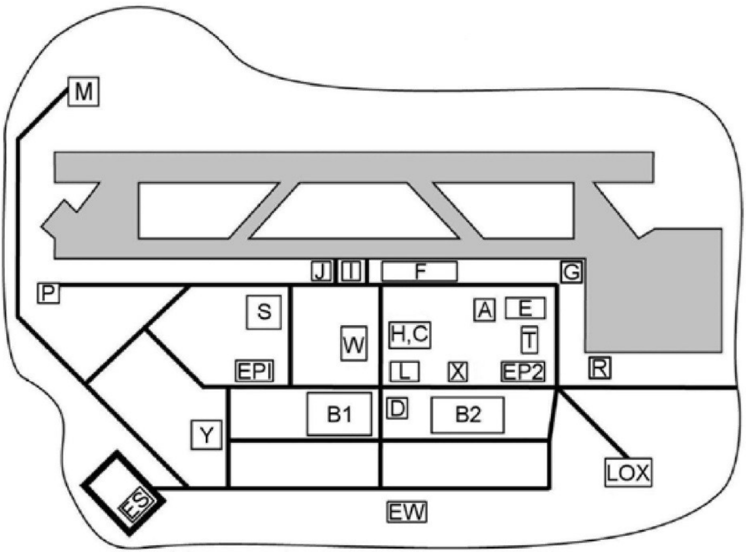
Chapter 3

BARE BASE FACILITY LAYOUT

3.1. General Information. Facility siting and layout are critical tasks that set the stage for bare base development. Planners consider the unit's organic assets, incoming BEAR, and other mobile and local assets when determining facility siting requirements. When there is limited or non-existent infrastructure, the placement and spacing of BEAR facilities and systems may depend on the physical layout of the terrain, tactical and operational requirements, integrated defense and force protection requirements, and the availability of resources. An organized facility layout enhances operations, whereas a poor site layout could degrade operations, increase operational costs, affect physical health, reduce coordination and corporation among units, and erode morale. **Note:** Facility layouts should also address any tactical or operational requirements, and any adaptive planning considerations related to application of ACE concepts.

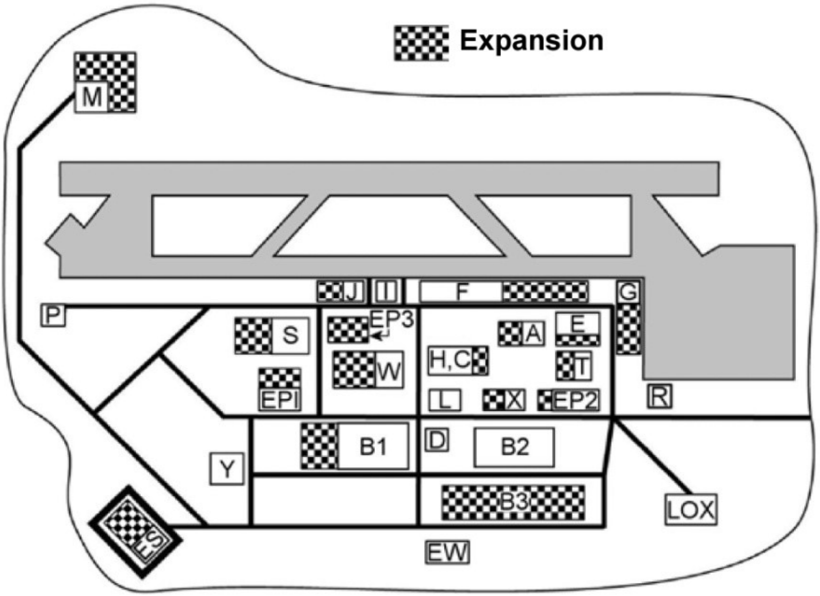
3.2. Facility Placement and Spacing. Laid out facility groups often affect each other. If the base boundary allows for a conventional layout, consider gradually relocating support facilities, billeting, and Force Support functions away from the flightline and industrial support areas. If the base area is long and narrow, a linear layout may be necessary. As illustrated in **Figure 3.1** and **Figure 3.2**, allocate space in each facility group for future expansion and growth (including utilities). Consult the theater engineer staff about command-specific, construction standards and potential beddown and space requirements for follow-on aircraft squadrons and other missions. In some instances, the base may need ramp space to disperse aircraft assets for protection. An airfield layout with varied parking patterns provides fewer lucrative targets for indirect-fire weapons. Review AFTTP 3-2.68, *Multi-Service Tactics, Techniques, and Procedures for Airfield Opening*, for airfield layout options and examples. Placement and spacing of facilities also affect the space available for construction of revetments and personnel bunkers. If we do not account for these requirements initially, the result may be higher risk facility configurations or a requirement to relocate utility systems. Be sure to consult Bioenvironmental Engineering for methods to reduce or minimize base population exposures to health hazards (noise, chemical, radiation, etc.) during base development. The Bioenvironmental Engineering flight conducts health-based site assessments for initial contingency locations up to enduring bases.

Figure 3.1. Notional 1,100-Person Facility Layout (Before Expansion).



A	Avionics	**F**	Maintenance	**R**	Alert
B	Billeting	**G**	Squadron Ops	**S**	Supply
C	Chaplain	**H**	Support Group	**T**	Transportation
D	Dining Hall	**I**	Emergency Svcs	**W**	Wing HQ
E	Engineering	**J**	Aerial Port	**X**	Medical Fac.
EP	Power Plant(s)	**L**	Laundry	**Y**	Comm Plant(s)
ES	Sewage Treatment	**M**	Munitions	**LOX**	Liquid Oxygen
EW	Water Plant(s)	**P**	POL		

Figure 3.2. Notional 3,300-Person Facility Layout (After Expansion).



3.2.1. Minimum Antiterrorism Standards. In addition to conforming to theater-specific construction standards, expeditionary structures should comply with UFC standards to the maximum extent possible given the current operational environment. See minimum antiterrorism standards prescribed in UFC 4-010-01, *DOD Minimum Antiterrorism Standards for Building*, Appendix D, and UFC 4-020-01, *DOD Security Engineering Facilities Planning Manual*. Standoff distances and facility separation is especially critical for these structures because hardening may not be possible or may be prohibitively expensive. The following paragraphs address standoff distances, structure separation, and facility dispersal.

3.2.1.1. Standoff Distances and Structure Separation. Using standoff distances minimizes the accessibility and vulnerability of a facility. These distances are critical when siting a facility and can effectively mitigate indirect fire and improvised explosive device attacks. Structure separation requirements are established to minimize the possibility an attack on one structure causes injuries or fatalities in adjacent structures. The separation distance is predicated on the potential use of indirect fire weapons. UFC 4-010-01 lists standoff distances and separation for expeditionary and temporary structures. Always refer UFC 4-010-01 and theater construction standards for specific requirements.

3.2.1.2. Facility Dispersal. While standoff and separation distances are important to base defense, dispersed facility layouts may also reduce risks in high threat areas by taking full advantage of terrain and site conditions. Consequently, nothing in the standoff distances or separation standards discourages dispersal were appropriate. **Figure 3.3** depicts examples of dispersed layouts for facility groups, excluding billeting. By combining the appropriate number of groupings, units can layout an entire facility group in a short period. Illustrated in **Figure 3.4** is an example of a dispersed billeting area layout. Plan an entire billeting group by combining this type of area layout. Remember, factors such as available resources and utilities may limit facility dispersal distances. For example, if dispersed facilities will be supported by utility systems (e.g., electrical, water and waste distribution systems), make appropriate adjustments to the utility sizes and quantities when site plans are changed to accommodate actual field conditions, topography changes, and local dispersal requirements.

3.2.2. Other Layout Considerations. When reviewing facility group layouts, make sure everything can fit well within the real estate available, and according to facility and group dispersal requirements. Additionally, since much of the initial base traffic will be operating from flightline locations, build the overall facility/group layout around a road network providing easy access to various points on the flightline. This is also a good time to look at the locations for utility plants, evaporation beds, and stabilization lagoons (if required). Ensure the locations of sewage lagoons are downwind from the base.

Figure 3.3. Example of Dispersed Facility Group Layouts.

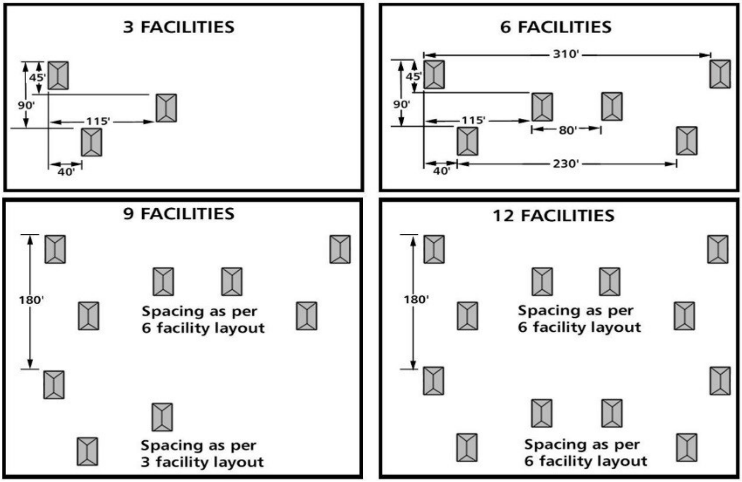
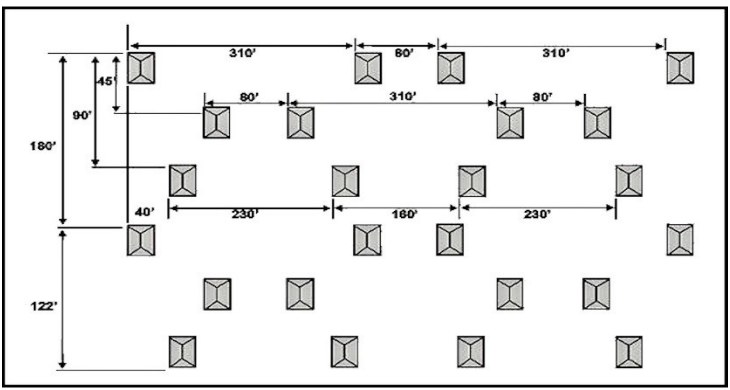


Figure 3.4. Example of Dispersed Billeting Area Layouts.



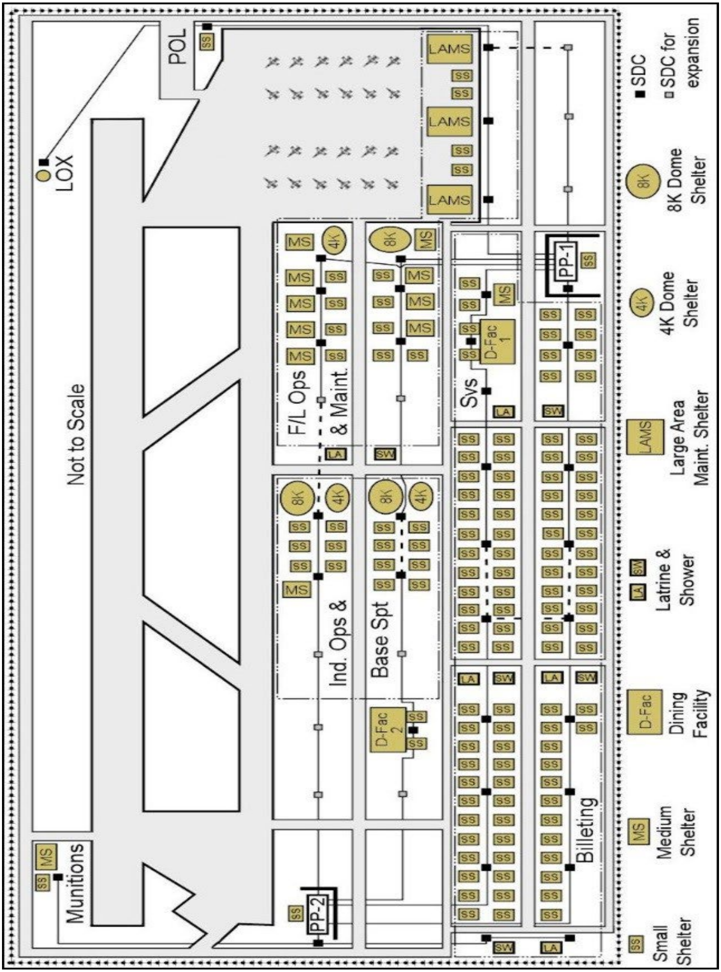
3.2.2.1. Illustrated in **Figure 3.5** is a hypothetical base layout using BEAR assets. The locations of all large facilities, such as aircraft hangers, frame supported tension fabric shelters or dome shelters should be marked on the site layout map. Illustrate a representative sampling of the more common medium and small shelter systems. Provide a general template (and dispersal pattern if necessary) to survey crews tasked to eventually stake out the facility groups.

3.2.2.2. Once site layout is completed, engineer survey crews should begin the sizable task of physically marking the locations of the various bare base assets. Use more than one crew and augment with other shop or base personnel, if necessary. If required, survey crews should identify and mark the locations of the mobile aircraft arresting systems and airfield lighting components.

3.2.2.3. Have crews initially mark the boundaries (corners and intermediate points if distances are long) of the various facility groups. Use markers that are relatively permanent (e.g. driven stakes) since they will become benchmarks for starting the location marking of individual facilities and assets. Use expedient survey methods during this process, for example, "walking off" distances, using vehicle odometers, or using a hand compass for turning angles.

3.2.2.4. After laying out facility groups, concentrate on locating individual facilities within each facility group. In smaller groups (e.g., aerial port, squadron operations, alert area, etc.), the location of all facilities can be pinpointed at one time. In large groups, such as the billeting complex, locate only a portion of the total requirement initially—do not get distracted trying to locate positions of facilities for people who will not be arriving for a few days. These large areas can be marked after other important operational portions of the base are completed. Use expedient survey methods for laying out individual facilities. Because individual facility layout is repetitious with respect to distances between buildings, a couple of pieces of rope cut to the proper spacing intervals can be used as a quick and accurate way of measuring and locating facility positions.

Figure 3.5. Hypothetical Base Layout using BEAR Assets.



3.2.2.5. Plan the locations of water and electrical plants and distribution systems early in the site layout process. Review AFH 10-222V11, *Contingency Water System, Installation and Operation*, and AFTTP 3-32.34V5, *Contingency Electrical Power Production and Distribution System*, when siting and installing these systems. Coordinate plans with shop superintendents and survey crews to optimize constructability, serviceability, and speed of initial setup. See **Chapter 7** and **Chapter 8**, in this publication for more information on bare base utilities.

3.2.2.6. Take into consideration the location and routing of fuel distribution system during the initial facility layout. Carefully consider the placement of fuel lines and hoses to ensure safety and fuel hose/line integrity. Strive to design road layout so fuel lines/hoses will not cross roads. If facility expansion requires intersecting fuel hoses/lines with roads, provide a trench with a hardened cover to protect the fuel hose/line.

3.2.2.7. Cryogenics (liquid oxygen and liquid nitrogen) storage and servicing facilities (**Figure 3.6**) have specific siting requirements and should be part of initial base planning. DAFMAN 91-203 lists siting and safety requirements for liquid oxygen and liquid nitrogen facilities. Because of the special hazards associated with liquid oxygen and liquid nitrogen, exercise care when siting these facilities. A paved road is required to and from the facility for delivery, maintenance, and emergency vehicles according to AFI 23-201, *Fuels Management*, and the area around the Cryogenics facilities where spills are most likely to occur (i.e., storage tanks, receiving and servicing area, and servicing cart parking areas) should be concrete with non-petroleum based sealant between the joints. Utility services (water, electricity and sewage) should also be coordinated with the installation civil engineer.

3.2.2.7.1. Liquid oxygen storage facilities having a capacity of 100 gallons or more will conform to the standards listed in DAFMAN 91-203.

3.2.2.7.2. Further information can be found in the Air Force 32-series publications (Civil Engineering) and T.O. 00-25-172, *Ground Servicing of Aircraft and Static*

Grounding/Bonding. Additionally, consult AFI 23-201, for information on security fencing and lighting requirements.

Figure 3.6. Liquid Oxygen Storage and Servicing Facility.

Chapter 4

AIRFIELD PREPARATIONS

4.1. General Information. Upgrading, modifying, or restoring an existing airfield to full operational or mission-ready status can be a considerable bare base development task. Even after the "Open the Airbase" phase is completed, our Prime BEEF forces continue the enormous task of developing the airfield and support facilities for the intended mission. Airfield development tasks include clearing airfield hazards and obstacles, repairing pavement, installing and repairing aircraft arresting systems, constructing revetments and berms, setting up airfield lighting, implementing dust control measures, and many other tasks. This chapter provides insight into these and other areas related to airfield development.

4.2. Airfield Hazard Clearance. Clearing airfield hazards is a top priority and usually begins during the airfield-opening phase of bare base development. Initial engineer forces, using information garnered from airfield assessments and the situation on the ground, start to clear hazards as soon as practical after arriving on station. Obviously, unexploded explosive ordnance or scattered wreckage and debris on airfield pavements pose considerable hazards and will probably have the innate attention of both the mission commander and engineers until the airfield is operational. When Prime BEEF forces arrive, the airfield clear zone should be free of most hazards and obstacles, but crews should remove or mitigate any remaining hazards early in the beddown process.

4.2.1. Unexploded Explosive Ordnance (UXO) Hazards. Whether found during force beddown operations or recovery after an attack, the presence of UXO is a threat to operations, installations, personnel and materiel. Safing and clearance of these deadly hazards is a responsibility of EOD teams. EOD teams may defuse, detonate, or perform other actions to neutralize munitions "in-place," or they may move munitions to a nearby, isolated, and protected location to defuse, detonate, or otherwise abate the immediate threat. As soon as EOD personnel have progressed sufficiently down the airfield, engineer teams using safe practices, can begin or continue tasks, such as crater repairs, wreckage removal, marking, etc.

4.2.1.1. Expect a slower, more extended UXO clearing process during site layout and construction (i.e., shelter erection, constructing defensive fighting positions, or running utilities). EOD teams will clear UXOs from these areas before construction begins. Heavy equipment operators should level any craters created by in-place UXO demolition. Once clearing procedures are completed, erection of facilities and surface layout of utilities can proceed within the cleared areas. Burying utilities can present additional challenges. Mines and UXOs located below the surface, especially in areas subject to flooding with drifting soil and sand, could explode when hit or uncovered during trenching operations. EOD teams may need to scan or sweep for additional UXO and mines directly along the planned pathways for utility trenching. **Note:** Under certain circumstances, our joint and coalition partners with UXO clearing capability may assist in clearing large numbers of mines or UXO from planned beddown areas.

4.2.1.2. While EOD teams are responsible for UXO clearing, civil engineer units task other engineer personnel to support them. **Table 4.1** lists a few tasks supporters may perform to assist EOD activities. Supporters should always follow EOD guidance and seek additional information on UXO operations from the references provided at the end of this chapter.

Table 4.1. Tasks Supporting EOD.

Support Tasks
Construct protective berms around danger zones
Provide heavy equipment support to access or remove UXO
Roping off areas around UXO
Reinforcing adjacent structures
Isolating major utilities around UXO areas

4.2.1.3. Protective Measures. Before any UXO clearance operation begins, take measures to protect personnel and equipment by evacuating, isolating, barricading, or any combination thereof.

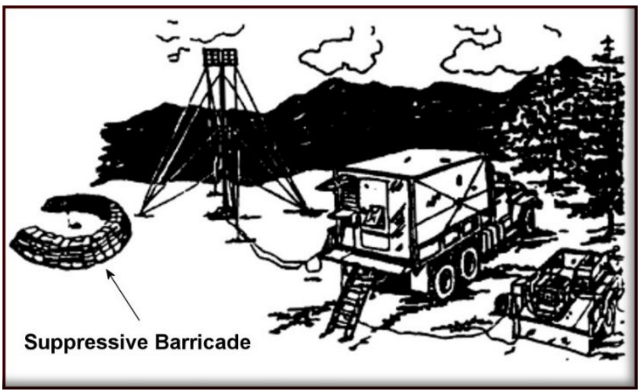
4.2.1.3.1. Evacuate. Adhering to evacuation distances in AFTTP 3-2.12, *Multi-Service Tactics, Techniques, and Procedures for Explosive Ordnance*, evacuate all nonessential personnel and equipment in the danger zone before commencing UXO clearance operations. Allow movement within the danger zone to essential personnel only. Personnel who must remain in the area should wear all protective equipment including Kevlar helmets and vests.

4.2.1.3.2. Isolate. For mission related, operational, or other critical reasons, when evacuation of some mission essential personnel or equipment is not an option. To the greatest extent possible, isolate these assets from, and limit exposure to, the immediate vicinity of the UXO.

4.2.1.3.3. Barricade. Use barricades to protect mission-essential personnel and equipment that must stay in the hazard area. Barricading provides limited protection by blocking blast and fragmentation from an explosion.

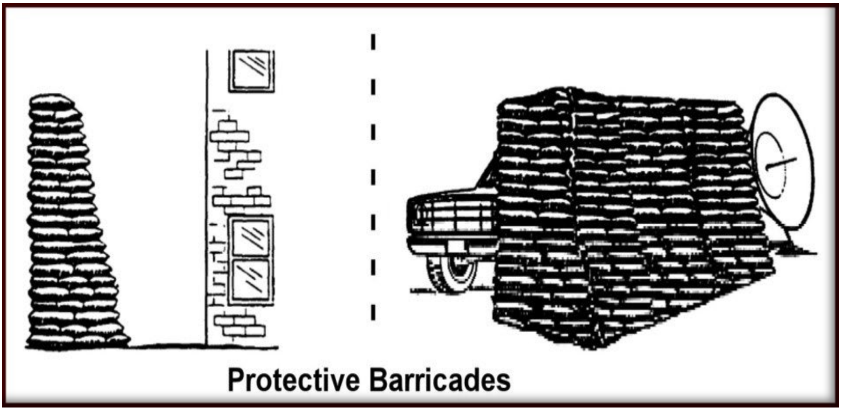
4.2.1.3.3.1. Construct suppressive barricades (**Figure 4.1**) to isolate an explosion, to deflect thermal and shock waves and absorb low-angle, high-speed fragments.

Figure 4.1. Suppressive Barricades Isolate Explosions.



4.2.1.3.3.2. On the other hand, construct protective barricades (**Figure 4.2**) around exposed resources to shelter them from overpressure and the impact of high-angle, low-speed fragments, which can escape over the top of "suppressive" barricades. See AFTTP 3-2.12 for more information on barricade construction and UXO operations.

Figure 4.2. Protective Barricades Shields Resources.



4.2.2. Wreckage and Debris Hazards. Removing wreckage and debris hazards from runways, taxiways, and aircraft parking areas is essential to increase airfield operability. Materials initially pushed aside to establish an expedient airfield (minimum operating strip or landing zone), or left in nonessential areas can be removed when time and resources become available. Consider pushing materials into craters at the scene, moving it to a central location for disposition, or loading it into dump trucks and transporting to a remote location for disposal. Whatever the case, engineers should remain vigilant when using heavy equipment and be on the lookout for UXO.

4.2.2.1. Equipment. The type of equipment needed to clear aircraft operating surfaces depends on the size and amount of debris. The presence of large pieces of wreckage or debris (e.g. damaged vehicles, aircraft, or pavement sections) necessitates the use of heavy equipment such as bulldozers and cranes. However, many of the heavy equipment items needed may not be on the first series of incoming airlift sorties. Until these assets arrive, consider working with the contracting officer to find local sources of heavy equipment and materials. The following are equipment options for performing debris-clearing operations:

4.2.2.1.1. Crane. For removing extremely large chunks of debris, a crane may be the only suitable piece of equipment.

4.2.2.1.2. Bulldozer. A bulldozer has the power to push large pieces of debris out of an area and can quickly clear large areas of smaller debris. One skilled dozer operator can clear an area that would require several hours of labor if done by hand.

4.2.2.1.3. Front-End Loader. Front-end loaders are especially useful in loading debris on dump trucks and other vehicles for removal from the site. They also are adequate for clearing paved areas and streets of large amounts of small debris.

4.2.2.1.4. Dump Truck. Dump trucks haul debris to disposal sites. Other suitable vehicles, such as cargo trucks and tractor-trailer units, can sometimes substitute for them.

4.2.2.1.5. Sweepers. After the removal of larger debris from an area, consider using street sweepers and vacuum trucks to clear smaller items from aircraft operating surfaces and primary access streets. If sweepers are not used, small metal items left on roadways and working areas can cause tire damage to aircraft and equipment involved in cleanup operations. Time spent repairing and replacing flat tires on these vehicles delay the overall recovery effort.

4.2.2.1.6. Towing Devices. Steel cable, chains, hooks, and similar items can be fashioned into towing devices for debris removal. Use care when selecting towing devices; ensure they are appropriate and strong enough for the job.

4.2.2.2. Manpower. Generally, manpower is stretched to the limit during airfield opening operations; therefore, focus available resources to clear debris from minimum airfield operating surfaces first.

4.2.3. Airfield Obstructions. Crews should quickly remove debris from airfield pavements to facilitate recovery and launch of aircraft and to accommodate aircraft parking and loading requirements. However, obstructions along the approach or departure ends of the runway, around ramps and taxiways, or near the adjacent terrain may still need to be removed (**Figure 4.3**). Be especially observant of terrain features or obstacles that could affect wing tip clearance of wide-body aircraft. However, it may not be prudent to have crews remove items in the outer edges of the clear zones that produce minimal danger (a culvert head wall for example)—in these instances, airfield authorities may initially accept the risk. Also, be sure to check the shoulders of runways and taxiways and the grounds along access routes to aprons and ramps for potential foreign object debris-producing areas.

Figure 4.3. Removing Destroyed Tank near Taxiway.

4.3. Airfield Repairs and Restoration. Immediate repair and restoration may include selection of a minimum operating strip, expedient airfield or landing zone marking and repairs, pavement sweeping and cleaning, pavement marking and striping, site preparation for installation of navigational aids, and installing airfield lighting and mobile aircraft arresting systems (MAAS). The goal is to have the airfield ready to commence aircraft operations as soon as possible. As soon as a minimum operating strip is established, plan on immediately dedicating equipment and personnel to around-the-clock airfield sweeping operations since there will likely be considerable aircraft and vehicle traffic on pavement surfaces as bare base assets are delivered, off-loaded and transported from ramp areas.

4.3.1. Navigational Aids. Support for navigational aids includes clearing and leveling areas for setting up mobile communications equipment. Normally these areas are not particularly large (2,500 sq. ft. or so), but plan on having to clear and grade vehicle access ways up to 1,000 feet long to these sites and provide electrical service. See UFC 3-260-01, *Airfield and Heliport Planning and Design*, and consult with Communications personnel for specific siting requirements.

4.3.2. Minimum Operating Strip. By definition, the Minimum Operating Strip is a runway that meets the minimum requirements for operating assigned and/or allocated aircraft types on a particular airfield at maximum or combat gross weight. When airfield damage, unexploded ordnance, or other obstructions prevent immediate and full use of the runway, quickly selecting a Minimum Operating Strip for operation of mission aircraft is essential. Minimum operating strip layout usually involves identifying the location or layout of the areas listed in **Table 4.2**. See AFPAM 10-219V4, *Airfield Damage Repair Operations*, for more Minimum Operating Strip information.

4.3.3. Landing Zones. Landing zones support contingency airlift operations for C-130 and C-17 aircraft. Potential landing zone areas fall into two basic categories: prepared and semi-prepared (unpaved). Prepared areas may include existing airfields, roads, highways, or other paved surfaces. Semi-prepared surfaces are natural areas such as deserts, dry lakebeds, and flat valley floors (**Figure 4.4**). These surfaces offer the ability to construct short airstrips for a limited use and may or may not have an aggregate surface. Although Prime BEEF forces do not usually perform the initial construction of landing zones, they could be involved with maintaining the landing zones if flight operations continue. Surface maintenance may include soil stabilization, adding an aggregate course, dust control, or compacting in-place soils. For additional surface maintenance information, refer to UFC 3-260-01, UFC 3-250-09FA, *Aggregate Surfaced Roads and Airfields Areas*, UFC 3-250-11, *Soil Stabilization for Pavements*, and UFC 3-260-17, *Dust Control for Roads, Airfields, and Adjacent Areas*.

4.3.4. Airfield Markings. Airfield markings should adhere to precise guidelines that conform to recognized standards for aircraft operations as identified in AFMAN 32-1040, *Civil Engineer Airfield Infrastructure Systems*. While these standards are ideal under normal circumstances, it is unlikely sufficient time will exist to restore the markings to their original condition following an attack. The marking team should be ready to apply expedient techniques that will mark the usable runway surface in the shortest possible time to launch and recover aircraft in a timely fashion.

Table 4.2. Minimum Operating Strip Layout Tasks.

1	Minimum Operating Strip Centerline
2	Minimum Operating Strip Corners
3	Taxiway entrances or exits
4	“T” Clear Zones
5	Mobile Aircraft Arresting System (MAAS)
6	Distance-To-Go (DTG) Markers
7	Precision Approach Path Indicators
8	Edge Markers
9	Taxiway holding lines, centerlines, and changes in direction
10	Emergency Airfield Lighting

Figure 4.4. C-17 Lands on Semi-Prepared Landing Zone.

4.3.4.1. Minimum Operating Strip Markings. Minimum Operating Strip markings consist of threshold and centerline pavement markings, edge markers, and aircraft arresting system location and distance-to-go (DTG) markers. Marking teams may use pavement markings and markers together or independently. For the basic layouts for marking and striping a Minimum Operating Strip, see T.O. 35E2-6-1, *Minimum Operating Strip Marking System, Layout and Marking Procedures for Rapid Runway Repair*.

4.3.4.2. Landing Zone Markings. Personnel should consult DAFMAN 13-217, *Drop Zone, Landing Zone, and Helicopter Landing Zone Operations*, for marking and lighting schemes and dimensional criteria for landing zones.

4.3.5. Expedient Airfield Pavement Repairs. There are various reasons why expedient repairs to airfield pavements may be necessary, they include, war damage by our forces in a battle for the airfield; deliberate damage the enemy did before yielding the field to our forces; poor or substandard construction; or general disrepair due to inadequate upkeep and maintenance. Whatever the reason, pavement repairs during the initial period of beddown should usually be rapid in nature (e.g., compacted crushed stone, cold mix, quick set cements, etc.), due to pressing operational need. When time permits, upgrade expedient repairs to sustainment repairs to allow more aircraft passes between maintenance of the repairs. When appropriate, upgrade the sustainment repairs to permanent repairs.

4.3.5.1. Spall Repair. Generally, a spall is pavement surface damage that does not penetrate through the pavement surface to the underlying layers (**Figure 4.5**), and less than 5 feet in diameter. As a norm, spalls are easier to correct than crater damage, providing the number of spalls are not overwhelming. For specific spall repair procedures, see UFC 3-270-01, *O&M, Asphalt and Concrete Pavement Maintenance and Repair*.

Figure 4.5. Repairing Spall Damage at Deployed Location.

4.3.5.2. Crater Repair. Craters represent damage that penetrates through the pavement surface into the underlying base and sub grade soil, which uplifts the surrounding pavement and ejects base, sub base soils, rock, and pavement debris around the impact area. Craters are more severe damage than spalls. Large craters have an apparent diameter equal to or greater than 6 m (20 ft.). Small craters have an apparent diameter less than 6 m (20 ft.). There are several crater repair methods and newer methods are often being tested and evaluated (**Figure 4.6**). For specific crater repair methods and criteria, refer to Tri-Service Pavement Working Group Manual (TSPWG M) 3-270-01.3-270-07 *O&M: Airfield Damage Repair,* and AFPAM 10-219V4.

Figure 4.6. Practicing New Rapid Airfield Damage Repair Methods.

4.3.6. Airfield Lighting. Airfield lighting may not be important for routine daytime aircraft operations, but it is essential for flight in an environment with limited visibility. Restoration of the existing permanent lighting system may not be feasible due to the extent of damage or location of existing lighting relative to the Minimum Operating Strip; if this is the situation, initially install an Emergency Airfield Lighting System (**Figure 4.7**). If considerable daylight will be available after anticipated airfield damage repair operations, airfield lighting should not be immediately critical to aircraft launch and recovery efforts; therefore, consider delaying installation so teams can work on higher priorities. On the other hand, if the onset of darkness or limited visibility due to bad weather is a factor, start airfield lighting installation as soon as possible. T.O. 35F5-3-17-1*, Lighting System, Airfield, Emergency A/E82U-2* provide procedures for installing the Emergency Airfield Lighting System. In most cases, the question will be when to install the lighting system, not whether one is necessary.

Figure 4.7. Engineers Install Emergency Airfield Lighting System.

4.3.7. Perimeter and Critical Area Lighting. Portable lighting is included in both the BEAR beddown sets and the equipment packages for airfield damage repair. They primarily consist of the Remote Area Lighting System and TF-2 Light Carts (**Figure 4.8**). However, some packages may still contain legacy lighting systems. The Remote Area Lighting System provide for general lighting along the flightline, around POL or Cryogenics storage, etc. Refer to T.O. 35F5-5-22-1, *Remote Area Lighting System (RALS)*, for installation instructions. The TF-2 light cart is a mobile floodlight unit used for large area lighting. Primarily for initial camp beddown, typical uses include perimeter lighting and flightline. To setup and operate the TF-2, see T.O. 35F5-5-21-1, *Flood Light, Trailer Mounted, Type TF-2*.

4.3.8. Mobile Aircraft Arresting System (MAAS). The MAAS provides expedient aircraft arresting capabilities for arresting hook-equipped fighter aircraft and is capable of up to 20 aircraft engagements per hour (**Figure 4.9**). If the arresting system is necessary, Minimum Operating Strip layout personnel should mark its location prior to the arrival of the MAAS installation team. Detailed information regarding applications and capabilities of this system is available in T.O. 35E8-2-10-1, *Mobile Aircraft Arresting Systems (MAAS)*.

Figure 4.8. Examples of Portable Area Lighting.

Figure 4.9. F-22 Engaging MAAS.

4.3.9. Aircraft Parking/Pavement Expansion. After meeting initial airfield operational requirements, additional pavement for aircraft parking and servicing may be necessary. Requirements may include aircraft parking aprons for incoming deployed aircraft and special pavement areas such as arm/de-arm pads, hot cargo pads, quick turn areas, compass rose, and wash racks, along with the accompanying tie-down anchors and static grounding points. Sometimes, existing pavements can double for some requirements; however, if it is necessary to provide additional pavement areas, be sure to follow safety distance criteria associated with the particular project (arm/de-arm, hot cargo, etc.). Also, ensure expansion projects meet specific characteristics (e.g., size, weight, etc.) of the supported aircraft. The Geospatial Expeditionary Planning Tool for automated aircraft parking plans may be helpful. For aircraft characteristics and parking information, refer to UFC 3-260-01 or the aircraft manual for the specific aircraft.

4.3.9.1. Start aircraft pavement expansions as soon as additional requirements are evident; otherwise, a massive backlog of aircraft flows and serious congestion in materiel and asset movement on the ground may occur. Pavement expansion could also be required to park incoming deployed aircraft. Contact wing operations during the site planning process to obtain the probable numbers and types of expected aircraft. Coordinate aircraft parking plans with maintenance personnel. If more parking positions are necessary, consider construction techniques identified in next paragraph.

4.3.9.2. Expanded parking areas can be constructed next to existing aircraft pavements using expedient techniques such as graded and compacted earth, compacted crushed stone or AM-2 matting over a compacted subbase. Once primarily for rapid runway crater repairs, AM-2 matting is now often used to repair or expand aircraft parking areas and as warehouse floors. Refer to TSPWG M 3-270-01.3-270-07, for more information on AM-2 matting assembly and installation.

4.3.10. Access Roads and Drainages. Construction, maintenance, repair, and rehabilitation of access roads and drainages are critical to airfield operations. In essence, these roads are the installation's arteries that support the flow of personnel and materials needed to accomplish the mission. Refer to UFC 3-260-01 for additional information.

4.3.10.1. Access Roads. At least one access road connecting the airfield with the existing road network is required. Bases with operations and service facilities on both sides of a runway should have a perimeter road connected to the access road.

Connect service roads to hardstands, the control tower, service areas, fuel storage and dispensing areas, munitions storage areas, and base camps. It may also be desirable to provide a turnaround loop to ease vehicle maneuvers around hardstands (including fuel storage and distribution areas). Below are other roadway concerns:

4.3.10.1.1. General. Roads on airfields should not cross or be within the lateral clearance distance for runways, high-speed taxiways, and dedicated taxiways for alert pads. This prevents normal vehicular traffic from obstructing aircraft in transit. Roads should be located so surface vehicles will not be hazards to air navigation and navigational aids.

4.3.10.1.2. Firefighting and Rescue Roadways. Firefighting and Rescue access roads shall provide unimpeded two-way access for firefighting vehicles and equipment to incident areas. When practical, connecting these access roads with airfield operational surfaces and other airfield roads will enhance Fire and Emergency Services operations.

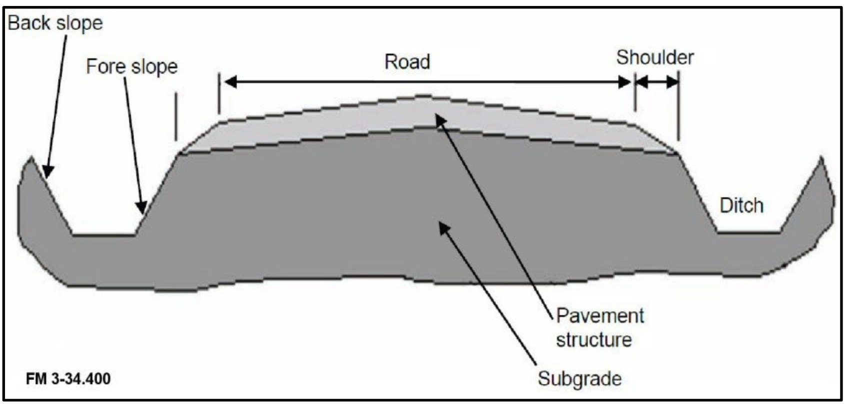
4.3.10.1.3. Fuel Truck Access. Fuel truck access points to aircraft parking aprons should be located so minimal disruptions and hazards to active aircraft movement occurs. Fuel truck access from aircraft areas to the fuel storage areas should be separate from other vehicular traffic. Bulk fuel, truck parking, and truck filling areas need to be as close to the flight line as is reasonably possible.

4.3.10.1.4. Explosives and Munitions Transfer to Arm/Disarm Pads. Transfer of explosives and munitions from storage areas to arm/disarm pads should occur on dedicated transfer roads. Use transfer roads exclusively for explosives and munitions transfer vehicles.

4.3.10.2. Drainages. Drainages should be constructed and maintained for all active roadways. Improperly channeled surface water can quickly undermine most roads, even when they are considered well-constructed. Pending or delayed surface water runoff can also seep into the pavement structure of paved roads if the road surface is not tightly sealed.

4.3.11. Road Design and Construction. Air Force engineers generally design and construct roads in the theater of operations to three standards: initial, temporary, or semi-permanent. During contingency operations, nearly all roads constructed meet temporary standards. In some rare cases, engineers build semi-permanent and permanent roads to support long-term operations. Initial and temporary roads are usually made of stabilized earth or gravel, while semi-permanent roads are typically made of asphalt with concrete turn pads. Generally, road construction consists of crowned driving surface and pavement structure, a shoulder area that slopes directly away from the driving surface to provide drainage off the driving surface, and side ditches for drainage away from the road itself (**Figure 4.10**). For detailed information related to flexible and rigid pavement designs, refer to UFC 3-250-01FA, *Pavement Design for Roads, Street, Walks, and Open Storage Areas*, UFC 3-250-03, *Standard Practice Manual for Flexible Pavements*, and UFC 3-250-04, *Standard Practice for Concrete Pavements*.

Figure 4.10. Typical Road Cross Section.



4.4. Revetment and Soil Berm Construction. Revetments and berms are simple and sometimes low-tech solutions that can satisfy certain protective construction requirements around airfields. Primarily, these structures protect and shield vital facilities, equipment, and other resources; suppress noise; control spills; limit access; or support waste management activities in the theater of operations.

4.4.1. Revetments. At contingency airbases, using revetments for force protection purposes is a routine option. These walls or barriers are routinely constructed using soil-filled wire and fabric containers, prefabricated concrete barriers, or metal bins. However, they may also be constructed using sandbags, wooden bins, sand grids, plastic bins, and various other expedient methods. Preliminary construction plans should include the locations for the revetments, their configuration, and a source (on-base quarry or off-base vendor) for revetment fill material. Consult GTA 90-01-011 (JFOB7 Handbook), UFC 4-022-02, *Selection and Application of Vehicle Barriers*, T.O. 35E4-170-2-WA-1, *Assembly and Erection Instructions, Aircraft Revetment, Type B-1*, and AFTTP 3-32.34V3, *Civil Engineer Expeditionary Force Protection*, for more information on constructing revetments.

4.4.2. Soil Berms. Soil or earthen berms have a wide range of uses at contingency airfields. They provide force protection as base perimeters, defensive fighting positions, traffic control barriers, or facility hardening. They also provide safety barriers for landfills, burn pits, hazardous materials storage sites, and for noise abatement and spill protection, among other things. Refer to GTA 90-01-011 (JFOB7 Handbook), UFC 4-022-02, AFTTP 3-32.34V3, and AFTTP 3-32.33V2, *Expedient Roads, Drainage, and Protective Structures*, for more information on berm construction.

4.5. Fuel Dikes. Referred to as either fuel dikes or fuel berms, these structures contain spills if tanks or bladders rupture or catch fire. They also act as a safety barrier and base defense measure (**Figure 4.11**). Engineers tasked to build fuel dikes should work closely with logistics (fuels) specialists responsible for the design and operation of fuel distribution systems. Consider the following when constructing dikes for Fuels Support Equipment refueling units:

Figure 4.11. Fuel Dikes Control Spills and Forms Protective Barrier.

4.5.1. The site should be reasonably level and well drained to prevent water damage. Avoid low areas to prevent danger of vapor collection. Also, avoid placing the site in low hill areas, rolling country, uphill, or upstream from other installations that would be in the path of escaping fuel. It should also be free of rocks and obstructions. The ground should be as level as possible with a maximum slope of three degrees to prevent the tank from creeping or crawling. Avoid low areas to prevent accumulation of trapped vapors. Give careful attention to receiving capabilities, such as rail cars, taxiways, and roads.

4.5.2. The size or height of fuel dikes should be able to contain the volume of liquid in the fuel bladder within the dike should a rupture occur. Consider adding secondary dikes around the primary dike to catch residual or accidental leakage and spillage due to hose/coupling breaks. If secondary dikes are used, the berm liner should be long enough to cover the secondary dike.

4.5.3. When setting up a bladder area, ensure all areas are within reach using a fire-fighting vehicle with a top turret throw range of 175 feet. Minimum distance between bladder storage areas should not exceed 150 feet. Roads built around fuel dikes should permit fuel trucks (fueling and de-fueling) to travel over the ground adjacent to the dike. Refer to AFPAM 23-221, *Fuels Logistics Planning*, and T.O. 37A12-15-1, *Collapsible Fuel Bladders*, for other fuel dike or berm construction details.

4.6. Ditches. During development of initial contingency locations, ditches are a common expedient method to enhance or establish drainage around the installation's roads, airfield, and facilities, but they are also useful as an anti-vehicle barrier to stop vehicles from penetrating the base's perimeter. For additional ditch construction information, refer to UFC 3-260-01, UFC 4-022-02, and GTA 90-01-011 (JFOB Handbook).

Chapter 5

SHELTERS AND SUPPORT FACILITIES

5.1. General Information. During wartime or other contingency operations, adequate beddown facilities are essential for deployed forces. Civil engineers help provide the required infrastructure to support planned operations and ensure an ample quality of life for base residents. Facilities erected at bare bases should meet certain theater construction standards. Joint Publication 3-34, *Joint Engineer Operations*, emphasize that Combatant Commanders, in coordination with Service components and the Services, specify contingency construction standards in the theater of operation. A good resource for contingency construction standards and non-permanent facility and utility designs is the Joint Construction Management System (JCMS). The JCMS provides specifications, standard drawings, bills of material, man-hour estimates, and other data for many structures used by the AF and other Services to beddown forces during contingencies. It includes designs for initial structures with an expected life of up to 180 days and temporary facilities with an expected life of up to two years. Consider using the JCMS whenever possible to reduce and streamline wartime design and procurement efforts.

5.2. Contingency Construction Standards in Theater. Generally, beddown or bare base construction standards fall into three categories: organic, initial, and temporary construction standards.

5.2.1. Organic. Organic construction uses host nation or unit organic equipment, facilities and labor to support deployments lasting up to 90 days. Since construction is time-consuming and often costly, the intent is to seek an alternative to new construction and use a minimum amount of labor and resources, until the arrival of the full engineer capability. Minimal or no land grading or site work, tents and pit latrines are examples of this standard. Although intended for use for up to 90 days, organic construction may be used for up to six months.

5.2.2. Initial. Initial construction is also characterized by relatively austere facilities and utilities that require minimal engineer effort. This construction is intended for use during the first six months of a contingency. Tents with flooring, latrines with sewage lift stations, tactical generators for electrical distribution and portable refrigeration are examples of this standard. BEAR assets are generally categorized as "initial" construction facilities. This connotation, however, does not mean they will be totally replaced after six months; but rather they will be used at the onset of a conflict. It is possible that some of these assets will last several years before needing replacement.

5.2.3. Temporary. Temporary construction is characterized by facilities and utilities of a more substantial nature. It is used to increase efficiency and sustain operations for at least 24 months and with upgrades for up to 5 years. Wood frame buildings, bathhouses, commercial electric power and paved roads are examples of the temporary standard.

5.3. Facility Assets and Preparation Actions. Successful BEAR facility erection depends on several actions being carried out prior to and during the arrival of personnel at a bare base. Some of the actions are easy to control, others not so much. The ones easily influenced include the degree of training the base populace has on erecting BEAR facilities, which in turn, could dictate how much involvement engineers will have in erecting facilities for other organizations, and the arrival timing and sequence of facility assets. Always make the best of your particular situation; for purposes of this publication, assume the base populace is generally knowledgeable in facility erection and assets flow into the base in a reasonable manner.

5.3.1. It is doubtful many people at a bare base will be able to identify all the various BEAR facility and utility components as they arrive. Consequently, engineers will have to accomplish this task since it is an engineer responsibility to place most of these items in service. Supply personnel deployed in support of BEAR help expedite assets as BEAR items arrive. These asset expediters will assist aerial port personnel in identifying equipment, arrange to have engineer-related items moved from the ramp area to the job site or interim holding area and maintain asset accountability. If a supply representative from the 635th Materiel Maintenance Group is available, they may be able to help identify BEAR assets as they arrive and assist in maintaining accountability.

5.3.2. Identify a reasonably large open storage area immediately upon arrival at a bare base for temporary storage and eventual longer-term storage for shipping containers. As facility and utility assets are off loaded, separate them by type of system or building and moved to the holding area or work site if needed at the time. Any forklift-qualified personnel can assist in moving items if necessary. Plan to have most BEAR facilities delivered to the engineer holding area, then to their final location for erection by user personnel as they arrive. Arrange with base supply personnel to consolidate all the shipping and storage containers once empty. If arrangements with supply personnel cannot be made early in the deployment, plan on initially storing these containers in the engineer holding area.

5.3.3. While assets are off loaded from incoming aircraft or vehicles, site layout and site preparation should be well underway. Try to have enough heavy equipment operators on the job so as not to fall way behind the site layout crews. Obviously, this tactic is dependent on equipment availability and the number of other heavy equipment tasks ongoing; however, the speed of facility erection directly relates to the degree of site preparation completed. If the terrain is relatively level, the site preparation task should go faster, if terrain is irregular, size the heavy equipment support accordingly. Look to contract support to fill heavy equipment gaps.

5.3.4. As site layout and preparations continue, begin delivering assets to the job sites; plan on doing this with engineer forces. Have someone use the site layout plan and a general list of facility allocations to oversee this effort.

5.4. BEAR Facilities. BEAR shelters and other structures are vital to beddown, standup, and support our forces at expeditionary locations regardless of the availability of local infrastructure and support facilities. Although the Air Force continually upgrade, modify, and improve BEAR facilities, bare base beddown typically use a mixture of current and legacy structures and support equipment.

5.4.1. Small and Medium Sized Shelters. Virtually all functional areas receive BEAR shelters like the Small Shelter System, so delivery of these assets should be reasonably straightforward. On the other hand, use of the Medium Shelter System is unique to certain areas, so carefully apportion those assets as necessary. Deliver shelter assets as close as possible to final locations to prevent moving them later. Pick up empty ship/store containers when returning to the holding area after delivering assets. This keeps the base less cluttered and protects containers from damage or misuse.

5.4.2. Large Shelters. Generally, users do not erect large shelters. Prime BEEF or RED HORSE teams, with support from the 635th Materiel Maintenance Group large structures team erect large shelters, including the dome shelter, large area maintenance shelter, and the frame supported tension fabric shelter. These specialized teams can handle the movement, unpacking, and erection of these larger facilities since they have the requisite training and skills.

5.4.3. Miscellaneous and Legacy Shelters. Some miscellaneous and legacy shelters, potentially still in use, include the Expandable Light Air Mobile Shelter, General Purpose Shelter, Expandable Shelter Container, and the Aircraft Hangar. These assets remain a potential option for multiple purposes at deployed locations worldwide.

5.4.4. From an engineer aspect, a basic premise of bare base development is that users will erect their own facilities, thereby freeing engineer personnel for other, more critical beddown tasks. This does not mean engineers provide no support at all for facility erection. Plan to erect all Medium Shelter Systems—these are probably too complex for most base organizations to handle. Plan to have a small cadre of personnel knowledgeable on erection techniques for Small Shelter Systems to assist the base populace. There will be occasions where untrained people are involved with facility erection tasks and engineers should be prepared to offer supervisory and instructional guidance. However, base populace should not attempt utility connections to facilities. The potential for damage to system components and harm to both base personnel and electrical crews is too great.

5.4.5. The facilities outlined in **Table 5.1** support various base functional areas. However, senior personnel determine final facility allocation locally. Make sure the base and wing command staffs are involved. Refer to AFPAM 10-219V6 for details and descriptions of BEAR shelters.

Table 5.1. Typical Bare Base Support Facility Allocations.

Function	Type Facility Support
Aviation Operations	Small Shelters, Medium Shelters
Aviation Maintenance	Medium Shelters, Small Shelters, Dome Shelters, Aircraft Hangars
Aircraft Maintenance Additive	Aircraft Hangars
Munitions Maintenance	Medium Shelters, Small Shelters
Airfield Damage Repair	Small Shelters, Aircraft Hangars, Medium Shelters
Supply	Small Shelters, Dome Shelters
Transportation	Small Shelters, Dome Shelters
Engineers	Small Shelters, Medium Shelters
Aviation Admin/Supply/Intelligence/ Medical, Headquarters, Office of Special Investigations, Intelligence Additive, Weather, Combat Camera, Medical, Postal, Security Forces, Information Management, Personnel, Force Support, Finance, Base Operations, Contracting, and Fuels Lab	Small Shelters

5.5. Force Support Facilities. During bare base development, Force Support functions generally consist of kitchen, billeting, laundry, and mortuary facilities. While many of these facilities use Small Shelter System assets and erected by Force Support personnel, CE personnel erect the larger facilities, perform site preparation, connect utilities such as power, water, and sewage, and install some of the more complicated equipment items such as water heaters, walk-in refrigeration units and air conditioning units.

5.5.1. Kitchens. Two types of kitchen packages are available for bare base development, the standard BEAR 9-2 Kitchen (550 personnel) and the Single Pallet Expeditionary Kitchen.

5.5.1.1. The BEAR 550 kitchen is a complete portable food preparation and serving complex. It can serve up to 550 personnel and seat 120. When siting the facility, select a site approximately 200 feet by 100 feet that is relatively level, has good drainage, is free of rocks and underbrush, is sheltered from high winds, and accessible to the rest of the installation. If configuring two BEAR 550 kitchen facilities to serve up to 1100 personnel, select a site that is approximately 300 feet by 300 feet. Refer to T.O. 35E4-169-31-WA-1, *Kitchen, Electric, Harvest Falcon/Eagle (Mess Kit Laundry Optional) Bare Base*, for more information.

5.5.1.2. The Single Pallet Expeditionary Kitchen is a complete food service facility inside an Expandable, Integrated Shipment Unit. It has a messing capability to feed hot meals to 500 personnel using Unitized Group Rations, not included. An accompanying Medium Shelter System provides seating for dining area and placement of Expandable, Integrated Shipment Unit. The Single Pallet Expeditionary Kitchen requires a clear, level area; ideally, the area underneath the container should be completely clear of obstructions and debris, and it should not be placed on any depressions or sharply raised areas. See T.O. 35E4-235-1-WA-1, *Operations and Maintenance Instructions w/IPB, Single Pallet Expeditionary Kitchen*, for siting and assembly information.

5.5.2. Billeting (Lodging). Billeting facilities generally utilize small and medium shelter systems from BEAR housekeeping packages for personnel shelter, showers and latrines, offices, laundries, and storage. However, in some instances, other shelters (including legacy assets) may be used. The bulk of personnel shelters are comprised of Small Shelter System assets. Site and erect these shelters as discussed earlier in this chapter. It is a good idea to obtain a listing of the lodging facility breakout from Force Support personnel before siting these facilities. The group breakout list identifies any personnel groups that should be within contiguous billeting blocks (examples: flight crews, officers, females, and foreign military). **Table 5.2** lists typical breakout groups. The number of personnel planned for each group could affect the layout plan. Spacing and distance for these personnel shelters should be according to specifications in UFC 4-410-01, *DOD Minimum Antiterrorism Standards for Buildings*.

Table 5.2. Lodging Facility Breakout Groups (Typical).

Lodging Breakout Groups	
1	Flight crews (by type/expected number of aircraft and crew numbers)
2	Officer and Senior Officers
3	Enlisted and Senior Non-Commissioned Officers
4	Men and Women
5	Civilians
6	Foreign Military/Visitors
7	Transient and Permanent personnel
8	Any special shift crews (example: firefighters)
9	Any quarters with requirements for higher security (example: special mission or VIP)

5.5.3. Showers and Latrines. Portable shower and latrine facilities are included in BEAR housekeeping and flightline operations packages. Normally housed in Small Shelter Systems, site these facilities on a relatively level surface that is free of debris. Refer to T.O. 35E35-5-1, *Field Deployable Latrine Assembly*, T.O.35E35-4-1, *Shower Facility Bare Base*, and T.O. 35E35-3-1, *Shave Stand Bare Base*, for more information. The Expandable Bicon Shelter Hygiene System is replacing these hygiene facilities via attrition.

5.5.3.1. During contingencies or in the early stages of bare base deployments, deployable shower and latrine kits may not be available. Additionally, even when BEAR assets begin to arrive, there may be locations on the base that need expedient latrine facilities due to the distances from main utility networks or inadequate quantities of deployable assets. Therefore, engineer support may be required to construct various types of field hygiene and sanitation facilities.

5.5.3.2. Expedient facilities could include any of the following: latrines, urinals, hand-washing stations, and shower and shaving stations. Construct these facilities when no other practical options are available or permitted. Refer to AFH 10-222V4, AFPAM 10-219V6, and AFTTP 3-32 Series for additional details on expedient hygiene and sanitation facilities.

5.5.4. Self-Help Laundry. The self-help laundry is an efficient field laundry system designed for rapid deployment and continuous operation. The site selected for the laundry facility should be relatively level with adequate drainage. Laundry equipment requires approximately 75 square feet of space inside a small shelter system or legacy tent. Consult T.O. 50D1-4-1 or 50D1-4-11, *Laundry, Self-Help, Bare Base*, for more information.

5.5.5. Mortuary. Commonly, field mortuary sites use a Small Shelter System for Mortuary Collection Point operations. The site also requires the Advanced Design Refrigerator, 300 Cubic Foot (ADR-300), or legacy 150-cubic foot refrigerators for refrigerated storage. The site and facility should be located away from other facilities. It may require a power generator if normal site power is not available during processing. The mortuary collection point should also have ample area lighting, a water supply, access for truck and forklift operations, good drainage and runoff protection, and ventilation. Depending on the location and temperatures, an environmental control unit may be necessary during processing. A contaminated waste collection point may also be necessary.

5.6. Non-BEAR Facilities. Non-BEAR facilities come in all shapes and sizes and from various sources. They may be special field-deployable medical systems, commercial-off-the-shelf items, deployable assets from other Services, locally manufactured structures, or pre-designed facilities built from the ground up using Class IV construction materials. Whatever the source, Prime BEEF forces are building and supporting bare base and force beddown facilities and structures around the world for Air Force, joint, combined, and multinational operations.

5.6.1. Expeditionary Medical Support System Facilities. Expeditionary medical and dental facilities provide an essential resource to treat (and evacuate, if necessary) casualties under all conditions. These facilities generally utilize Small Shelter System or the Multipurpose Tent System; however, using other shelters may be an option. Expeditionary Medical Support Systems are expandable equipment packages that range from a basic, rapid response facility to an Air Force Theater Hospital. While medical personnel possess the training and experience to erect medical facilities, deployed civil engineers provide significant beddown support for these facilities. Expeditionary Medical Support System facilities require specific siting and utility requirements. Site medical units in lower threat areas of the base but as near as practical to force support facilities such as billeting, showers and laundry. In addition to performing site preparations and providing basic utilities like heat, electric, and water, engineers should also consider factors below:

- Emergency back-up power needs
- Oxygen and vacuum lines, if required
- Refuse and medical waste disposal requirements
- Room for possible expansion of medical treatment facilities
- Adequate access roads
- Areas for erection of a radio antenna/satellite
- Location of latrines (should be in close proximity)
- Flightline accessibility (incoming/outgoing aeromedical patients)

5.6.2. Commercial-Off-The-Shelf Facilities. Procure commercial-off-the-shelf building systems when necessary to meet specific mission requirements. These facilities are usually frame, fabric, and/or steel structures, which may be set up rapidly, are cost effective, and generally have a life span that exceeds theater temporary construction standards. These facilities function as aircraft sunshades and hangars, maintenance buildings, warehouses, and other purposes. While commercial contractors may construct some of these, engineers will likely be required to maintain and repair these facilities. If the facilities are portable, like the aircraft sunshade in **Figure 5.1**, Prime BEEF personnel may be required to relocate these structures to satisfy operational requirements.

Figure 5.1. Engineers Relocate Aircraft Sunshades.

5.6.3. Force Provider Facilities and Equipment. Army beddown facilities and equipment (referred to as Force Provider) will likely be encountered when deployed to a joint environment, and engineer work crews could be tasked to help beddown troops using these facilities. In some instances, work crews may need to complete site preparation, build access roads, and provide water and power to these facilities. In other situations, crews may be required to erect these facilities. Force Provider assets are similar to Air Force BEAR and legacy equipment assets, but there are some variations, and workers should review applicable technical manuals before erecting or maintaining these assets. As shown in **Table 5.3**, some examples where Force Provider assets differ from BEAR assets includes Army Prime Power and Air Force BEAR Power Unit, emergency power generators, Reverse Osmosis Water Purification Units (ROWPUs), and latrine and shower units. In addition, there are some differences in the water distributions systems, field laundry configurations, and methods for collecting and treating gray water.

Table 5.3. Force Provider/BEAR Comparison.

Army	Air Force
Army Prime Power Support and 60kW Tactical Quiet Generators	BEAR Power Unit and MEP-12 Prime Power and Tactical Power Generators (30, 60, 100kW)
3,000 GPH ROWPU	1500 GPH ROWPU
Army Water Distribution System	BEAR Water Distribution System
Containerized Batch Laundry	Self-Help Laundry
International Organization for Standardization Container Latrines and Showers	Latrine/Shower Setup in Small Shelter Systems or Expandable Bicon Shelter Hygiene System
Gray Water Collection System	Gray Water Field Treatment

5.6.4. **Pre-Designed Theater-Constructed Facilities.** There are numerous, pre-designed initial, temporary, and semi-permanent facilities intended for contingency operations outside the continental United States. They include barracks, latrines, administrative areas, hospitals, storage and distribution facilities, and many others. In today's joint operations environment, Prime BEEF work crews often build these and other pre-designed structures (**Figure 5.2**). Engineering data for pre-designed, theater-constructed facilities is available in the Joint Construction Management System. The Joint Construction Management System offers design plans and provides two and three-dimensional drawings of various facilities. Additionally, a 360-degree animated fly-through of selected facilities is available so engineers can see what the structure looks like before it is constructed.

Figure 5.2. Building Shower Facilities at Contingency Location.

Chapter 6

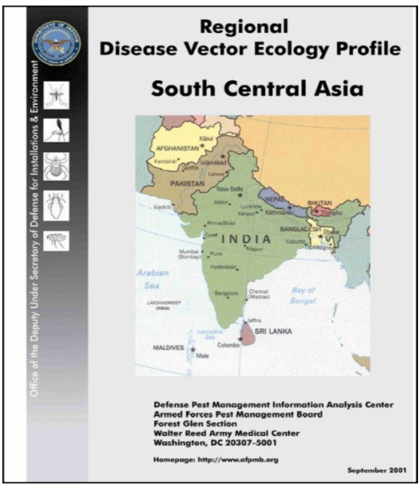
PEST MANAGEMENT

6.1. General Information. Control of insects, rodents, and associated vermin is vital for force protection. These pests carry disease and quickly spread contamination throughout the airbase if left uncontrolled. The civil engineer pest management team performs critical tasks that help preserve the health and welfare of deployed forces. Primarily, they provide entomological services to rid an installation of pests and help maintain a healthy work and rest environment under austere conditions (**Figure 6.1**). This task includes more than the sensible use of pesticides, but rather a comprehensive, integrated pest management program. The integrated pest management approach combines a variety of techniques—including physical, mechanical, educational, biological and chemical—to prevent medical injury or economic damage from pests and disease vectors.

Figure 6.1. Judicious Application of Pesticides Help Control Insects.

6.2. Guidance and Resources. AFMAN 32-1053, *Integrated Pest Management Program*, implements Department of Defense and Air Force pest management policies, it generally applies to Air Force installations in the United States and its territories. For overseas contingency operations, theater-specific guidance applies. Combatant Command policy and requirements may be available in the environmental annex of the Operations Plan and/or Order. The Armed Forces Pest Management Board is also an important resource. It provides, collects, stores, and disseminates published and unpublished information on arthropod vectors and pests, natural resources, and environmental biology important to the Department of Defense. Other products include technical guides and country- or region-specific Disease Vector Ecology Profiles, like that illustrated in **Figure 6.2** for Afghanistan and the South Central Asia region. The Armed Forces Pest Management Board Technical Guide No. 24, *Contingency Pesticide Usage Guide*, provides basic information on using pesticides to control insects that transmit disease and for other pests encountered during field situations worldwide. While some information from Technical Guide-24 is available here, personnel should go to the Armed Forces Pest Management Board web site at https://www.acq.osd.mil/eie/afpmb/technicalguides.html for this and other contingency-related entomological information.

Figure 6.2. Disease Vector Ecology Profiles.



6.3. Safety. When working with pesticides and pest management equipment, safety is paramount. A dangerous temptation during contingency operations is to relax safety requirements. Some people think, "The rules don't apply here." Yielding to that temptation can cost you your health and the health of those around you. **Table 6.1** lists general safety requirements and precautions to observe.

Table 6.1. General Pest Management Safety Checks.

Item or Activity
Are pesticides only used as part of an integrated pest management program?
Is proper PPE on hand and utilized in accordance with pesticide label?
Do workers adhere to safety requirements and restrictions on pesticide labels?
Do workers follow all directions, restrictions, and warnings for protecting the general population and non-target organisms?
Are empty pesticide containers rendered "UNUSABLE" and properly disposed as per label?

6.4. Sanitation. Good sanitation and proper waste disposal under contingency conditions are the most important principals in combating diseased pests such as filth flies and rodents. Even in mobile field situations, these pests have historically amplified sanitation problems, often causing epidemics of diarrheal diseases. This threat is even greater in urban areas converted to temporary or semi-permanent military use because personnel will not move every day to a different, cleaner area. In this situation, cockroaches may join other pests associated with poor sanitation in compounding the problem, especially in and around structures used for food storage, preparation and consumption, and buildings used for troop housing. All these pests should be controlled, but only in conjunction with efforts to correct the sanitation problems that provide them food, breeding areas, and shelter. Successful pest control requires good sanitation practices be established and maintained. You cannot control pests with pesticides alone.

6.5. Contingency Pesticides. As previously addressed, the ideal means of pest control is good sanitation and proper disposal of waste materials and garbage. Sometimes that may not be enough to control the pest population, and extermination may be required. Control insects by spraying an insecticide in and around nesting and feeding areas and fogging or spraying throughout the installation. Control rodents with poison baits, trapping, and sealing access points. The pesticides found on the Armed Forces Pest Management Board contingency pesticide list are suitable for contingency use by one or more of the military Services. A current list is available on the Armed Forces Pest Management Board web site at https://www.acq.osd.mil/eie/afpmb/.

6.5.1. Using Pesticides in Foreign Countries. Different rules concerning the application of pesticides may apply in areas outside the jurisdiction of the Environmental Protection Agency. The Department of Defense follows applicable international agreements, other DoD Directives and Instructions as appropriate and environmental annexes incorporated into operation plans or operation orders. For North Atlantic Treaty Organization operations, Standardization Agreement 2048, *Chemical Methods of Insect and Rodent Control*, lists pesticides approved for use by member nations. See Armed Forces Pest Management Board Technical Guide-24 for additional guidance on use of pesticides during contingencies.

6.5.2. Pesticide Storage. Isolate pesticide storage areas from congested areas for reasons of health and safety, fire protection, environmental protection, and security, if possible. The most compelling reason for the isolation of pesticide storage facilities is the fire safety. If a fire occurs in a facility located within or adjacent to an office complex, extensive decontamination of nearby areas from drift of toxic vapors, smoke, liquids, and particulates is required. Designated pesticide storage areas are essential to safely protect and store pesticides and related chemicals. See Armed Forces Pest Management Board Technical Guide-24 for additional guidance.

6.5.3. **E**mergency Procurement of Pesticides/Pest Management Equipment. Deploying forces often need pesticides and equipment on short notice. The

Defense Logistics Agency has established an Emergency Supply Operations Center to provide equipment and supplies to deploying forces with urgent requirements and in a timely manner. Use the contact information in **Table 6.2**. The most current list of pesticide dispersal and surveillance equipment is available on the https://www.acq.osd.mil/eie/afpmb/. All items may be suitable for contingency use by one or more of the military Services. The list contains the most current products and prices.

Table 6.2. Defense Logistics Agency Contact Information.

Equipment and Supplies	Contact
For insect repellents, pesticides, pesticide application equipment, and personal protection equipment (bed nets, head nets, etc.) and respirators:	Contact the Defense Logistics Agency Customer Interaction/Contact Center at 1-877-DLA-CALL (1-877-352-2255) or Defense Switched Network: 661-7766. They are open 24/7 365 days a year for all customer inquiries and submittal of requisitions. Email and related info is listed below: Email Address: DLAContactCenter@dla.mil Phone: 1-877-352-2255 Phone: 269-961-7766 Fax: 269-961-7791 Defense Switched Network Fax: 661-7791
Information and Assistance	**Contact**
For technical, quality, logistical, ordering inquires, or questions:	Contact the Defense Logistics Agency Chemist/ Product Manager at (804) 279-3995/ Defense Switched Network: 695-3995. Normal duty hours are 0800-1700 hours weekdays Eastern Standard Time.

6.5.4. Department of Defense Pesticide Hotline. The Department of Defense Pesticide Regulatory Action System provides the pesticide hotline service as a Department of Defense-wide source for all pesticide-related information and enables Department of Defense personnel to obtain information on pesticide labels, Materiel Safety Data Sheets, recent pesticide regulatory actions, and pesticide use and disposal information. Pre-deployment units can utilize this service to determine the current availability of approved pesticides in the military supply system and to receive recommendations on the availability and suitability of non-standard pesticides for use in the deployed areas. Contact the Department of Defense Pesticide Hotline at (410) 436-3773, Defense Switched Network: 584-3773, Email at pesticide.hotline@amedd.army.mil.

6.6. Transporting Pesticides. Vehicles used to transport pesticides should be single use vehicles and clearly identified as vector control vehicles. Do not transport food, water, or medical supplies in vehicles not designated for single use. Maintain vehicles in a clean and orderly appearance, free from observable pesticide spills, or residues. Vehicles used to transport pesticides will be equipped with a fire extinguisher and a spill kit capable of handling the maximum amount of pesticide transported at any given time.

6.7. Department of Defense Repellents. The best strategy for defense against disease-bearing arthropods includes the application of extended-duration DEET (chemical name, N, N-diethyl-meta-toluamide) lotion to exposed skin, coupled with the application of permethrin to the field uniform. When used with a properly worn uniform, this system will provide nearly complete protection from arthropod-borne diseases. Additional information on repellents and their application is available in the Armed Forces Pest Management Board Technical Guide-36, "*Personal Protection Measures against Insects and Other Arthropods of Military Significance*."

6.8. Controlling Vegetation with Herbicides. There are specific limits imposed on the use of herbicides during wartime and peacetime, inside and outside the United States. According to Executive Order 11850, *Renunciation of Certain Uses in War of Chemical Herbicides and Riot Control Agents*, 8 April 1975, the

United States has renounced first-use of herbicides in war except under regulations applicable to their domestic use on bases or for control of vegetation around the immediate defensive perimeters of bases. Only the President of the United States may authorize other wartime uses. Make sure any use of herbicides is according to established procedures and limits.

Chapter 7

CONTINGENCY WATER AND WASTEWATER SYSTEMS

7.1. General Information. Establishing a viable water and wastewater system is essential to the success of deployed military operations. It has a direct impact on the health, welfare, and morale of the troops. The Air Force's contingency water system (BEAR Water System) can fulfill water purification, potable water distribution, and wastewater recovery needs at austere locations. This chapter briefly addresses water consumption planning factors, water system sighting and layout, and an overview of the contingency water system. In addition to the information addressed here, CE Airmen should refer to T.O. 40W4-21-1, *Basic Expeditionary Airfield Resources (BEAR) Water System,* T.O. 40W4-20-1-WA-1, *1500 Reverse Osmosis Water Purification Unit (ROWPU)*, AFH 10-222V11, AFH 10-222V4, *Environmental Considerations for Overseas Contingency Operations* and UFC 3-240-01, *Wastewater Collection and Treatment,* for information on contingency water and wastewater treatment systems. Consult the Bioenvironmental Engineering flight when designing and developing drinking water systems and processes. Bioenvironmental engineering personnel have an instrumental role in accessing drinking water quality, treatment, and vulnerability.

7.2. Water Source Development and Water Production. Water sources have a significant impact on water system development. For example, is the source fresh water, brackish, or salt water? Does it come from a well, river, lake, ocean, or municipal water supply? How far is the water source from the base? What is the water temperature? These factors determine how much effort and equipment is required to capture and treat the water during the initial beddown period. In some instances, work crews may need to clear a road to the water source, or an expedient water intake system may need to be set up. Even building a temporary dam to create an expedient reservoir could possibly be required. In any case, once the source and location are usable, install and use raw water pumps to retrieve the water. If the water production plant will not be located near the water source, it may be necessary to fill bladders, tanks, or other water vessels for transport to the site chosen for the water.

7.2.1. Water supplied during deployments and at contingency locations must meet military field water standards (MFWS) in Air Force Manual 48-138_IP and required by Joint Publication (JP) 4-03, *Bulk Petroleum and Water Doctrine*. These standards are applicable to military- and contractor-operated water purification systems and apply to treated drinking water whether it is in storage; distributed by pipes, vehicles, or trailers; or packaged and distributed by military or contractor systems and personnel.

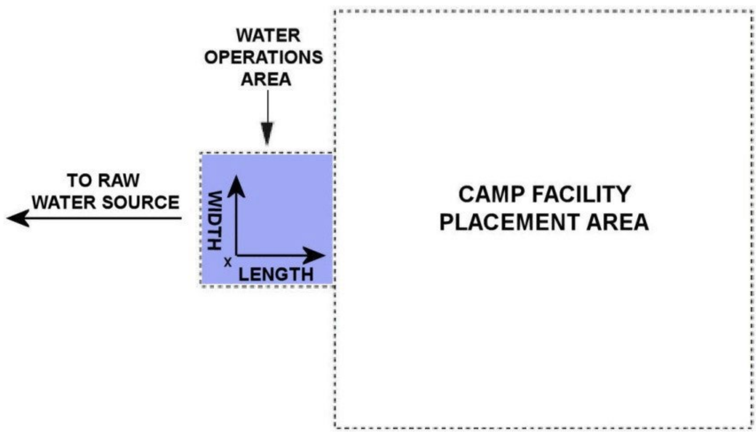
7.2.2. Providing essential water to support the anticipated base population and projected mission is a priority-1 task. Complicating the situation somewhat is the fact that the entire contingency water system package is unlikely to arrive at one time early in the deployment. An initial water production package (consisting of two ROWPUs, storage bladders, pumps, hoses, fittings, and power source for standalone operation) is usually the first BEAR water production items received. If the source water is located over 500 feet from the anticipated water production location, a Source Run subsystem package may also be included with the initial water package. Take immediate steps to develop water sources, set up water production, and set up potable water storage bladders. Later, additional BEAR water system assets should arrive to enable installation of a complete water plant, distribution, and wastewater collection system.

7.2.3. Water Operations Area (WOA) Site. Wherever the camp is located, there should be enough real estate outside the camp placement area to allow for the Water Operations Area. The WOA is an area identified for the Dual Water Pump Station, Water Tank Farm, and Water Production subsystems. Site the WOA on terrain that is relatively flat and free of debris. **Table 7.1** provides WOA dimensions and the quantity of water production subsystems required based upon camp population. **Figure 7.1** illustrates location for a WOA in relation to the camp facilities layout area.

Table 7.1. WOA Layout Dimensions and Water Production Data.

Camp Populace	Gallons Required Per Day (30 GPPPD)	Tank Farm (TF) ONLY	TF w/600 Water Production Subsystem (WPS)	TF w/1500 Water Production Subsystem (WPS)	600 WPS Quantities 36,000 GPD	1500 WPS Quantities 60,000 GPD
		Area in Feet (Width x Length)			3 ROWPUs	2 ROWPUs
550	16,500	50 x 130	160 x 230	140 x 230	1	1
1100	33,000	80 x 130	160 x 230	140 x 230	1	1
1650	49,500	160 x 130	250 x 230	140 x 230	2	1
2200	66,000	160 x 160	250 x 260	210 x 260	2	2
2750	82,500	160 x 190	340 x 290	280 x 290	3	2
3300	99,000	160 x 190	340 x 290	280 x 290	3	2
4400	132,000	200 x 220	430 x 320	350 x 320	4	3

Figure 7.1. Location of Water Operations Area (Typical).



7.3. Water Planning Factors.

7.3.1. Consumption. Anticipated water consumption is usually based on the size of the deployed force and its consumption requirements. Joint Publication 4-03, *Joint Bulk Petroleum and Water Doctrine*, describes essential water requirements as drinking, personal hygiene, field feeding, medical treatment, heat casualty treatment, personal contamination control, patient decontamination in CBRN environments and in arid regions, and vehicle and aircraft maintenance. When requirements exceed production, reduce all but essential consumption. Where BEAR mobile assets (ROWPUs and associated distribution systems) are used exclusively, the water-use planning factor should be about 30 gallons per person per day (gpppd). If a fixed or permanent water treatment plant along with adequate water storage facilities is provided at the beddown location, consider using a 60-gpppd planning factor. Listed in **Table 7.2** is a breakdown of the 30-/60-gpppd planning factor.

Table 7.2. Water Use Planning Factors.

Functions	Water Usage Factor (gal/person/day)	
Potable Water	**Using BEAR (30 gpppd)**	**Using Fixed Treatment Plant (60 gpppd)**
Drinking	4.0	4.0
Personal Hygiene	3.0	3.0
Shower	3.0	15.0
Food Preparation	4.0	5.0
Hospital	1.0	2.0
Heat Treatment	1.0	1.0

Functions	**Water Usage Factor (gal/person/day)**	
Non-Potable Water	**-**	**-**
Laundry	5.0	14.0
Construction	2.0	2.0
Graves Registration	0.5	0.2
Vehicle Operations	0.5	1.8
Aircraft Operations	2.0	3.0
Firefighting	2.0	4.0
Loss Factor (10%)	2.0	5.0
Total	**30.0**	**60.0**

7.3.2. Wastewater Estimates. Often, we view potable water as the most essential element to bare base operations, and the disposal of wastewater and other wastes seems to be of lesser importance. On the contrary, unless we dispose of all types of wastes quickly and properly, unsanitary conditions quickly develop. Flies, mosquitoes, and rodents can overwhelm a developing base, spreading disease with them. Of the 30 gpppd of potable/non-potable water provided at a bare base for initial beddown, approximately 21 gpppd (70 percent) will become wastewater. For an estimated 60 gpppd of potable/non-potable water, about 42 gpppd will become wastewater.

7.3.3. Wastewater Disposal. Water usage generally results in wastewater that requires disposal. The volume of wastewater alone can cause significant problems in the field, and depending on the source, wastewater may also contain suspended solids and particulate matter, organic material, dissolved salts, biological and pathogenic organisms, and even toxic chemicals. In any case, proper wastewater disposal is essential to protect the health of the force. Deployed units should comply with DODI 4715.22 and the Environmental Annex of the OPLAN/OPORD and follow other applicable theater-specific procedures and guidance for wastewater disposal. Consider the following options:

7.3.3.1. Connection to an established installation sanitary sewer system.

7.3.3.2. Collection and retention of wastewater for engineer/contractor removal to a fixed treatment facility.

7.3.3.3. Engineer construction of semi-permanent wastewater collection and disposal systems.

7.3.3.4. Use of a field expedient wastewater disposal system, if available.

7.4. BEAR Water System. The BEAR contingency water system provides water to support kitchens, latrines, showers, laundries, and other bare base facilities and recovers the wastewater for appropriate disposal. The water system consists of five distinct subsystems: Source Run, Water Production, Initial Distribution, Follow-on Distribution, and Industrial Operations and Flightline Extension subsystems. The water system is modular in design and scalable to meet a variety of user deployment needs. Work crews have the flexibility to configure the subsystems to meet their unit's specific needs. The wastewater disposal elements of the BEAR water system use a similar concept as a typical municipal wastewater system. The system collects and transports wastewater to a centralized treatment area via hose or pipe, where it receives the equivalent of secondary treatment subsequent to discharge for disposal. Setting up the BEAR water system takes time and until it is operational, pick up the wastewater at the point of generation using wastewater removal trailers. Discharge the waste away from the base or into a lagoon system, if one is available. The following paragraphs provide an overview of each BEAR water subsystem. See T.O. 40W4-21-1 and AFTTP 3-32-Series for a detailed description of these subsystems.

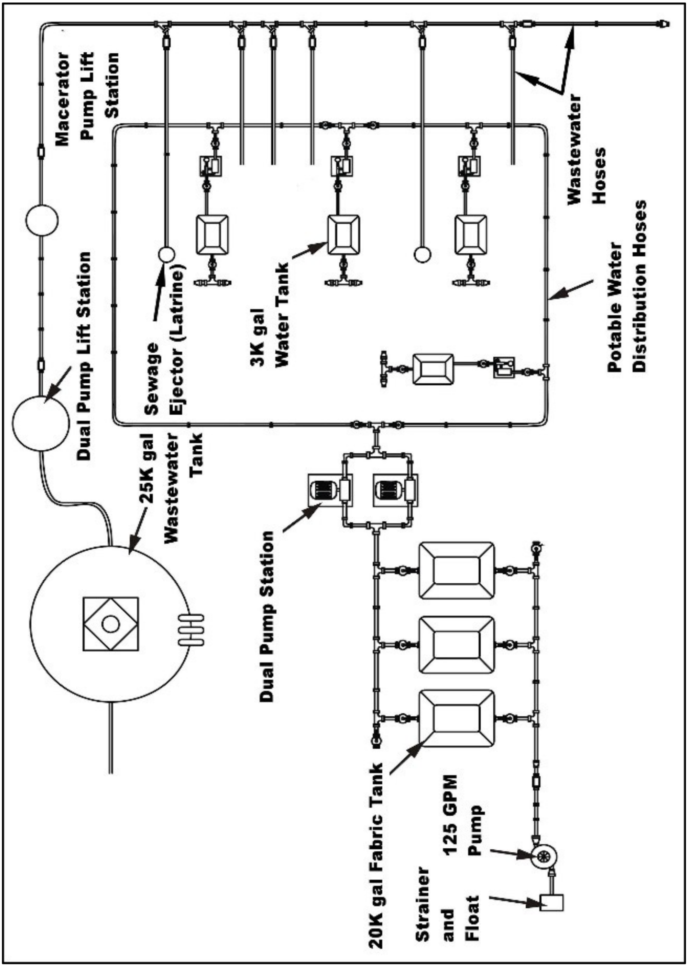
7.4.1. Source Run Subsystem. The Source Run Subsystem provides raw water input (source water) for the contingency water system. It can pull water from a raw water source (i.e., river, lake, sea, or ocean) up to 100 feet away and 20 feet below the pumping station. The Source Run Subsystem can pump source water up to a distance of 6000 feet and to a height of 150 feet to a raw water storage tank.

7.4.2. Water Production Subsystem. The Water Production Subsystem generates potable water for distribution to user facilities within the contingency water system. Generally, bases accomplish water purification using 1500 ROWPUs set up in a parallel configuration. Distribution of potable water generated by the ROWPUs is through another series of hoses and fittings to 20,000-gallon potable water storage tanks.

7.4.3. 550-Initial Subsystem. The 550-Initial Subsystem (550-I) is the primary distribution subsystem of the contingency water system. Bases can use the 550-I as a stand-alone distribution subsystem; but its purpose is for expansion and buildup to meet varying user deployment and operational needs.

7.4.3.1. The 550-I subsystem normally receives potable water input from the Water Production Subsystem. However, supplied adapters also provide a means to draw water from other similar potable water sources. As illustrated in **Figure 7.2**, potable water input to the subsystem is stored in three 20,000-gallon fabric storage tanks. The water in the tanks runs to the camp via a dual pumping station and potable water distribution hoses. Similarly, various wastewater lines and lift pumps collects and distributes wastewater output from user facilities for disposal.

Figure 7.2. Initial Subsystem.



7.4.3.2. In the layout shown in **Figure 7.3**, all wastewater runs to a 25,000-gallon wastewater collection tank. In another configuration (**Figure 7.4**), only wastewater from latrines and kitchens go to the wastewater tank. The remaining wastewater (graywater) from showers and laundries go to graywater drying beds.

Figure 7.3. Total Wastewater Collection Layout (1100-Person Camp).

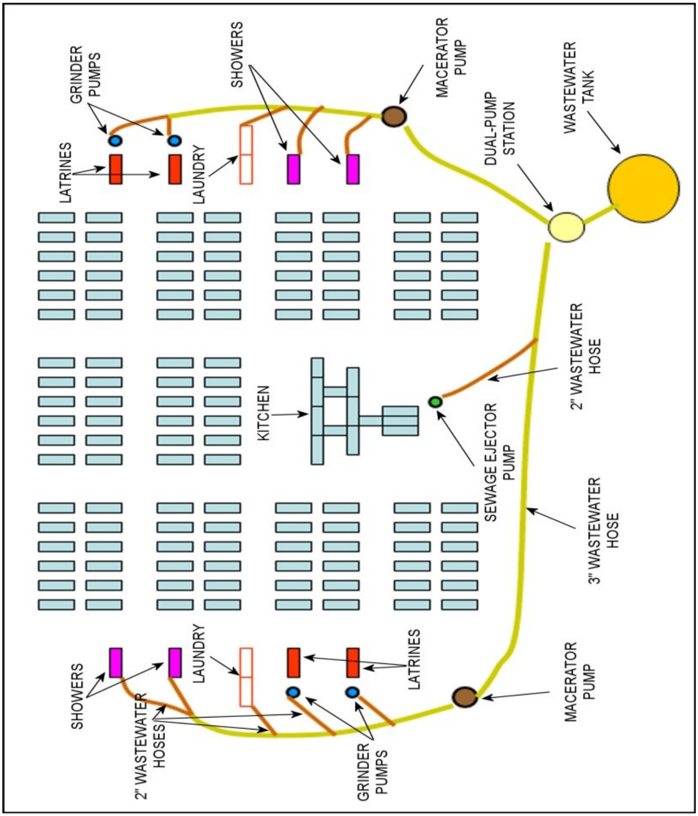
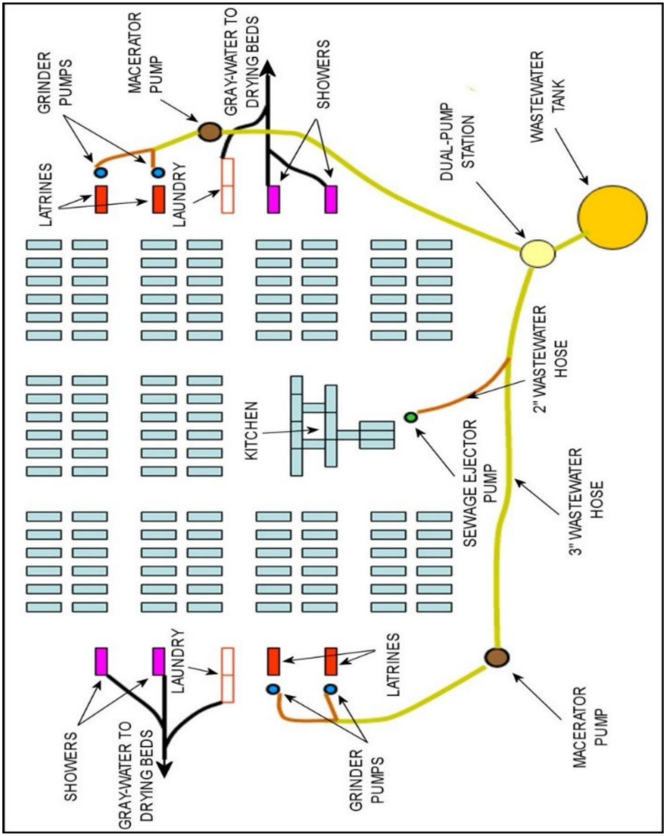


Figure 7.4. Partial Wastewater Collection Layout (1100-Person Camp).



7.4.4. 550-Follow-On Water Distribution Subsystem. The 550-Follow-On Subsystem (550-F) expands and builds off the 550-I subsystem; it is not intended to function alone. When used as an expansion to the 550-I subsystem, this system functions identically to the 550-I.

7.4.5. Industrial Operations and Flightline Extension Subsystem. The Industrial Operations and Flightline Extension Subsystem is a potable water expansion subsystem for the 550-Initial, 550-Follow-On, or Water Production Subsystems. The extension subsystem can branch off any part of the 3-inch pressurized feed line from these systems and can supply potable water to isolated user facilities such as latrines, showers, and kitchens. Additionally, hose rollover protection ramps (hose bridges) safeguard hoses in the event potable water distribution lines need to cross roadways or similar heavy vehicular traffic areas.

7.5. Expedient Wastewater Disposal Methods. The following paragraphs provide a brief description of common expedient wastewater disposal methods, including evaporation beds, seepage pits, soakage pits and trenches, sewage lagoons, and leach fields. Information relating to the construction and use of these methods is available in UFC 3-240-01, AFTTP 3-32.33V1, *Expedient Hygiene, Water and Waste Methods*, and theater-specific guidance. Additional information on wastewater disposal during contingency operations is provided in AFH 10-222V4. See **Attachment 7** for the pros and cons of various expedient wastewater disposal methods, including special considerations for disposal facilities in desert environments.

7.5.1. Evaporation Beds. Contingency bases may use evaporation beds (aka drying beds) to dispose of graywater from shower and laundry facilities in hot, dry climates and in locations where clay soil prevents the use of standard soakage pits. Generally, expedient evaporation beds measure 8 by 10 feet, although larger evaporation fields may be necessary to handle greater amounts of graywater.

7.5.2. Seepage Pits. Seepage pits also disposes of wastewater efficiently. The required size of a seepage pit can be determined from a percolation test and the estimated amount of effluent from the facility. Several smaller pits for a facility may be more feasible than one large pit. When more than one pit is used, ensure there is equal distribution of the wastewater to all the pits. The pits should be located outside the base camp and at least 100 feet from the nearest water source.

7.5.3. Kitchen Soakage Pits and Trenches. Prior to installation of the BEAR water system, wastewater from kitchens can be disposed of using a kitchen soakage pit or trench. Consider using soakage trenches when the groundwater level or a rock formation precludes digging a soakage pit.

7.5.4. Grease Traps. There are many types and variations of expedient grease traps. Typically, they are necessary for kitchen soakage pits and trenches to prevent premature clogging. Personnel usually place the trap directly over the soakage pit or on a platform with a trough leading to the pit; sometimes, users embed the grease trap within the soakage pit.

7.5.5. Sewage Lagoons. Sewage lagoons are common throughout the world. Although easy to construct, sewage lagoons are not a recommended theater practice. If used, sewage lagoons should be located at least *one-half mile* from the population center because of the odors produced by anaerobic digestion. The increased length of the sewer collection system, compounded by the possible need for automatic lift stations, significantly increases the materiel cost and construction effort required for a complete system.

7.5.6. Leach Fields. Use leach fields (also termed "absorption fields") in conjunction with septic tank treatment as the final treatment and disposal process for the septic system. Leach fields normally consist of perforated distribution pipes laid in trenches or beds filled with rock. The perforated pipes distribute the septic tank effluent and allow it to percolate through the ground. This percolation process filters and treats the effluent by naturally occurring bacteria and oxygen. Once released from the septic tank, the effluent travels by gravity through a solid Polyvinyl Chloride pipe to the distribution box. The distribution box is a reinforced concrete structure that distributes the septic tank effluent evenly throughout the absorption field through several 4-inch diameter perforated pipes.

Chapter 8

ELECTRICAL POWER GENERATION AND DISTRIBUTION

8.1. General Information. Developing a bare base electrical power generation and distribution system is a two-phase approach. The first phase is to provide initial power via tactical power generators to those functions critical to initial base operation. The second and much more complex phase is to establish primary power plants and install the overall base electrical distribution network. It is advantageous to have multi-skilled, and forklift qualified, electrical systems and electrical power production personnel to enable the expeditious, independent, and concurrent completion of these phases. Ensure personnel wear appropriate PPE (including arc flash protection), as required in UFC 3-560-01. Install noise hazard and high voltage warning signs where appropriate.

WARNING

Working on energized electrical equipment is prohibited except in rare circumstances, and then only when justified and approved by the Base Civil Engineer or equivalent in accordance with AFMAN 32-1065, *Grounding & Electrical Systems*.

8.2. Tactical Power Generators. During the initial base planning and layout stages, precisely identify the locations of mission-critical facilities that require immediate tactical power generator support. In most instances, these facilities will also require fulltime standby or backup power generators; AFMAN 32-1062, *Electrical Systems, Power Plants and Generators*, identifies standby and backup power authorizations. Typical authorized facilities include command and control facilities, air traffic control towers, feeding facility, water plant, communication facilities, and other mission-essential facilities. The Wing Commander has final authority to determine which facilities receive dedicated generator support. Once facility selection is complete, electrical power-production personnel determine the appropriate size generator for each facility. Almost without fail, there will be more facilities requiring dedicated generator support than there are generators.

One way to overcome this problem is to feed multiple facilities from a centrally located secondary distribution center (SDC) that is power by a single generator. Attempt to place SDCs in positions where they can eventually integrate into the primary distribution network without having to relocate them. After erecting facilities, electrical personnel connect the secondary service to the facility distribution panels when appropriate. Once tactical power generators are online, specifically designate personnel to accomplish regularly scheduled operational checks, recurring maintenance, and establish a refueling plan with base fuels personnel. Anticipate that tactical power generators will provide power between 10 and 15 days—it may take that long to install and energize the base electrical distribution grid.

8.3. Prime Power Plants. Concurrent with installing tactical power generators, a team should setup prime power plants. This effort includes placing prime power generators (including BEAR Power Units and MEP-12s), installing and connecting fuel bladders, setting up control panels for remote operation, installing and connecting primary switching centers and installing grounding systems. Refer to T.O. 35C2-3-474-11-WA-1, *Basic Expeditionary Airfield Resources (BEAR) Power Unit (BPU)*, when siting and installing BEAR Power Units. The BEAR Power Unit delivers a nominal voltage of 4160/2400 Volts Alternating Current at 60 Hz and a nominal voltage of 3800/2200 Volts Alternating Current at 50 Hz. When installing and siting MEP-012A generators, refer to T.O. 35C2-3-474-1, *Generator Set, Diesel Engine-Driven, Wheel-Mounted 750-KW, 3-Phase, 4-Wire, 2200/3800 and 2400/4160 Volts*.

8.3.1. Centrally located high-voltage generators offer the most advantageous primary distribution system. However, in high threat areas, consider dispersing these generators between prime and slave power plant locations to improve survivability. Multiple power plants and primary distribution loops that interconnect these plants are especially critical in high-threat locations. If a power plant becomes inoperative for any reason, energize the electrical grid using the remaining power plant(s).

8.3.2. Diesel generators produces hazardous noise levels so to prevent personnel injury, place the generators a sufficient distance from work or lodging facilities. If separation distances are an issue, install noise barriers or baffles. Concrete revetments and earthen berms have proven to be effective in this regard. However, be sure to maintain adequate airflow and safety clearances around the equipment.

8.4. Electrical Power Distribution. The SDC is an integral part of BEAR electrical distribution. It is designed to receive regulated electrical power at 2400/4160 Volts Alternating Current and transforms the power into 120/208 Volts Alternating Current. Following the site layout plan, electrical personnel place SDCs at their required locations and begin connecting the SDCs to primary switching centers at the power plants.

8.4.1. After erecting facilities, crews make secondary distribution connections between the SDCs and power distribution panels in the facility, and the internal connections of equipment within facilities.

8.4.2. For planning and installation purposes use the following "rules of thumb" regarding SDCs:

8.4.2.1. Limit the load on each SDC circuit to 21.6 kVA.

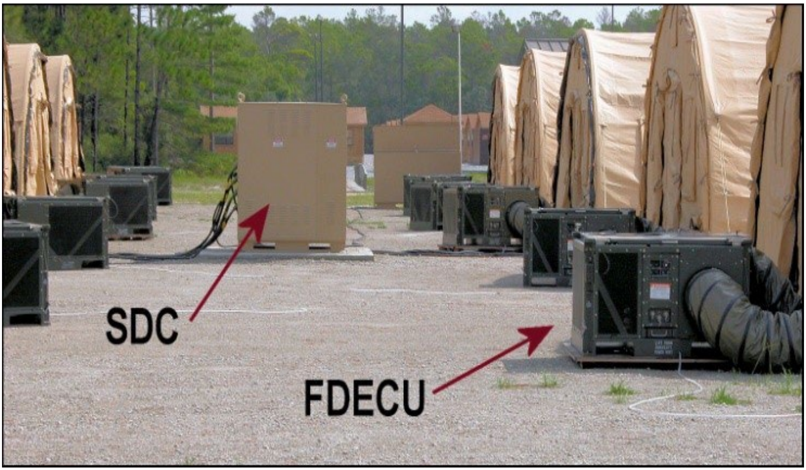
8.4.2.2. Limit the total load on each SDC to 150 kVA.

8.4.2.3. Limit the number of shelters on a SDC to ten when using the Field-Deployable Environmental Control Unit (FDECU) in each shelter.

8.4.2.4. Under normal operating loads, a power plant with at least two generators operating will support 6 to 10 SDCs per primary switching center circuit when facilities have FDECUs (**Figure 8.1**), and 10 to 15 SDCs per primary switching center circuit when facilities do not have FDECUs.

8.4.3. Several remote area lighting sets are included in BEAR unit type codes (UTCs), and most should arrive relatively early in the overall asset flow. Powered by SDCs, Remote Area Lighting Systems support area lighting requirements for functions such as aerial port offloading, aircraft maintenance, POL transfer and security of critical assets. Be prepared to provide electrical support to these lighting systems as soon as they come online. Refer to T.O. 35F5-5-22-1 to site, install, and operate these systems.

Figure 8.1. Typical SDC/Facility Configuration with FDECUs.



8.4.4. Site facilities and SDCs to optimize to the number of facilities each SDC serves. Up to a maximum of 10 facilities with FDECUs or up to 16 without air conditioners as long as the total load does not exceed 150 kVA per SDC and the length of secondary cable runs (shorter is generally better, ideally no more than 150 feet). Refer to T.O. 35CA2-2-17-1-WA-1, *Operation and Maintenance Manual, Secondary Distribution Center (SDC) 150 KVA (DPGDS)*, for additional SDC installation and siting instructions.

8.4.5. When initially laying prime power (high voltage) electrical cable, if soil conditions or time and equipment constraints prevent its immediate burial, the

Base Civil Engineer may make an operational risk management decision to leave some or all of the high-voltage cable on the surface initially. If that is the case, take measures to mitigate the risk of personnel injury or damage to the cables. As a minimum, bury or otherwise protect cables crossing roads and high-traffic walkways. Bring the base onto the electrical grid in stages as the population increases and functional area activities dictate. Whenever the primary electrical grid can pick up facilities served by tactical power generators, reconfigure these units as standby or backup power. Obviously, as the primary power plants energized, devote a portion of electrical power production crews to plant operations and maintenance. Once the electrical generation and distribution system is fully installed and operational, bury all aboveground primary power electrical cables (**Figure 8.2**). See AFTTP 3-32.34V5 for detailed information on power generation and distribution during base development at austere locations.

Figure 8.2. Burying Electrical Distribution Cable.

Chapter 9

SOLID WASTE DISPOSAL

9.1. General Information. Disposing of solid waste at contingency locations can be challenging. The goal is to dispose of solid waste in an environmentally acceptable manner consistent with good sanitary engineering principles and still accomplish the unit mission. Information sources for solid waste management principles, requirements, and methods include DODI 4715.19, *Use of Open-Air Burn Pits during Contingency Operations*, DODI 4715.22, *Environmental Management Policy for Contingency Locations*, AFI 32-7001, *Environmental Management*, AFMAN 32-7002, *Environmental Compliance and Pollution Prevention*, UFC 3-240-05A, *Solid Waste Incineration*, UFC 3-240-11, *Landfills in Support of Military Operations*, and AFH 10-222V4. However, engineers should follow theater-specific waste management guidance and procedures.

9.2. Basic Guidelines. Disposal of solid waste is dependent on the location and surrounding environment. Some bases use host-nation or local contractors to dispose of solid waste; some use on-site facilities, and others use a combination of these methods. Whatever method the installation uses, attempt to minimize the amount of solid waste requiring disposal while still satisfying command requirements. Solid waste managers typically use the hierarchy in **Table 9.1** when making waste diversion and disposal decisions. However, additional considerations may be necessary for overseas contingency operations.

Table 9.1. Waste Diversion and Disposal Hierarchy.

Waste Diversion and Disposal Hierarchy			
1	Source Reduction	6	Incineration with Energy Recovery
2	Reuse	7	Incineration for Volume Reduction
3	Donation	8	Other Forms of Volume Reduction
4	Recycling	9	Landfill Disposal
5	Composting/Mulching		

9.2.1. Disposal methods should be thoroughly planned out and sited (collocated if necessary) for easy use. Waste collection areas should be downwind of base populated areas to prevent nuisance odors.

9.2.2. Improper disposal of waste may contribute to environmental contamination, and accumulated waste could serve as a breeding ground for rodents and arthropods. If using on-base locations for garbage and refuse disposal, institute a stringent pest control program to alleviate the danger or spread of disease. Weigh all issues and alternatives before selecting the installation's disposal methods. Consult DODI 4715.22 for more information.

9.3. Waste Reduction and Disposal Methods.

9.3.1. Recycling. Recycling is an effective means to reduce solid waste disposal streams. Solid waste like high-grade paper, plastic, cardboard, scrap metals, glass, wood cartons, pallets, used oil, tires, batteries, and more can be disposed of without burying or burning. Keep in mind, it may be necessary to purchase equipment or contract services to grind, compress, and bundle the recyclables for movement. Materials separated for recycling should be stored so they do not constitute a fire, health or safety hazard or provide food or harborage for vectors. They should also be contained or bundled to avoid spillage.

9.3.2. Solid Waste Contractors. Using host-nation contractors can sometimes be the most practical approach to disposing of solid waste. Many expeditionary air bases are located at existing airports near towns and cities with large municipal solid waste disposal operations. While there are clear advantages to using a well-established and proficient local contractor for waste disposal, use of host-nation workers could create security issues. Some installations may address these security issues by using military escorts and establish waste collection points outside of key areas. Others may establish a solid waste transfer station near a base entry point where contractors can pick up the waste, thereby denying their access to other areas of the base. The latter method, while more secure, requires significant resources and personnel for on-base waste collection before moving the solid waste to a transfer station.

9.3.3. Composting. Another method of reducing solid waste, composting is an engineered process that promotes the biochemical decaying of organic material. During bare base development, a large percentage of the solid waste is packaging materials (such as cardboard, paper, and plastic), waste food, and sewage sludge. Although plenty of this material is biodegradable, it still presents a significant waste management challenge, especially in countries with few modern waste facilities. When composting, shred solid waste with most of the nonorganic material removed. Arrange the organic material into a row and turned it frequently to promote decomposition. In addition to disposing of unwanted solid waste, compost can be useful for agricultural purposes and as a cover material on slopes or at sanitary landfills because of its resistance to erosion. If a compost operation is near the airfield, monitor the operation to ensure it does not adversely affect air operations. Installations anticipating establishing a composting operation should comply with requirements in the applicable Environmental Annex of the OPLAN and/or OPORD, the Combatant Command Solid Waste Management Plan, and other applicable theater requirements.

9.3.4. Landfills. Disposing of solid waste in a landfill is a common practice at expeditionary contingency bases. However, before establishing a new landfill or expanding an existing landfill, units should have the approval of the Combatant Commander. Landfills at expeditionary bare bases generally fall into two categories—municipal solid waste landfills or sanitary landfills. **Note:** See UFC 3-240-11 for additional guidance for landfills in support military operations.

9.3.4.1. A municipal solid waste landfill is a discrete area of land or an excavation, on or off an installation, that receives solid waste like durable goods (e.g., appliances, tires, batteries), non-durable goods (e.g., newspapers, books, magazines), containers and packaging, food wastes, yard trimmings, and miscellaneous organic wastes from residential, commercial, and industrial non-process sources. During landfill operations, work crews should use standard sanitary landfill techniques of spreading and compacting solid wastes and placing daily cover over disposed solid waste at the end of each operating day.

9.3.4.2. Sanitary landfilling is an engineered solid waste disposal process that minimizes environmental hazards and nuisances of land disposal. Solid waste goes to a carefully selected and prepared site, deposited into a trench or controlled area, compacted, and covered with soil or other material daily. The sanitary landfill is capable of accepting a wide variety of solid waste types. Nearly all rubbish, garbage, trash, ashes, solid organic waste, and miscellaneous solids may be disposed of safely. This method is usable in combination with other waste reduction methods for example, incineration, baling, compacting, or shredding.

9.3.5. Incinerator Facilities. In the context of this chapter, an incinerator is any furnace used in the process of burning solid or liquid waste to reduce the volume of the waste by removing the combustible matter (**Figure 9.1**). Incinerators should meet published air emissions/air quality requirements. Generally, incinerator operations at expeditionary bases are waste reduction methods and not disposal methods. However, incineration for energy recovery may be an option at more technically sophisticated facilities. Regardless, ash by-product from the incineration process should be disposed of through normal waste disposal methods. So, the incineration facility should be located as close to the waste collection point as possible to simplify the collection process. Although many factors affect the location of an incinerator plant, below are two basic factors:

Figure 9.1. Incinerator Facility at Forward Operating Base.

9.3.5.1. *Traffic.* Consider the frequency and size of vehicles utilizing the incinerator facility. Access roads should be all-season permanent roads; however, travel on and across primary roads shall be minimized.

9.3.5.2. *Location.* Select locations that help mitigate noise and odors from the incinerator. Be sure to evaluate prevailing wind direction to avoid transmitting odors to residential sites.

9.3.6. Burn Pits. According to DODI 4715.19, *Use of Open-air Burn Pits in Contingency Operations*, open-air burn pits may be used as a short-term solution during contingency operations where no alternative disposal method is feasible. Combatant Commanders make determinations for circumstances in which no alternative disposal method is feasible. See additional guidance for planning, constructing and operation of burn pits in AFH 10-222V4.

9.4. Hazardous Waste. Disposal of hazardous waste at expeditionary contingency bases must comply with Department of Defense policy and guidance, the Environmental Annex of Operations Plans or Orders, and applicable international agreements. The Defense Logistics Agency should approve any incinerators used for disposing hazardous waste. Review requirements in DODI 4715.22 and the Environmental Annex of the Operations Plan and/or Order and consult with base environmental personnel for additional guidance and assistance on the handling and disposing of hazardous waste.

Chapter 10

BASE DEFENSE

10.1. General Information. Protection of personnel and assets is always an important task at expeditionary bases. It can be especially challenging when forces are beddown at austere, forward operating bases close to the battle area or areas with a high probability of terrorist attacks. Although absolute protection against all attacks is not possible, implement protective plans and procedures based on the latest threat information. During bare base development, engineer and security forces coordinate base defense requirements, establish protection zones, reinforce fighting positions, clear or establish obstacles, and harden base perimeters; all to protect vital resources (**Figure 10.1**). Depending on potential threats, engineer work crews can also be heavily engaged in bunker construction and facility hardening activities. Even at low threat locations, workers may need to build force protection facilities and structures because low threat can easily turn into high threat overnight.

Figure 10.1. Engineers and Security Forces Harden Base Perimeter.

10.2. Planning and Considerations. Site work is often the most visible part of base defense and force protection measures; however, engineer involvement in the planning process, including site surveys and site layout, is equally important. During the site survey, learn as much as possible about the region and specific location to assist in selecting a site suitable to beddown the expected population, weapon systems, support equipment, and other assets. Additionally, be sure to address and integrate force protection into the site layout. If site layout is ineffective, it could be extremely difficult and costly to rearrange assets to provide increased protection once beddown is complete. For additional guidance on force protection measures and protective construction requirements, review UFC 4-010-01, GTA 90-01-011 (JFOB7 Handbook), and AFTTP 3-32.34V3, and consult with the theater engineer staff.

10.2.1. As expeditionary airbases experience planned and unplanned growth, they typically end up needing additional land and resources. Consequently, every change that increases the base's footprint usually requires modification to local force protection measures. Always consider force protection requirements when planning future expansion and growth.

10.2.2. Many expeditionary and temporary structures used during contingencies are composed of metal frames and fabric or wood frames and rigid walls, they are generally impractical to harden or retrofit. For this reason, *standoff distance* is the primary approach to force protection in the expeditionary environment, which often drives the need for larger sites. Space should be sufficient to allow for dispersal of certain functions and equipment and to provide the commander the flexibility to increase the beddown population and standoff distances if needed in response to higher threat levels.

10.2.3. Although BEAR shelters provide beddown forces with vital temporary protection from the elements at locations with limited infrastructure and support facilities, these same shelters create additional force protection challenges for the reasons addressed above. The inherent advantages of lighter, leaner, and more mobile shelters means designers had to make some tradeoffs in survivability. Most BEAR facilities cannot withstand even small arms fire, let alone fused munitions detonation. This makes it imperative that planners seriously consider personnel and asset protection at bare base locations, especially in high threat areas. In fact, in serious high threat areas, one of the first tasks might be digging foxholes and protective trenches for personnel protection.

10.2.4. BEAR packages also include assets for aircraft protection, such as bin revetment kits addressed in **Chapter 4**. However, because of their weight, do not expect to receive these kits until well into the deployment timeline. In fact, they may even arrive by ship rather than air. Nevertheless, have all parking plans, revetment locations and configurations and fill material sources identified early. Start installing the kits as soon as they arrive.

10.3. Physical Security Measures. A key element of force protection is physical security. The two broad areas of physical security that civil engineers might dedicate the majority of time and resources in expeditionary environments include perimeter security and internal security.

10.3.1. Perimeter Security. An important force protection tasks civil engineers undertake during the initial stages of deployment and beddown is establishing perimeter security. Working with security forces, civil engineers help establish a continuous physical barrier that clearly defines the physical limits of the site to prevent unauthorized access. Perimeter security may include the following:

- Perimeter berms and ditches
- Perimeter fencing
- Obstacles
- Terrain modification and vegetation-clear zones
- Obscuration screens
- Entry control points and search pits
- Security lighting
- Guard towers/observation posts
- Defensive fighting positions

10.3.2. Internal Security. The focus on internal security, from a civil engineer perspective, generally involves establishing protective measures inside the base, and may include the following:

- Side-wall protection and facility hardening
- Dispersal
- Compartmentalization
- Revetments
- Personnel bunkers
- Power and water protection

10.3.3. Protective Bunkers. When base development using BEAR assets nears completion, focus attention on providing protective bunkers for the base populace. These protective structures provide personnel immediate, short-term protection from the effects of weapon attacks. They may be constructed using prefabricated concrete modular forms, improvised materials, or built by local contractors.

10.3.3.1. Field-expedient bunkers may be the only alternative when there are not enough permanently hardened facilities in the right locations—be sure to site these structures in areas readily accessible to base personnel.

10.3.3.2. The best bunker usually provides the most protection but requires the least amount of effort to construct. Bunkers should have as much overhead cover as possible. Belowground bunkers require more construction effort but generally provide the highest level of protection from conventional and chemical weapons. Aboveground bunkers provide the best observation and are easier to enter and exit than belowground bunkers. They provide less protection from conventional weapons but may provide protection against liquid droplets of chemical agents. Aboveground bunkers are better when groundwater levels are close to the surface or when the ground is so hard that digging a belowground bunker is impractical. **Figure 10.2** is an example of a contemporary expedient bunker.

Figure 10.2. Example of Contemporary Expedient Bunker.

10.3.3.3. If necessary, construct other types of improvised bunkers using general construction materials, sandbags, containers, and other available materials. During base development, look for and store such items as 55-gallon drums, pieces of revetment material, structural steel shapes, timber and wood packing materials, ship dunnage, steel or precast concrete culvert sections, container express (CONEX) boxes, etc. Unserviceable aluminum matting may be readily available, but exercise caution using these items because they do not support heavy loads over a large clear span. Do not use BEAR shipping and storage containers for bunker or shelter components; the base will need them intact later on for reconstitution of assets.

10.3.4. Defensive Fighting Positions. These fighting positions range from expediently constructed bunkers to elevated hardened observation towers. Site defensive fighting positions in locations that support base defense operations. Position these structures mostly around the base perimeter; and other areas as needed. When necessary, civil engineer personnel use these protective structures for work party security and in conjunction with dispersed operations. **Note:** see UFC 3-260-01, for information on siting defensive fighting positions within the primary surface and land use control area of the clear zone. When temporary defensive fighting positions are not in use or are no longer required, they must be removed from the airfield and grades restored.

10.3.5. Obstacles and Barriers. During bare base development, erect or place obstacles and barriers where needed to support force protection requirements. While there are many different types and functions, expedient anti-personnel and anti-vehicle structures will often be necessary at various locations around the base perimeter and at key on-base facilities.

10.3.6. Berms and Revetments. It may be necessary to build berms and revetments around critical facilities and utility nodes. Although it will be nearly impossible to construct protective features for all candidate locations quickly due to material, time or worker shortfalls, prioritize your requirements carefully. Look primarily at mission sensitivity. Consider protecting water and power plants early—without these utility services bare base operations will rapidly shut down. Also, consider key secondary distribution centers, maintenance shops, and command posts. See **Chapter 4** for more information on siting berms and revetments.

10.3.7. Clearing Obstacles. In addition to erecting obstacles, removing unwanted obstacles is also an important force protection task for engineers. Work crews may need to clear obstacles on or around the airfield or clear terrain along the base perimeter. Especially, in areas where security forces need clear areas or vegetation-free zones for observation or to eliminate possible areas of enemy concealment near the installation's boundary.

10.4. CBRN Defense. The potential for accidental or deliberate release of CBRN agents within the operational area is a major concern. Additionally, the threat of an adversary or enemy combatant using CBRN materials against a contingency base, either during base development or after construction, is always present.

10.4.1. Engineers are responsible for a number of force protection tasks associated with CBRN defense; some include:

- Coordinate CBRN defense operations
- Layout CBRN defense areas
- Establish CBRN monitoring points
- Establish alerting system and contamination control areas
- Construct and improve personnel shelters
- Determine decontamination procedures
- Site Decontamination Stations

10.4.2. While Emergency Management specialists primarily support all of the CBRN defense tasks listed above, other engineer specialists will also be involved. For example:

- Utilities personnel may need to run water lines to decontamination stations
- Engineering assistants may need to survey potential sites for decontamination stations, contamination control areas, and shelters
- Heating, ventilation, air conditioning, and refrigeration personnel could be involved with installing and maintaining collective protection systems
- Heavy equipment operators might have to level terrain or dig drainage ditches for decontamination operations
- Nearly every Prime BEEF specialty will somehow be involved in CBRN defense and force protection operations

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Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

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Prescribed Forms

No prescribed forms are implemented in this publication.

Adopted Forms

Air Force Form 847, *Recommendation for Change of Publication*

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Abbreviations and Acronyms

AFCEC—Air Force Civil Engineer Center

AFI—Air Force Instruction

AFMAN—Air Force Manual

AFPAM—Air Force Pamphlet

AFTTP—Air Force Tactics, Techniques, and Procedures

BEAR—Basic Expeditionary Airfield Resources

BEAR PPDT—BEAR Planning and Power Distribution Tool

CBRN—Chemical, Biological, Radiological and Nuclear

CONEX—Container Express

DEET—(chemical name, N, N-diethyl-meta-toluamide)

DESR—Defense Explosives Safety Regulation

DODI—Department of Defense Instruction

DTG—Distance-To-Go

ECS—Environmental Condition Study

EOD—Explosive Ordnance Disposal

FDECU—Field-Deployable Environmental Control Unit

FOUO—For Official Use Only

GPH—Gallons per Hour

GPPPD—Gallons per Person per Day

GTA—Graphic Training Aid

JCMS—Joint Construction Management System

JFOB—Joint Forward Operating Base

LBS—Pounds

MAAS—Mobile Aircraft Arresting System

MEP—Mobile Electric Power

NFPA—National Fire Protection Association

O&M—Operation and Maintenance

OPR—Office of Primary Responsibility

POL—Petroleum, Oil, and Lubricants

PPDT—Planning and Power Distribution Tool

PPE—Personal Protective Equipment

Prime BEEF—Prime Base Engineer Emergency Force

PSI—Pounds Per Square Inch

RHS—RED HORSE Squadron

ROWPU—Reverse Osmosis Water Purification Unit

SDC—Secondary Distribution Center

TF—Tank Farm

T.O.—Technical Order

UFC—Unified Facilities Criteria

USCENTCOM—United States Central Command

USPACOM—United States Pacific Command

UTC—Unit Type Code

UXO—Unexploded Ordnance

WOA—Water Operations Area

Office Symbols

AF/A4CX— Air Force Directorate of Civil Engineers, Readiness Division

AFCEC/CXX—Air Force Civil Engineer Center, Expeditionary Engineering Division

Terms

Base Development—The acquisition, development, expansion, improvement, construction and/or replacement of the facilities and resources of a location to support forces. (Joint Publication 3-34)

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

Beddown—A location at which a deploying unit operates during a contingency. It is usually, but not always, in the area of responsibility. (Air Force Doctrine Annex 4-0)

C-day—The unnamed day on which a deployment operation commences or is to commence.

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.

Collective Protection—Systems that protect those inside a building, room, shelter or tent against contamination through the combination of impermeable structural materials, air filtration equipment, air locks, and over pressurization.

Contingency—A situation requiring military operations in response to natural disasters, terrorists, subversives, or as otherwise directed by appropriate authority to protect US interest. **Beddown**—A location at which a deploying unit operates during a contingency. It is usually, but not always, in the area of responsibility. (Air Force Doctrine Annex 4-0)

Contingency Location—A non-enduring location outside of the United States that supports and sustains operations during contingencies or other operations and is categorized by mission life-cycle requirements as initial, temporary, or semipermanent. (JP 4-04)

C-day—The unnamed day on which a deployment operation commences or is to commence.

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.

Collective Protection—Systems that protect those inside a building, room, shelter or tent against contamination through the combination of impermeable structural materials, air filtration equipment, air locks, and over pressurization.

Contingency—A situation requiring military operations in response to natural disasters, terrorists, subversives, or as otherwise directed by appropriate authority to protect US interest.

Disease Vector—Any animal capable of transmitting the causative agent of a human disease; serving as an intermediate or reservoir host of a pathogenic organism; or producing human discomfort or injury, including (but not limited to) mosquitoes, flies, ticks, mites, snails, and rodents.

Environmental Condition Study (ECS)—A study, report, analysis, or other documentation that adequately describes the environmental conditions at a contingency location. Includes an environmental baseline study, condition report, status report, and closure report, and depends on and follows the operational phases of the location.

Expeditionary Structures—Those structures intended to be inhabited for no more than 1 year after they are erected. This group of structures typically includes tents, Small and Medium Shelter Systems, Expandable Shelter Containers, International Organization for Standardization container and CONEX containers, and General Purpose Medium and Large tents, etc.

Force Beddown—The provision of expedient facilities for troop support to provide a platform for the projection of force. (Joint Publication 3-34)

Hazardous Waste—Waste characterized as hazardous in accordance with applicable international agreements or as defined in DoDM 4715.05 Volume 5, Overseas Environmental Baseline Guidance Document: Waste.

Integrated Pest Management—A sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks.

Initial Contingency Location—A locale occupied by a force in immediate response to a contingency operation and characterized by austere infrastructure and limited services with little or no external support except through Service-organic capabilities. (Joint Publication 4-04)

Minimum Operating Strip—A runway that meets the minimum requirements for operating assigned and/or allocated aircraft types on a particular airfield at maximum or combat gross weight.

Pests—Arthropods, birds, rodents, nematodes, fungi, bacteria, viruses, algae, snails, marine borers, snakes, weeds, and other organisms (except for human or animal disease-causing organisms) that adversely affect readiness, military operations, or the well-being of personnel and animals; attack or damage real property, supplies, equipment, or vegetation; or are otherwise undesirable.

Pest Management—The prevention and control of disease vectors and pests that may adversely affect the Department of Defense mission or military operations; the health and well-being of people; or structures, materiel, or property.

Pest Management Professional— Department of Defense military officers commissioned in the Medical Service or Biomedical Sciences Corps or Department of Defense civilian personnel with college degrees in biological, physical or agricultural sciences whose current job includes pest management responsibilities. Department of Defense civilian employees shall also meet Office of Personnel Management (OPM) qualification standards. Based on assignment, some professional pest management personnel are pest management consultants.

Pesticide—Any substance or mixture of substances, including biological control agents, that may prevent, destroy, repel, or mitigate pests and is specifically labeled for use by the Environmental Protection Agency. In addition, any substance or mixture of substances used as a plant regulator, defoliant, desiccant, disinfectant, or biocide. The Armed Forces Pest Management Board does not review or approve disinfectants or biocides.

Solid Waste—Garbage, refuse, sludge, and other discarded materials, including solid, semi-solid, liquid, and contained gaseous materials resulting from industrial and commercial operations and from community activities. It does not include solids or dissolved material in domestic sewage or other significant pollutants in water resources, such as silt, dissolved or suspended solids in industrial wastewater effluent, dissolved materials in irrigation return flows, or other common water pollutants.

Temporary Structures—Structures that are erected with an expected occupancy of 3 years or less. This group of structures typically includes wood frame and rigid wall construction, and such things as Southeast Asia (SEA) Huts, hardback tents, International Organization for Standardization container and CONEX containers, pre-engineered buildings, trailers, stress tensioned shelters, Expandable Shelter Containers, and Aircraft Hangars.

Theater of Operations—An operational area defined by the geographic combatant commander for the conduct or support of specific military operations. Also called TO.

Wastewater—Used water from any combination of domestic, industrial, commercial, or agricultural activities and any sewer inflow or sewer infiltration. It can contain physical, chemical, and biological pollutants.

Attachment 2

ENGINEER REACHBACK AND OTHER USEFUL LINKS

Table A2.1. Useful Organizational and Product Links.

Organization and Products Links
Air Force Civil Engineer Center (AFCEC): https://www.afcec.af.mil/
CE DASH (AFCEC Technical Support Portal): https://usaf.dps.mil/teams/CEDASH/scripts/homepage/home.aspx
CE Playbooks: https://www.ceplaybooks.com.
DAF Publications and Forms: https://www.e-publishing.af.mil/
My Learning (Learning Management System): https://lms-jets.cce.af.mil/moodle/login/index.php
AF Design Guides (AFDG): https://www.wbdg.org/ffc/af-afcec
Whole Building Design Guide (WBDG): https://www.wbdg.org/
US Army Corp of Engineers Official Publications, http://www.publications.usace.army.mil/Home.aspx
Unified Facilities Criteria (UFC): https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc
Unified Facilities Guide Specifications (UFGS): https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs
USACE Reachback Operations Center (UROC): https://uroc.usace.army.mil
USACE Protective Design Center: https://intelshare.intelink.gov/sites/pdc/SitePages/Home.aspx
Army Publications and Forms: https://armypubs.army.mil/
Navy Doctrine Library System: https://doctrine.navy.mil/
DOD Issuances: https://www.esd.whs.mil/DD/DoD-Issuances/
Joint Publications: https://jdeis.js.mil/my.policy
Armed Forces Pest Management Board: https://www.acq.osd.mil/eie/afpmb/

Attachment 3

NOTIONAL BARE BASE DEVELOPMENT TASK TIMELINES

Table A3.1. Bare Base Development Task Timelines.

TASK	DAY							
	0	5	10	15	20	25	30	30+
Grade primary roads	•							
Accomplish expedient airfield repairs	•							
Set up tactical power generators	•							
Set up engineer cantonment area	•							
Establish engineer holding area	•							
Perform EOD inspection	•							
Set up emergency/area lighting	•							
Install Emergency Airfield Lighting System	•							
Install MAAS	•							
Check TF-2 light carts	•							
Set up expedient latrines	••							

Table A3.1. (Continued)

TASK	DAY 0	5	10	15	20	25	30	30+
Prepare site layout/site plan	••							
Establish/develop water points	•••							
Haul water to treatment plants	••••••	•						
Establish treatment plants	••••••	••						
Perform site preparation	••••••	••••••						
Perform environmental condition study	••••••	••••••						
Provide Fire and Emergency Services	••••••	••••••	••••••	••••••	••••••	••••••	••••••	•••
Layout facility groups	••••							
Install static grounds	••••	•						
Set up main power plants	••••	•••						
Install grounding systems	••••	••••						
Establish airfield support operations	••••	••••••	••••••	••••••	••••••	••••••	••••••	•••
Establish base alerting system	•							
Establish base defense network	••							

Table A3.1. (Continued)

TASK	DAY 0	5	10	15	20	25	30	30+
Establish base defense network	••							
Establish munitions holding area	••							
Erect engineer shops	••							
Deliver facilities to users	••••	••••						
Provide technical assistance for facility erection	••••	••••						
Berm POL storage area	••	•						
Establish CBRN monitoring points	••	•						
Install flexible aboveground water lines	••	••						
Grade secondary road network	••	••						
Install field latrines and showers	••	•••						
Clear airfield hazards	••	•••••						
Expand airfield parking	••	•••••						
Layout electrical distribution system aboveground	••	•••••						

Table A3.1. (Continued)

TASK	DAY 0	5	10	15	20	25	30	30+
Establish waste collection capability	••	•••••	•••••	•••••	•••••	•••••	•••••	•••
Operate sanitary land fill	••	•••••	•••••	•••••	•••••	•••••	•••••	•••
Layout utility systems	•	•••						
Install above-ground water source lines	•	••••						
Connect facilities to power	•	•••••	•					
Connect facilities to flexible water hose lines	•	•••••	•					
Install heaters		•••••	••					
Convert tactical power generators to backup		••						
Construct expedient munitions berms		••••						
Establish hazardous waste control area		••						
Construct sewage lagoons		•••	•••••	•••••	••			
Construct aircraft revetments		••	•••••	•••••	•••••	•••••		
Prepare EOD range		•	••					
Clear perimeter/expand base defense		•	•••••	•••••	•••••	•••••	•••••	••

Table A3.1. (Continued)

TASK	DAY 0	5	10	15	20	25	30	30+
Provide maintenance and repair support		•	•••••	•••••	•••••	•••••	•••••	••
Install air conditioners			••••	•				
Perform camouflage and concealment activities			••••	•••••	•••••	••		
Build defensive fighting positions			•	•••••				
Construct aircraft/vehicle wash racks			•	•••••	•			
Construct personnel shelters				•••••	•••••	•••••	•	
Develop dispersal locations				•••••	•••••	•••••	•	
Build/place obstacles				•	•••••			
Harden critical facilities				•	•••••	•••••	••	
Install waste collection system					•••••	•••••	•••••	•••
Bury electrical cables					•••	•••••		
Connect latrines/showers to waste system					•	•••••		
Construct flooring for facilities					•	•••••	•••••	•••
Establish engineer supply stocks						••	•••••	••

Table A3.1. (Continued)

TASK	DAY 0	5	10	15	20	25	30	30+
Provide quality of life improvements						••	•••••	••
Upgrade road network						•	•••••	••
Construct recreational facilities						•	•••••	••
Improve personnel shelters							•••••	•
Improve camouflage/ concealment/hardening							•••••	•
Improve security measures							•••••	•
Construct sunshades/wind breaks							•••••	•
Construct permanent berms for munitions							•••••	•
Provide permanent pavement repairs							•••••	•
Develop recovery plans/training programs							•••••	•

Table A3.2. Water and Waster Development Task Timelines.

	DAY							
TASK	0	5	10	15	20	25	30	30+
Establish/develop water points	•							
Set up expedient latrines	•							
Haul water to treatment plants	••••••	•						
Establish treatment plans	••••••	•						
Install flexible aboveground water lines	••	••						
Install field latrines and showers	••	•••						
Establish waste collection capability	••	•••••	•••••	•••••	•••••	•••••	•••••	••••
Operate sanitary landfill	••	•••••	•••••	•••••	•••••	•••••	•••••	••••
Install above-ground water source lines	•	••••						
Connect facilities to flexible water hose lines	•	••••						
Construct sewage lagoons		•••	•••••	•••••	•			
Provide maintenance and repair support		•	•••••	•••••	•••••	•••••	•••••	•••
Install waste collection system					•••••	•••••	•••••	••
Connect latrines/shower to waste system						•••••	•	

Table A3.3. Electrical Development Task Timelines.

TASK	DAY 0	5	10	15	20	25	30	30+
Install MAAS	•							
Install Emergency Airfield Lighting System	•							
Set up emergency/area lighting	•							
Set up tactical power generators	•							
Check TF-2 light carts	•							
Install static grounds	••••	•						
Set up main power plants	••••	•••						
Install grounding system	••••	••••						
Layout electrical distribution system aboveground	••	•••••						
Connect facilities to power	•	•••••	•					
Convert tactical power generators to backup		••						
Provide maintenance and repair support		•	•••••	•••••	•••••	•••••	•••••	••
Install air conditioners			••••	•				

Table A3.3. (Continued)

	DAY							
TASK	0	5	10	15	20	25	30	30+
Bury electrical cables					•••	••••••		
Increase security measures (lighting)							••••••	•

Table A3.4. Equipment Operations Development Task Timelines.

	DAY							
TASK	0	5	10	15	20	25	30	30+
Accomplish expedient airfield repairs	•							
Establish engineer holding area	•							
Grade primary roads	•							
Perform site preparation	•••••							
Establish airfield support operations	••••	•••••	•••••	•••••	•••••	•••••	•••••	•••
Establish base defense network	••							
Establish munitions holding area	••							
Deliver facilities to users	••••	••••						

Table A3.4. (Continued)

TASK	DAY 0	5	10	15	20	25	30	30+
Berm POL storage area	••	•						
Grade secondary road network	••	••						
Clear airfield hazards	••	•••••						
Expand airfield parking	••	•••••						
Operate sanitary landfill	••	•••••	•••••	•••••	•••••	•••••	•••••	•••
Construct expedient munitions berms		••••						
Construct sewage lagoons		•••	•••••	•••••	••			
Construct aircraft revetments		••	•••••	•••••	•••••	•••••		
Prepare EOD range		•	••					
Clear perimeter/expand base defense		•	•••••	•••••	•••••	•••••	•••••	•••
Build defensive fighting positions			•	•••••				
Construct aircraft/vehicle wash racks			•	•••••	•			
Construct personnel shelters				•••••	•••••	•••••	•	
Develop dispersal locations				•••••	•••••	•••••	•	

Table A3.4. (Continued)

TASK	DAY 0	5	10	15	20	25	30	30+
Build/place obstacles				•	•••••			
Harden critical facilities				•	•••••	•••••	••	
Install waste collection system					•••••	•••••	•••••	•••
Bury electrical cables					•••	•••••		
Upgrade road network						•	•••••	••
Improve personnel shelters							•••••	••
Improve camouflage/ concealment/hardening							•••••	••
Increase security measures (fencing)							•••••	•
Construct permanent berms for munitions							•••••	•
Provide permanent pavement repairs							•••••	•

Attachment 4

PERSONAL PROTECTIVE EQUIPMENT (PPE) FOR CIVIL ENGINEERING OPERATIONS

A4.1. Supervisors should coordinate with the Bioenvironmental Engineering Flight and Wing Safety on PPE for their personnel. **Table A4.1** lists PPE by type of operation. The Bioenvironmental Engineering flight ensures hearing protection is adequate. Respiratory protection is not authorized without Bioenvironmental Engineering approval.

Table A4.1. Listing of Typical PPE by Operation.

Operation or Equipment	Typical PPE Required
Dump Truck	Safety-toe boots Gloves
Loader, Grader, Sweeper, Backhoe, Bulldozer, Roller, Paver	Safety-toe boots Gloves Eye protection (dust and bright sun) Hearing protection Respiratory protection (if dusty)
Crane	Safety-toe boots Gloves Hearing protection Head protection
Jackhammer, Pneumatic Drill	Respiratory protection Safety-toe boots Eye protection Hearing protection Gloves

Concrete Saw, Router, Pavement Grinder	Safety-toe boots Eye protection Hearing protection Respiratory protection (if dusty) Gloves
Asphalt Kettle	Safety-toe boots Eye protection Gloves Apron
Concrete Mixer	Safety-toe boots Eye protection Respiratory protection Hearing protection
Walk-Behind Mower, Powered Edger	Safety-toe boots Eye protection Hearing protection Respiratory protection (if dusty)
Riding Mower	Safety-toe boots Eye protection Hearing protection Respiratory protection (if dusty)
Tractor-Towed Mower	Safety-toe boots Eye protection Hearing protection Respiratory protection (if dusty) Gloves Head protection (if overhead hazard exists)

Chain Saw	Safety-toe boots Eye protection Hearing protection Respiratory protection (if dusty) Gloves Head protection Leggings (if available)
Powered Auger Rototiller	Safety-toe boots Eye protection Hearing protection Gloves
Stump Cutter, Chipper	Safety-toe boots Eye protection Hearing protection Gloves Head protection
Lawn Roller	Safety-toe boots Gloves
Fertilizer Handling and Application	Safety-toe boots Eye protection Rubber gloves Respiratory protection
Stationary Woodworking Machinery	Eye protection Hearing protection Respiratory protection (if dusty)
Portable Power Tools	Eye protection Hearing protection Respiratory protection (if dusty)
Powder-Actuated Tools	Eye protection Hearing protection Respiratory protection (if dusty)

General Carpentry, Painting, Plumbing, Sheet Metal, Welding, and Masonry	Safety-toe boots Eye protection Knee pad protection (extended kneeling) Gloves
Roofing	Fall protection Eye and burn protection (if using asphalt, e.g., gloves, long sleeve shirts, aprons, etc.)
Soldering, Brazing, Welding	Safety-toe boots Eye protection Welder's gloves Respirator (if poorly ventilated spaces)
Spray Painting	Eye protection Respirator (if using dry tints) Gloves Coveralls
Paint Mixing	Eye protection Respiratory protection (if using dry tints) Gloves
Working in Sewers	Respiratory protection Gloves Rubber boots, knee and hip waders Head protection
Metal-Working Machinery	Safety-toe boots Eye protection Gloves Head protection (if overhead crane system is in use)
Mixing Concrete or Mortar	Safety-toe boots Gloves Eye protection Respiratory protection

Placing Brick or Block, etc.	Safety-toe boots Gloves Eye protection
Cleaning Masonry	Eye protection Acid resistant gloves
General Refrigeration or Heating Work	Safety-toe boots Gloves
Exterior Electric Work or Overhead Distribution	Head protection Fall protection (safety harness/ lanyard) Electrician gloves Safety-toe boots Arc Flash Apparel (see UFC3-560-01)
General Interior Electric and Power Production Work or Barrier Maintenance	Safety-toe boots Gloves Respiratory protection Eye protection Arc Flash Apparel (see UFC3-560-01)
Battery Work (Liquid Electrolyte)	Safety-toe boots Acid resistant gloves and apron Eye and face protection
General Water or Waste Work	Safety-toe boots Gloves Life vest
Water or Waste Laboratory	Eye protection Respiratory protection Chemical resistant gloves
General Materials Handling	Safety-toe boots Gloves Hard hat (overhead hazard)

Pest Management	Rubber boots (knee or hip) Coveralls Unlined neoprene gloves Non-vented goggles Respirators Hearing protection

Attachment 5

CIVIL ENGINEER SAFETY CHECKS

Table A5.1. Heavy Equipment Operations.

Item or Activity
Backhoes • Are the front bucket (if so equipped) and outriggers in full-down positions before digs are attempted? • Is the entire area where the digging arm may swing cleared of people and equipment? Is clearance for fixed obstructions assured? • Is operation under energized lines permitted only when absolutely necessary? Are these operations approved by the commander? • During travel to and from worksites, is the backhoe folded, secured, and centered? Is the front bucket raised only high enough to provide adequate ground clearance?
Mobile Cranes • Are mobile cranes operated only by authorized and qualified persons possessing a valid Operator's Identification Card or persons in training under direct supervision of a qualified operator? • During operation, is a person appointed to provide signals to the operator? • Before leaving the crane unattended, are all shutdown procedures performed? • Is a pre-operational inspection performed and are discrepancies reported to the supervisor? • Are load weights determined before lifting? • Are outriggers set before lifting, telescoping the boom, or turning a load within the ratings? • Are loads transported on cranes specifically designed for this purpose? • Are personnel restricted from riding on loads or the hook?

• Are outriggers used, regardless of the load, when the ground is soft or otherwise unstable? • When two or more cranes are used to lift one load, is one person designated as the responsible individual? • Are required safety measures such as securing the empty hook, attaching warning flags (as necessary), etc., taken before the crane is moved to a new job site? • Are all parts of the crane and load restricted within 10 feet of an energized power line? If this is not practical, is the line de-energized? • Are added clearances assured for work near lines greater than 50 kV? • Is a permanent sign posted within the crane cab warning of electrical power line dangers and restrictions? • Are operators aware of necessary precautions in the event of contact with power lines? • Is an approved fire extinguisher kept in the crane cab?
Dump Trucks • Are dump trucks operated within the load capabilities established by the manufacturer and consideration given to the specified weights of the material being carried? • Are personnel restricted from the bed while it is being raised?
Graders, Loaders, and Bulldozers • Are operators familiar with manufacturer's operating instructions, including clearances and weight limitations, if applicable?
Sweepers • Are sweepers operated on airfields equipped with headset radios in direct contact with control tower or escorted by a vehicle that is?

Table A5.2. Pavement Operations.

Item or Activity
Concrete Saw • Is a water supply maintained during operation?
Pavement Breaker (Jackhammer) • Are proper lifting techniques used during equipment operation and transport?
Concrete Mixer • Are mixers supported in stable positions prior to operation?
Joint Seal Kettle-Melter • Is an approved fire extinguisher available near the kettle? • Is the safe heating temperature specified by the manufacturer maintained during heating? • Is material eased into the kettle to prevent splashing? • Are open flames or other sources of ignition not permitted near material heated to its flashpoint?

Table A5.3. Compressed Air, Pneumatic, and Portable Power Tools.

Item or Activity
Compressed Air and Pneumatic Tools • Is compressed air never used to blow debris from personnel? • Is the downstream pressure of compressed air used for cleaning purposes maintained below 30 psi and only used when effective chip guarding and eye protection are used? • Are air supply lines marked or tagged to identify the maximum psi on the line?

Portable Power Tools • Are electric power tools never operated in rain, sprinklers, or any kind of precipitation?

Table A5.4. Carpentry and Structural Maintenance.

Item or Activity
General • Are all woodworking machines turned off when left unattended? • Are workers restricted from clearing or repairing equipment while it is operating? • Are machines shut down, locked out, and tagged during maintenance? • Are all machine guards in place and, if not, is the machine locked out and tagged?
Ventilation Systems • Are industrial ventilation systems installed, as required, and are they operational? • Do industrial ventilation systems exhaust to an enclosed collection container?
Storage and Handling of Lumber • When lumber is stored in tiers, is it stored properly? • Is smoking prohibited in lumber storage areas? • When stock cannot be safely handled by hand, is suitable material handling equipment available and used?
Powder-Actuated Fastening Tools: • Are only specific size powder charges used as required by manufacturer’s instructions? • Are powder-actuated tools prohibited from use for attaching material to soft construction materials?

- Are operators trained and issued a qualified operator's card by the manufacturer or PATMI?
- Is the tool loaded only when ready to make the required fasten?
- Are tools unloaded during transfer?
- Are tools cleaned, maintained, and checked prior to use according to manufacturer's instructions?
- Are tools stored unloaded and in a locked container?
- Are tools equipped with proper shields?
- Is use restricted in explosive or flammable atmospheres?
- Are operators familiar with procedures in the event of a misfire?
- Are unfired powder loads disposed of properly?
- Are tool powder loads transported properly?
- Are tool powder loads stored according to instructions in Defense Explosives Safety Regulation (DESR) 6055.09_AFMAN 91-201, *Explosives Safety Standards*?
- Are warning signs posted in areas of tool use?
- Does the operator ensure no personnel are present on the opposite side of the wall, structure, or material prior to firing a fastener into it?

Roofing Operations

- Are scaffolds provided or fall protection equipment used as required?
- Is roofing material segregated and stored in stable conditions?
- Are tar kettles and pots located so they will not pose a fire hazard?

Masonry

- Are workers aware of potential hazards associated with the use of Portland cement?
- Are personnel aware of the hazards and is required PPE used when cleaning and etching brick and concrete work?
- When using power mixers and trowels, are gears, pulleys, chains, or belts adequately guarded?
- When preparing footings, are locations of underground utilities identified prior to any excavations?

Table A5.5. Protective Coating Maintenance.

Item or Activity
General • Are flammable and combustible liquids used and stored according to instructions in DAFMAN 91-203? • Are required control measures for exposures to pigments, extenders, and fillers instituted and enforced? • Are required control measures for exposure to solvents instituted and enforced?

Table A5.6. Plumbing Maintenance.

Item or Activity
Torches and Furnaces • Are operators trained and familiar with operating instructions of torches and furnaces before being permitted to use them? • Are torches and furnaces restricted from use where flammable or explosive environments may be present? • Is the use of gasoline torches and furnace prohibited in small, unventilated spaces? • Are appropriate fire extinguishers available as required?
Soldering and Brazing • Are electric soldering irons grounded unless double insulated? • Are soldering irons placed in suitable non-combustible receptacles when not in use?
Industrial Waste Drains/Open Storm Drains • Are industrial waste manholes treated as confined spaces and appropriate safety measures taken prior to entry? • Are proper pry bar tools, special lifting tools, and additional help used when lifting storm drain manhole covers as necessary?

Gas Systems • Where a gas leak is suspected, is the area properly vented and purged and do personnel entering the area utilize required PPE? • Are tools used to repair leaks or perform maintenance on gas lines spark-free and is clothing static-free?
Tunnels, Pits, and Sumps • Are atmospheric conditions tested prior to entry into tunnels, pits, and sumps? • Are tunnels, pits, and sumps (which are known to be contaminated) tagged or identified for information of work crews? • Is a second person available to provide emergency assistance for persons entering a subsurface?
Compressed Air • Are lines completely drained of existing air prior to opening compressed air lines? Are new lines completely secured prior to air entry into the system? • Is air used for cleaning restricted to 30 psi and below?

Table A5.7. Metal Fabrication and Welding.

Item or Activity
Inert Gas Brazing and Welding • Are workers instructed on the hazards of inert gas asphyxiation in confined spaces? • Are chambers completely ventilated and cooled prior to entry? • Is adequate ventilation or, as necessary, air-supplied respiratory protection available?
Electron Beam Welding • Are operating instructions for electron beam welding established and adhered to?

Plasma Arc Cutting • Is required shielding in place and do walls, floors, ceilings, etc., have non-reflective surfaces? • Are adequate controls (e.g., exhaust ventilation or approved respiratory protective devices) provided?
Induction (Spot) Welding and Brazing • Do welders replace filter materials within induction coils and not attempt to adjust placement while the welding or brazing equipment is activated?
Magnesium-Thorium Welding, Cutting, and Grinding • Prior to welding, cutting, or grinding operations on magnesium-thorium, is the Installation Radiation Safety Officer (IRSO) consulted? The IRSO in most instances is the base Bioenvironmental Engineer.
Welding and Cutting Tanks, Cylinders, or Containers • Are all tanks, cylinders, or containers to be welded or cut, purged or made inert prior to the operation being conducted? • Are pipelines to these containers disconnected prior to welding or cutting?
Portable Gas Units • Are compressed gas cylinders equipped with pressure reducing regulators? • Are cylinders stored in upright position with caps installed and secured with materials other than rope or other readily combustible material? • Are gaseous systems and containers color-coded? • Are pressure hoses secured to prevent whipping? • Are oxygen cylinders and fittings free of grease and oil? • Are cylinders kept separate from external sources of heat? • Are approved devices provided for flashback protection?

Portable Electric Units • Are units de-energized before they are tested, repaired, or transported? • Are motor generators and other electrical equipment grounded prior to use?
Arc Welding • Are necessary cable splices performed only by qualified electricians and are splices prohibited within 10 feet of the electrode holder? • When welders are working close together on one structure, are machines connected to minimize shock hazards according to DAFMAN 91-203?
Resistance Welding • Are thermal protection switches in use on ignition tubes? • Are controls safeguarded from inadvertent activation? • Are multi-gun welding machines guarded at the point of operation? • Are all external weld-initiating control circuits operated on required voltage and are interlocks available to prevent access by unauthorized individuals?
Welding in Confined Spaces • Are confined spaces where welding or cutting is performed adequately ventilated? • Is an attendant positioned on the outside of a confined space entry point to ensure the safety of those in the confined space? • Are gas cylinders and welding machines left outside confined spaces? • Are confined spaces tested for oxygen content and combustible vapors prior to entry?
Hazards Associated With Fluxes, Coverings, Filler Metals, and Base Metals • Are precautions identified and requirements met according to DAFMAN 91-203 when welding Fluorine compounds, Zinc, Lead, Beryllium, Cadmium, and Mercury materials?

Table A5.8. Refrigeration/Air Conditioning Maintenance.

Item or Activity
General • Are all belts, pulleys, and rotating shafts adequately guarded?
Storage and Handling • Are compressed gas cylinders adequately stored and handled?

Table A5.9. Interior and Exterior Electric Maintenance.

Item or Activity
General • Do all personnel strictly adhere to AFMAN 32-1065, *Grounding & Electrical Systems,* any time lethal voltages are involved.
Electric Motor Rewind Shops • Are capacitors disconnected for at least 5 minutes before circuit terminals are shorted by an approved method?
Storage Batteries • Are open flames or spark-producing devices restricted in the vicinity of storage battery banks? • Is a neutralizing solution available when work involves contact with electrolyte? • When mixing acid and water, is the acid poured into the water and not vice-versa?
Work on Energized Circuits • Is work on energized circuits performed only when absolutely necessary? • Is approved protective equipment used when work on energized conductors or parts is performed?

Work Near Energized Circuits • When air operated equipment is used around live parts, are the nozzles made of non-conducting material? • Are appropriate warning tags used as a temporary means of warning employees of existing electrical hazards?
Exterior Electric • Are leather gloves and safety-toed shoes worn when removing or re-placing manhole covers? • Are confined space entry precautions used when entering manholes and vaults?

Table A5.10. Electrical Power Production.

Item or Activity
General • Do all personnel strictly adhere to AFMAN 32-1065, *Grounding & Electrical Systems,* any time lethal voltages are involved?
Plant Operations • Are generators located in outside facilities housed in weatherproof protection and all moving parts and electrical connections adequately guarded or covered? • Are all metal frames for electrical control panels, switches, meters, and other hazardous electrical devices grounded not to exceed 25 ohms? • Are standard operating procedures developed and posted for normal and emergency operations for equipment controls? • Are noise hazard and high voltage warning signs posted where appropriate?

Plant Maintenance • Is jewelry removed prior to working on machinery? • Are appropriate safety clearance tags and interlocks used to prevent accidental or unintentional startup of equipment that is being worked on? • Does all test equipment have current calibration? • Are proper jacking procedures used?
Plant Switchgear and Substation • When work is performed on energized circuits, is it approved by the Civil Engineer Commander or designated representative? • When performing approved work on energized circuits, are at least two fully qualified workers and required PPE available? • When working adjacent to energized circuits exceeding 600 volts, are rubber blankets or other guards provided?
Batteries • Are nickel-cadmium and unsealed lead-acid batteries stored separately? • If required, are emergency eyewashes and showers provided?
Vaults and Manholes • Are vaults and manholes considered confined space hazards until proven otherwise and if so, are confined space requirements followed?
Air Compressors • Are adequate safety relief valves installed on air tanks? • Are valves prohibited between air tanks and safety valves?

Table A5.11. Water and Wastewater Treatment.

Item or Activity
Nature of Hazards • Are chlorinator treatment rooms that are identified as potentially immediately dangerous to life and health (IDLH), equipped with a telephone or are other means of communication? • Are chlorinator treatment rooms equipped with mechanical exhaust systems that are turned on prior to entry? • Are written procedures developed for emergency conditions for chlorinator treatment rooms?
Personal Sanitation: • Are emergency eyewashes and showers provided when necessary?
Treatment Plant • Are emergency OIs developed? • At shredding and grinding stations, is power turned off, tagged, and locked out before servicing? • Are guards and screens in place at shredding and grinding stations?
Sedimentation Basin (Clarifier) • Are approved life vests and lifelines located around the clarifier? • Are guards provided around moving parts? • Is the rotary distributor of the trickling filter anchored prior to inspection or servicing?
Aeration Tanks • Are firm guardrails in place for work areas and walkways? • Are approved life vests with lifelines located at appropriate points around aerator rails?
Stabilization Ponds • Are life vests available and worn when working on a boat or raft?

Laboratories • Are laboratories clean and designed safely and are chemicals stored properly? • Is electrical equipment properly grounded in laboratories? • Is pipetting of chemicals by mouth restricted?

Table A5.12. Aircraft Arresting Systems.

Item or Activity
General • Is good housekeeping maintained in all aircraft arresting system operations and maintenance areas? • Are flammable and combustible liquids stored, used, and handled according to instructions in DAFMAN 91-203? • When using compressed air for cleaning is air pressure less than 30 psi and is required PPE used? • Where necessary, are emergency eyewashes and showers provided? • When working on active runways, is total communication maintained with the tower and operations?
Runway Barriers • Are facilities housing the aircraft arresting system evacuated to proper distances? • After engagement and upon returning to the aircraft arresting system housing facility is required PPE designated and used? • Is the minimum number of operators, according to applicable T.O.s available?

Attachment 6

PROS AND CONS OF EXPEDIENT LATRINES

A6.1. Pail Latrines.

Pail Latrines	
• Buckets are placed under box latrine seats. • Double trash bags or similar liner is recommended for ease of disposal and cleaning. • 4 seats with pails (e.g., 5-gallon).	
PROS	CONS
• Can be constructed quickly. • Can last indefinitely. • Can be constructed in areas where conditions prevent digging (e.g., populated areas, rocky plateau desert). • Can be constructed in areas where trenches cave in (e.g., sandy dune desert). • Can be constructed in areas with high water table (e.g., desert marsh such as those near Basra, Iraq).	• Labor intensive. Pails should be emptied and cleaned daily. • Should find proper disposal area immediately.
Technical Suitability For Desert Use: Good.	
Desert-Specific Limitations/Conditions: None.	
Notes and Other Factors:	

A6.2. Straddle Trench Latrines.

<table>
<tr><th colspan="2">Straddle Trench Latrines</th></tr>
<tr><td colspan="2">• Uncovered trenches without a seat above.
• Boards may be placed on the ground along both sides of trench to provide better footing and prevent crumbling/cave in of sides.
• Two trenches. Each trench is 1 foot wide x 2.5 feet deep x 4 feet long and can accommodate 2 people at a time.
• Excreta should be covered with soil after each use since the trenches are open to filth flies, thereby reducing the serviceable volume.
• Design capacity: 2 trenches (capacity for 4) per 100 males, 3 trenches (capacity for 6) per 100 females.
• An interim measure, only expected to last 1-3 days while final facilities are being constructed are installed.</td></tr>
<tr><td>PROS</td><td>CONS</td></tr>
<tr><td>• Can be dug quickly</td><td>• Don’t last long (1-3 days)
• Trenches open to filth flies—should cover excreta after each use
• Covering excreta partially fills trench.
• Difficult to use—no seats or support.
• Sides may collapse in some sandy desert soils.</td></tr>
<tr><td colspan="2">Technical Suitability For Desert Use: Good.</td></tr>
<tr><td colspan="2">Desert-Specific Limitations/Conditions: Sidewall strength may be insufficient in some sandy desert soils.</td></tr>
<tr><td colspan="2">Notes and Other Factors:</td></tr>
</table>

A6.3. Deep-Pit Latrines.

<table>
<tr><th colspan="2">Deep-Pit Latrines</th></tr>
<tr><td colspan="2">• A 6-foot deep trench with a 2-seat or 4-seat box on top.
• The edges around the box and hole are sealed with soil, and seat lids seal when closed to keep filth flies out.</td></tr>
<tr><td>PROS</td><td>CONS</td></tr>
<tr><td>• The standard configurations would be expected to last roughly 33 to 35 days.</td><td>• Deserts too rocky or too sandy may preclude its use.
• Desert soil should be soft enough to dig and firm enough to hold the walls and edges without caving in.</td></tr>
<tr><td colspan="2">Technical Suitability For Desert Use: Good.</td></tr>
<tr><td colspan="2">Desert-Specific Limitations/Conditions: Side wall strength may be insufficient in some sandy desert soils. In other locations, clayey soils can hinder or prevent percolation. If permitted, pit life can be extended by burning the contents of the deep-pit latrine weekly.</td></tr>
<tr><td colspan="2">Notes and Other Factors:</td></tr>
</table>

A6.4. Bored-Hole Latrines.

<table>
<tr><th colspan="2">Bored-Hole Latrines</th></tr>
<tr><td colspan="2">• Made by boring a cylindrical hole 6 to 20 feet in the ground.
• Half a drum (e.g., 55-gallon) with a hole cut in it and a seat on top of the half-drum is placed over the hole.</td></tr>
<tr><td>PROS</td><td>CONS</td></tr>
<tr><td>• Can be constructed quickly with a drill rig and cutting torch.
• The standard configurations would be expected to last roughly 16 to 63 days.</td><td>• Deserts too rocky or too sandy may preclude its use.
• Desert soil should be soft enough to dig and firm enough to hold the walls and edges without caving in.
• Bored-hole latrines may need side wall support. (e.g., from cylindrical drums) in sandy desert soils, or should be more shallow.
• Requires engineering support to bore hole and cut drums.</td></tr>
<tr><td colspan="2">Technical Suitability for Desert Use: Ranges from very good to poor, depending on side wall strength.</td></tr>
<tr><td colspan="2">Desert-Specific Limitations/Conditions: Side wall strength may be insufficient in some sandy desert soils.</td></tr>
<tr><td colspan="2">Notes and Other Factors:</td></tr>
</table>

A6.5. Mound Latrines.

Mound Latrines	
• A mound above grade with a trench in it and a 4-seat box over the pit. • Either a mound is constructed and a trench is dug in the mound, or soil is piled up in stages around supporting walls that will become the trench. • Trench is located 1 foot above groundwater or rock; depth is variable.	
PROS	CONS
• May be suitable in rocky desert soil or mountainous deserts where the ground is too rocky to dig. • The standard configurations of a 4-seat mound latrine with a 6-foot deep pit would be expected to last roughly 35 days.	• Requires engineering support to construct mound and trench. • Liquid wastes may escape through the side of the mound if the soil is too permeable.
Technical Suitability For Desert Use: Very good in absorbing soils. Poor where liquid waste could break through the mound.	
Desert-Specific Limitations/Conditions: Leakage from side of the mound is possible with sandy desert soils.	
Notes and Other Factors:	

A6.6. Burn-Out Latrines.

Burn-Out Latrines	
• 55-gallon metal drum is cut in half and placed under a seat. Handles are welded onto the drum. • Plywood shelter to support toilet seat and provide privacy.	
PROS	CONS
• Can be constructed quickly with the right equipment. • Can last indefinitely, requiring only the remaining ash to be buried.	• International agreements and the Environmental Annex of the OPLAN and/or OPROD may prohibit open burning or air emissions. • Requires engineering support to cut drums and weld handles. • Labor and fuel intensive. • Smoke from burning waste can announce presence. Detrimental if tactical security is a concern.
Technical Suitability For Desert Use: Very Good.	
Desert-Specific Limitations/Conditions: None.	
Notes and Other Factors:	

A6.7. Chemical, Portable or Self-Contained Vault Toilets.

Chemical, Portable and Self-Contained Toilets	
• Self-contained portable or non-portable outbuildings with a holding tank under the seat. • May contain chemical additives that aid in the decomposition of the waste and odor control.	
PROS	CONS
• Have been used successfully when serviced adequately and wastes disposed of properly. • Can be adapted for use as burn-out latrines if wastewater treatment facility or waste disposal support (e.g., sewage vacuum trucks) is unavailable.	• Should be pumped out at weekly to break the filth fly reproductive cycle, or as frequently as daily depending upon usage. • Pumped out material should be disposed of properly. • A proper waste disposal area should be prepared within 1 week. • Length of use is limited by the disposal area.
Technical Suitability For Desert Use: Very Good.	
Desert-Specific Limitations/Conditions: None.	
Notes and Other Factors:	

Attachment 7

PROS AND CONS OF EXPEDIENT WASTEWATER DISPOSAL FACILITIES

Table A7.1. Evaporation Beds.

Evaporation Beds	
• Intended for kitchen, wash, and bath wastewater. • Expedient evaporation beds are often small (8 feet x 10 feet x 6 inches) with rows or in 3 tiers where one pond flows into the next if space is limited. • 3 square feet/person/day for kitchen waste plus 2 square feet/person/day for wash and bath water • Beds are flooded to an average depth of 3 inches on successive days. Beds are rotated and water should evaporate and percolate within 4 days. Underlying soil is spaded and bed is reused.	
PROS	CONS
• Simple to build	• Labor intensive. • Time consuming to maintain. • Small capacity. • Space consuming.
Technical Suitability For Desert Use: Good. Suitable for small units (generally 90 or less people).	
Desert-Specific Limitations/Conditions: Clayey soils may expand, become impermeable, and prevent sufficient percolation. Impermeable caliche may prevent sufficient percolation.	
Notes and Other Factors:	

Table A7.2. Soakage Pits and Trenches.

<table>
<tr><th colspan="2">Soakage Pits and Trenches</th></tr>
<tr><td colspan="2">• Designed for liquids only.
• Pit 4 feet x 4 feet filled with gravel, rubble, or shredded metal, e.g., aluminum cans.
• Constructed as stand-alone urine soakage pits with urine tubes or pipes.
• Should be constructed in conjunction with standard in-ground latrines, chemical toilets or burn-out latrines for solid human waste.
• Soakage pits or trenches for shower and kitchen are built separately from urine soakage pits. Four trenches radiating from a central1-foot deep pit are 6 feet long, 2 feet wide and increase in depth from 1 to 1-1/2 feet. Kitchen soakage pits or trenches also need grease traps to prevent percolation from being blocked.
• No estimate of length of service for soakage pits and trenches is made in any field manuals, except the instruction to build a new one when the existing one stops working (standing water observed).</td></tr>
<tr><td>PROS</td><td>CONS</td></tr>
<tr><td>• Reduces traffic in latrines intended for solid human waste.
• Reduces liquid in burn-out latrines, which reduces the amount of fuel required for burning out semi-solids.
• Can last indefinitely if soil is permeable.</td><td>• Should compete for gravel that can be in high demand for other uses.
• Rubble or gravel may not be plentiful at the beginning of deployment when needed to build soakage pit.
• May need to build new one on short notice, especially if soil is not permeable.</td></tr>
<tr><td colspan="2">Technical Suitability For Desert Use: Good.</td></tr>
<tr><td colspan="2">Desert-Specific Limitations/Conditions: Clayey soils may expand, become impermeable, and prevent sufficient percolation. Impermeable caliche may prevent sufficient percolation.</td></tr>
<tr><td colspan="2">Notes and Other Factors:</td></tr>
</table>

Table A7.3. Sewage Lagoons.

<table>
<tr><th colspan="2">Sewage Lagoons</th></tr>
<tr><td colspan="2">• Shallow lagoon or pond dug into ground. Excavated material is sometimes formed into earthen walls. Walls and bottom may require waterproof skin.
• Wastewater is pumped from camp to lagoon.</td></tr>
<tr><td>PROS</td><td>CONS</td></tr>
<tr><td>• Lagoon proper can be constructed easily with mechanized equipment.
• One option for sewage disposal prescribed in “The Sand Book.”</td><td>• Should be located at least 1/2 mile from population center because of odor and filth fly/mosquito breeding.
• Requires sewer collection system piping and possibly automatic lift stations.
• Earthen walls can leak.</td></tr>
<tr><td colspan="2">Technical Suitability For Desert Use: Satisfactory to Poor.</td></tr>
<tr><td colspan="2">Desert-Specific Limitations/Conditions: Clayey soils may hold water. May act similar to an evaporation bed, except that the pest reproduction cycle is not broken by a drying period.</td></tr>
<tr><td colspan="2">Notes and Other Factors:</td></tr>
</table>

Table A7.4. Leach Fields.

<table>
<tr><th colspan="2">Leach Fields</th></tr>
<tr><td colspan="2">• A gravity-fed subsurface drainage bed system, such as a tile or plastic pipe drain field consisting of narrow, shallow trenches through which effluent is discharged.
• The effluent infiltrates the soil primarily through the sides of the trenches.
• Provides physical, biological, and chemical treatment.
• Settling system, such as septic tank or Imhoff tank, to remove sewage solids, at a minimum is implied as pretreatment.</td></tr>
<tr><td>PROS</td><td>CONS</td></tr>
<tr><td>• Underground system eliminates surface discharge and subsequently human contact or filth fly and mosquito breeding.
• Can be close to human habitation.
• Treatment and disposal work well where soil porosity is moderate.
• Low maintenance.
• Can last many years.</td><td>• Requires a significant amount of space.
• Slope should be less than 25%.
• Can clog permanently if solids enter the leach field.
• Requires moderately porous soil so that sewage will neither backup or pond on the surface nor percolate too rapidly to contaminate the ground water.</td></tr>
<tr><td colspan="2">Technical Suitability For Desert Use: Excellent to Good.</td></tr>
<tr><td colspan="2">Desert-Specific Limitations/Conditions: None.</td></tr>
<tr><td colspan="2">Notes and Other Factors:</td></tr>
</table>

Attachment 8

METRIC/FOREIGN CONVERSION TABLES

Table A8.1. U.S. to Metric Conversion Table.

Length		
U.S. Units	**Multiplied By**	**Metric Equivalent**
Inches	2.5400	Centimeters
Inches	25.4001	Millimeters
Feet	0.3048	Meters
Feet per second	0.3050	Meters per second
Miles	1.6093	Kilometers
Area		
Pounds per square inch	0.0700	Kilogram per square centimeter
Square inches	6.4516	Square centimeter
Square feet	0.0929	Square meter
Cubic feet	0.0283	Cubic meter
Cubic inches	16.3900	Cubic centimeters
Volume		
Gallons	3.7854	Liters
Mass (Weight)		
Pounds	0.4536	Kilograms
Temperature		
Degrees (F) -32	0.5556	Degrees (C)
Angle		
Degrees (angular)	17.7778	Mils

Table A8.2. Metric to U.S. Conversion Table.

Length		
Metric Units	**Multiplied By**	**U.S. Equivalent**
Centimeters	0.39370	Inches
Millimeters	0.03937	Inches
Meters	3.28080	Feet
Meters per second	3.28100	Feet per second
Kilometers	0.62140	Miles
Area		
Kilogram per square centimeter	14.22300	Pounds per square inch
Square centimeter	0.15500	Square inches
Square meter	10.76400	Square feet
Cubic meter	35.31440	Cubic feet
Cubic centimeters	0.06102	Cubic inches
Volume		
Liters	0.26420	Gallons
Mass (Weight)		
Kilograms	2.20460	Pounds
Temperature		
Degrees (C) + 17.8	1.8000	Degrees (F)
Angle		
Mils	0.0562	Degrees (angular)

Table A8.3. Foreign Weights and Measures.

Denominations	Where Used	U.S. Equivalents
Almude	Portugal	4.422 gals.
Ardeb	Sudan	5.6188 bushels
Are	Metric	0.02471 acre
Arr't'l or li'ra	Portugal	1.0119 lbs.
Arroba	Argentine Republic	25.32 lbs.
Arroba	Brazil	32.38 lbs.
Arroba	Cuba	25.36 lbs.
Arroba	Paraguay	25.32 lbs.
Arroba	Venezuela	25.40 lbs
Arroba (liquid)	Cuba, Spain and Venezuela	4.263 gals.
Arshine	Russia	28 in.
Arshine (sq.)	Russia	5.44 ft.2
Artel	Morocco	1.12 lbs.
Baril	Argentine Republic	20.077 gals.
Baril	Mexico	20.0787 gals.
Barrel	Malta (customs)	11.2 gals.
Berkovets	Russia	361.128 lbs.
Bongkal	Fed. Malay States	832 grains
Bouw	Sumatra	7,096.5 meters2
Bu	Japan	0.12 inch
Bushel	British Empire	1.03205 U.S. bu.
Caffiso	Malta	5.40 gals.
Candy	India (Bombay)	569 lbs.
Candy	India (Madras)	500 lbs.
Cantar	Egypt	99.05 lbs.
Cantar	Morocco	112 lbs.
Cantar	Turkey	124.45 lbs.
Cantaro	Malta	175 lbs.

Cast, Metric	Metric	3.086 grains
Catti	China	1.333 1/3 lbs.
Catti	Japan	1.32 lbs.
Catty	Java, Malacca	1.36 lbs.
Catty	Thailand	1.32 lbs.
Catty	Sumatra	2.12 lbs.
Centaro	Central America	4.2631 gals.
Centner	Brunswick	117.5 lbs.
Centner	Bremen	127.5 lbs.
Centner	Denmark, Norway	110.23 lbs.
Centner	Russia	113.44 lbs.
Centner	Sweden	93.7 lbs
Chetvert	Russia	5.957 bu.
Ch’ih	China	12.60 in.
Ch'ih (metric)	China	1 meter
Cho	Japan	2.451 acres
Comb	England	4.1282 bu.
Coyan	Thailand	2.645.5 lbs.
Cuadra	Argentine Republic	4.2 acres
Cuadra	Paraguay	94.70 yds.
Cuadra (sq.)	Paraguay	1.85 acres
Cuadra	Uruguay	1.82 acres
Cubic meter	Metric	35.3 cu. ft.
Cwt. (hund. weight	British	112 lbs.
Dessiatine	Russia	2.6997 acres
Drachma (new	Greece	15.43 gr., or 1 gram
Fanega (dry)	Ecuador, Salvador	1.5745 bu.
Fanega	Chile	2.75268 bu.
Fanega	Guatemala, Spain	1.53 bu.
Fanega	Mexico	2.57716 bu.
Fanega (doublé)	Uruguay	7.776 bu.

Fanega (single)	Uruguay	3.888 bu.
Fanega	Venezuela	3.334 bu.
Fanega (liquid)	Spain	16 gals.
Feddan	Egypt	1.04 acres
Frall (rais's)	Spain	50 lbs.
Frasco	Argentine Republic	2.5098 liq.qts.
Frasco	Mexico	2.5 liq. qts.
Frasila	Zanzibar	35 lbs.
Fuder	Luxemburg	264.18 gals.
Funt	Russia	0.9028 lb.
Gallon	British Empire	1.20094 U.S. gals.
Garnice	Poland	1.0567 gal.
Gram	Metric	15.432 grains
Hectare	Metric	2.471 acres
Hectolitre: Dry	Metric	2.838 bu.
Hectolitre: Liquid	Metric	26.418 gals
Jarib	Iran	2.471 acres
Joch	Austria (Germany)	1.422 acres
Joch	Hungary	1.067 acres
Ken	Japan	5.97 feet
Kilogram (kilo)	Metric	2.2046 lbs.
Kilometre	Metric	0.62137 mile
Klafter	Austria (Germany)	2.074 yds.
Koku	Japan	5.119 bu.
Kwamme	Japan	8.2673 lbs.
Last	Belgium (Netherlands)	85.135 bu.
Last	England	82.56 bu.
Last	Germany	2 metric tons (4,409 + lbs)
Last	Russia	112.29 bu.
Last	Scotland, Ireland	82.564 bu.
League (land)	Paraguay	4.633 acres

Li	China	1,890 ft
Libra (lb.)	Argentine Republic	1.0128 lbs.
Libra	Central America	1.014 lbs.
Libra	Chile	1.014 lbs.
Libra	Cuba	1.0143 lbs.
Libra	Mexico	1.01467 lbs.
Libra	Peru	1.0143 lbs.
Libra	Uruguay	1.0143 lbs.
Libra	Venezuela	1.0143 lbs.
Litre	Metric	1.0567 liq. qts.
Litre	Metric	0.90810 dry qts.
Livre (lb.)	Greece	1.1 lbs
Load, timber	England	50 cu. ft.
Lumber (std.)	Europe	165 cu. ft., or 1,980 ft.b.m
Manzana	Nicaragua	1.742 acres
Manzana	Costa Rica, Salvador	1.727 acres
Marc	Bolivia	0.507 lb.
Maund	India	82 2/7 lbs.
Metre	Metric	39.37 inches
Mil	Denmark	4.68 miles
Mil (geographic)	Denmark	4.61 miles
Milla	Nicaragua	1.1594 miles
Milla	Honduras	1.1493 miles
Mina (old)	Greece	2.202 lbs.
Morgen	Germany	0.63 acre
Oke	Egypt	2.8052 lbs
Oke (Ocque)	Greece	2.82 lbs.
Oke	Turkey	2.828 lbs.
Pic	Egypt	22.82 inches
Picul	Borneo, Celebes	135.64 lbs.
Picul	China	133 1/3 lbs.

Picul	Java	136.16 lbs.
Picul	Philippines	139.44 lbs.
Pie	Argentine Republic	0.94708 ft.
Pie	Spain	0.91416 ft.
Pik	Turkey	27.9 inches
Pood	Russia	36.113 lbs.
Pund (lb)	Denmark	1.102 lbs.
Quart	British Empire	1.20094 liq. qt.
Quart	British Emp	1.03205 dry qt.
Quarter	Great Britain	8.256 bu.
Quintal	Argentine Republic	101.28 lbs.
Quintal	Brazil	120.54 lbs.
Quintal	Castle, Peru	101.43 lbs.
Quintal	Chile	101.41 lbs.
Quintal	Mexico	101.47 lbs.
Quintal	Metric	220.46 lbs.
Rottle	Israel	6.35 lbs.
Sack (flour)	England	280 lbs.
Sangene	Russia	7 feet
Salm	Malta	8.2 bu.
Se	Japan	0.02451 acre
Seer	India	22-35 lbs.
Shaku	Japan	11.9303 inches
Sho	Japan	1.91 liq. qts.
Skalpund	Sweden	0.937 lbs.
Stone	British	14 lbs.
Sun	Japan	1.193 inches
Tael Kuping	China	575.64 grains (troy)
Tan	Japan	2.05 pecks
Tchvtert	Russia	5.96 bu.
To	Japan	2.05 pecks

Ton	Space measure	40 cu ft.
Tonde cereals	Denmark	3.9480 bu.
Tonde Land	Denmark	1.36 acres
Tonne	France	2204.62 lbs.
Tsubo	Japan	35.58 ft.2
Tsun	China	1.26 inches
Tunna (wheat)	Sweden	4.5 bu.
Tunnland	Sweden	1.22 acres
Vara	Argentine Republic	34.0944 inches
Vara	Costa Rita, Salvador	32.913 inches
Vara	Guatemala	32.909 inches
Vara	Honduras	32.953 inches
Vara	Nicaragua	33.057 inches
Vara	Chile and Peru	32.913 inches
Vara	Cuba	33.386 inches
Vara	Mexico	32.992 inches
Vedro	Russia	2.707 gals.
Verst	Russia	0.663 mile
Vloka	Poland	41.50 acres
Wey	Scotland and Ireland	41.282 bu

Attachment 9

BEDDOWN/BARE BASE DEVELOPMENT CONSIDERATIONS

Table A9.1. Site Planning and Layout.

Sight Planning and Layout Considerations
• Are basic planning source documents available?
o AFPAM 10-219V6, Planning and Design of Expeditionary Airbases
o Base/Joint Support Plans (if published/ applicable)
o Base maps or Installation Geospatial Information and Services data
o High-fidelity Satellite Imagery
o National Geospatial-Intelligence Agency Topographic Data Store and Airfield Foundation Data
• Has Wing Intelligence been contacted to provide the latest threat estimate?
• Has Wing Operations been contacted to provide verification on numbers/ types of aircraft and base population to be supported?
• Has an exploratory trip been made around the base to ascertain terrain features, land area available, locations of existing pavements, location of water source, locations of useable structures, etc.?
• Has the Wing Weather function been contacted to obtain germane climatic factors?
• Has a decision been made concerning a dispersed vs non-dispersed layout?
• Have areas unsuitable for facility layout been highlighted on the base layout maps?
• Have facilities in each facility group been laid out with though to utility system routings, i.e., reasonably straight runs and vehicle access ability?

• Have all facility groups (e.g. maintenance, supply, engineer, transportation, etc.) been sized based on typical quantities of facility assets and appropriate spacing distances?
• Have likely locations for all facility groups been selected considering their functional relationship with the base mission and other base organizations?
• Has an allowance for future expansion been included in each facility group when appropriate?
• Does the layout of all facility groups meet the safety distance/quantity distance criteria pertaining to munitions, Cryogenics, and POL storage?
• Has a road network been planned between facility groups that permits easy access and egress to and from the flightline?
• Have utility plants been sited?
• Have areas for construction of evaporation beds and sewage lagoons been identified downwind of the main base area?
• Have areas for temporary disposal of waste and wastewater been identified pending completion of permanent lagoons and evaporation beds?
• Have site layout maps been made for survey crews who will mark locations of facility group areas and individual facilities?
• Have site layout crews been identified?
• Have stakes or similar marking devices been obtained?
• Have vehicles (if available) been identified for site layout crews?
• Have site layout crews been briefed on how to accomplish their tasks and the timeframe they have to work within?
• Do site layout crews have the surveying equipment necessary to layout the more complex requirements, e.g., the mobile aircraft arresting barrier?
• If other functional areas participated in site layout of their facilities and equipment; have the chosen locations been checked for suitability, e.g., drainage patterns, safety distance criteria, airfield clear zones, etc.?

Table A9.2. Electrical System.

Electrical System Considerations
• Has a holding area for temporary storage of incoming electrical system components been established?
• Have mission essential facilities been identified and coordinated with the appropriate command elements?
• Have the locations of mission essential facilities been identified?
• Has a requirement for sustained operations at the contingency location been confirmed?
• Has an initial estimate of the electrical loads of mission essential facilities been made to aid in sizing generators to the requirements?
• Has vehicle/equipment support for moving electrical equipment to site locations been arranged?
• Do all electrical installation crews have an individual capable of operating materials handling equipment?
• Have SDCs been placed at locations where tactical power generators can serve multiple mission essential facilities?
• Have tactical power generators been connected to mission essential facilities?
• Have TF-2 light carts been operationally checked and allocated to critical flightline functional areas?
• Have personnel been identified to perform routine maintenance and refueling operations on tactical power generators?
• Have electrical feeder schedules been developed based on the layout of the various base facility groups?
• Have SDC circuits been sized to handle future air conditioning loads (if applicable)?

• Has a plan showing the layout of the electrical distribution system been developed?
• Have locations for power plants been determined?
• Have prime power generators (750kW - 840kW) been positioned at power plant locations?
• Have fuel bladders been installed at power plant locations?
• Have fuel bladders been properly bermed?
• Have control panels been correctly connected to the prime power generators?
• Have primary switching centers been placed and connected at power plants?
• Have adequate grounding systems been installed at the power plants?
• Have SDCs been allocated to and placed in the various facility groups in such a way that portions of the groups can be brought on line as facilities are erected?
• Have SDCs been placed in areas accessible to vehicles yet not adjacent to heavy traffic or personnel flow?
• Have SDCs been grounded?
• Have the cables connecting the facilities, panel boxes, SDCs, primary switching centers initially been installed along the surface of the ground?
• Have cables that cross roadways been adequately protected from damage by vehicle traffic?
• Have facilities been brought onto the base electrical grid as soon as reasonably possible once electrical connections have been completed?
• Have tactical power generators serving mission essential facilities been placed in back up power mode once power plant electrical service was available?

• Have personnel been specifically designated to provide around-the-clock power plant operation?
• Have Remote Area Lighting System units been installed at locations requiring large-scale area lighting?
• If sustained operations are planned and the electrical system is fully functional in an above ground mode, have efforts been started to bury electrical cables?
• Have accurate records/drawings been made of the locations of buried electrical cables?
• Do power plant operators properly maintain plant operation records?
• Have arrangements been made for power plant refueling?

Table A9.3. Water System.

Water System Considerations
• Has a holding area for temporary storage of incoming water system components been established?
• Has the installation's source of water been identified and located?
• Has the water source been developed sufficiently to allow pumping?
• Has vehicle/equipment support for moving water system components to site locations been arranged?
• Have vehicles been identified for use in hauling water from source locations to treatment plants?
• Have water trailers or bladders mounted on trailers been identified to support the water hauling requirement?
• Have raw water pumps been installed at water source locations?
• Have locations for water plants been determined?

• Has the distance from the water source to the nearest treatment plant been limited to two miles or less?
• Have ROWPUs been delivered to the water plant locations?
• Have arrangements been made to have electrical power support readily available at the water plant locations?
• Have personnel been assigned to set up ROWPUs and associated storage tanks and begin water production?
• Have personnel been assigned to continuously haul water from the water source location to the water plants?
• Have brine discharge lines from the ROWPUs been laid out to discharge brine back to the source, into a low-lying contained area, or temporary storage system?
• Has sufficient space been allowed around the water treatment plants to permit installation of additional water storage bladders at a later time?
• If demineralized water is required, has a 20,000-gallon water bladder been specifically identified for demineralized water storage?
• Have key facilities (hospital, kitchen, etc.) requiring potable water been identified?
• Has the layout of aboveground flexible hose from the treatment plants to key facilities requiring potable water been started?
• Have hoses that cross roadways been adequately protected from vehicle traffic?
• Have fill points for both potable and non-potable water been set up?
• Has a reasonably level and clear path been made between the nearest water treatment plant and the water source?
• For long term installation, has a hardwall source line been installed between the water source and the nearest water treatment plant?

• Have installation personnel verified in the field the planned locations of the hardwall distribution system for feasibility and practicability?
• Do all utilities crews have an individual capable of operating trenching equipment or a backhoe?
• Have pipelines that cross roadways been adequately protected from damage by vehicle traffic?
• Have additional water storage bladders provided as part of the distribution system been installed at the water treatment plants?
• Have the storage bladders been installed so that approximately 60% of the storage capacity is dedicated to potable water?
• Has a requirement for sustained operations at the contingency location been confirmed?
• If sustained operations are planned and the water system is fully functional in an aboveground mode, have efforts been started to install and bury a hardwall piping distribution system?
• Have accurate "as-built" drawings of buried hardwall pipe locations been made?
• If/after installing in-ground hardwall piping, is the flexible hose initial distribution system serviced and stored properly in system shipping containers?

Table A9.4. Sewage and Wastewater Systems.

Sewage and Wastewater System Considerations
• Has a holding area for temporary storage of incoming waste system components been established?
• Have locations for construction of expedient latrines been identified?
• Have personnel been identified to construct expedient latrines at all required locations?

• Have the locations of BEAR field latrines been identified?
• Has the potential of tapping into off base sewage collection systems been investigated?
• Have locations downwind of the base been identified for stabilization lagoons and evaporation ponds?
• Have areas for temporary disposal of waste and wastewater been identified pending completion of permanent lagoons and evaporation beds?
• Have personnel been identified for servicing of expedient latrines?
• Are personnel available who are qualified to operate the wastewater disposal trailer?
• Has local contract support for waste disposal been investigated?
• If not connected to wastewater system, are graywater lines from showers and laundry been run to evaporation beds?
• Are grease traps installed in wastewater lines leading from the kitchen, when necessary?
• Have Force Support personnel been instructed in grease trap use?
• Has a plan for the layout of the waste collection system been developed?
• Have installation personnel verified in the field the planned locations of the hardwall collection piping and lift stations for feasibility and practicability?
• Are lift stations located near a source of electrical power (not tactical power generator)?
• Has a requirement for sustained operations at the contingency location been confirmed?
• Do utilities crews have personnel qualified to operate trenching equipment, back hoes and materials handling equipment?
• If sustained operations are planned and all required system components are on hand, have efforts been started to install the underground sewage collection system and construct stabilization lagoons/evaporation ponds?

• Have stabilization lagoons and evaporation ponds been sized for the anticipated base population and duration of deployment?
• Have accurate "as-built" drawings of pipeline locations been made?
• Have arrangements been made for continued servicing of latrines that are not connected to the collection system?

Table A9.5. Facility Erection.

Facility Erection Considerations
• Has a holding area for temporary storage of incoming facility assets been established?
• Have selected engineer personnel been designated to identify and segregate engineer-related BEAR assets as they arrive?
• Are some of the individuals selected to identify incoming assets qualified to operate materials handling equipment?
• Has a method of asset accountability been established?
• Has an allocation of facility assets been made to the various facility groups to be set up at the bare base?
• Has command level (wing/base) agreement been reached on the asset allocation?
• Has a site layout been made identifying locations of facility groups and representative types of buildings within the groups?
• Have the specific locations of all dome shelters, frame supported tension fabric shelters and aircraft hangers been identified? Is the site preparation task underway and sufficiently manned so as not to delay facility delivery and erection?
• Are facilities delivered to the erection sites or engineer holding area (as appropriate) when they arrive?

• Has the capability for engineer personnel to assist in the delivery of facilities to erection locations been established?
• Are facilities being delivered close to their final set up locations?
• Have engineer shop and cantonment facilities been set up fairly early in the beddown process?
• Have selected engineer personnel been designated to provide technical expertise to the base populace in erecting facility assets?
• Have instructions been given to the base personnel erecting their own facilities concerning facility orientation and meaning of layout stakes/markers?
• Are dome shelter, frame supported tension fabric shelter and aircraft hangar facility components being identified and set aside for RED HORSE or 635th Materiel Maintenance Group activities?
• Have engineer crews been designated for all Medium Shelter and general use shelter erection?
• Have engineer crews been identified to provide utility connections to facilities once facilities are erected and utility services are in place?
• Are shipping containers being collected and stored in the holding area once they are empty?

Table A9.6. Pavement and Equipment.

Pavement and Equipment Considerations
• Have contract options been investigated for obtaining and/or augmenting heavy equipment assets?
• Have heavy equipment assets been thoroughly checked for serviceability upon arrival?
• Has an airfield survey been made to identify emergency maintenance, repair and operations requirements?

• Have potential "show stopping" airfield pavement repairs been made?
• Has construction required to develop a water source been completed?
• Has a road or access way from the water source to the water treatment plants been established?
• Has site preparation for aircraft arresting barrier installation been accomplished?
• Have airfield pavement sweeping operations been instituted?
• Has site preparation for navigational aids installation been accomplished?
• Has site preparation for facility erection begun?
• Has a road network from the flightline been established?
• Has an engineer holding area (open storage) been established?
• Have roads or access ways to locations of each of the planned facility groups been graded?
• Have temporary munitions holding areas been established?
• Have berms been constructed around aircraft refueling bladders?
• Have aircraft parking expansion requirements been completed?
• Have specialized aircraft pavements (hot cargo pads, arm/dearm pads, etc.) been completed?
• Have critical obstacles in airfield clear zones been removed?
• Have critical base drainage conditions been corrected?
• Have serious foreign object debris-producing areas been corrected?
• Have sources of supply for revetment fill materials and general horizontal construction been located?
• Have berms for POL storage areas and power plant fuel storage been completed?
• Has a sanitary landfill operation been established?

• Have perimeter clearing and base defense network expansion operations been started?
• Has aircraft revetment erection been started?
• Have hazardous waste control areas been identified and established?
• Has construction of stabilization lagoons and evaporation ponds been started?
• Has construction of personnel protective shelters been started?
• Has construction of facility revetments been started?
• Have permanent munitions storage berms been constructed?
• Has support for burying utility lines been provided?
• Have obstacles and barricades been fabricated and placed?
• Have dispersal locations been developed?
• Have roads been upgraded to withstand sustained vehicle traffic?
• Have airfield pavement expedient repairs been replaced with permanent repairs?

Table A9.7. Fire and Emergency Services.

Fire and Emergency Services Considerations (see AFTTP 3-32.41 for contingency firefighting requirements)
• Has contact been made with local fire protection officials to determine host nation support possibilities?
• Have firefighters set up the tents that comprise the fire station?
• Has a fire alarm communications center (FACC) or Emergency Communication Center (ECC) (consolidated dispatch) been established?
• Have communications been established between the FACC and appropriate base agencies and command posts?

• Has vehicle availability been ascertained?
• Have vehicle shortfalls been identified and passed to higher headquarters for action?
• Has firefighting agent availability been determined?
• Have shortfalls in agent availability been identified?
• Have water sources for firefighting been identified and located?
• Have fire extinguishers contained in the BEAR packages been checked, serviced, and distributed?
• Has a dispersal plan for Fire and Emergency Services equipment and materials been developed?
• Have dispersal locations been prepared (hardened and camouflaged)?
• Have Fire and Emergency Services assets that cannot be moved been hardened and camouflaged?
• Have Fire and Emergency Services officials participated in initial base layout planning?
• Have fire reporting procedures been established and disseminated to the base population?
• Has auxiliary firefighting equipment, e.g., extinguishers, shovels, hoses, etc., been made available for use in tent city areas?