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Volume 4. Contingency Responsibilities

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THIS IS THE FOURTH of four volumes for the career development course (CDC) 3E551, Engineering Journeyman. The material in it pertains to the engineering technology principles that make up the foundation of this career field.

Unit 1 covers the principles for contingency planning.

Unit 2 covers the skills for Employment Operations.

A glossary is included for your use.

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For Guard and Reserve personnel, this volume is valued at 12 hours and 3 points.

NOTE:

In this volume, the subject matter is divided into self-contained units. A unit menu begins each unit, identifying the lesson headings and numbers. After reading the unit menu page and unit introduction, study the section, answer the self-test questions, and compare your answers with those given at the end of the unit. Then complete the unit review exercises.

Unit 1. Contingency Planning

CONTINGENCY IS THE REASON we are members of the armed forces. We respond to emergencies, whether they are natural disasters or enemy actions. The Air Force as a whole brings the fight through the air but without bases and runways, aircraft cannot take off or land. That is where engineering comes in. We are part of planning efforts involving bases in austere locations. It is our tools and knowledge, along with our ability to wield them, that ensure personnel at all levels of planning make the best decisions. Make no mistake; your place in the planning process is critical. Your knowledge of assets, the planning phases, and aircraft parking and protection requirements can mean the difference between achieving the mission and exceeding the mission.

1–1. Planning Considerations

Planning is a big part of our responsibilities as engineering. In order to be on the same page when communicating, planners share a framework—the Air and Space Expeditionary Force (AEF) force module framework. The force module framework gives all planners an expected order of events to work from and an agreed upon timeline those events will follow.

The number of personnel planned for, based on the mission, will drive what equipment and personnel we request. We organize equipment and personnel into unit type codes (UTC) that allow planners to order what they need based upon function. Most missions require a substantial population, much like a small town. Like a small town, an airbase needs basic services such as water, sewer, power, housing, and so forth. Unlike a small town, the environment is rough and requires unique solutions and considerations. The framework, UTC, and basic requirements are where we start planning our airbases.

601. Air and Space Expeditionary Force force module framework

Every plan begins with a mission; every mission is a series of objectives. Your objective as a planner is to build a sustainable airbase within 30 days. The framework for this objective is the Air and Space Expeditionary Task Force (AETF) force module framework. The framework is broken into force modules, or stages, consisting of multiple functions. UTCs describe these personnel and equipment functions as airfield marking, lighting, and air traffic control.

Unit type codes

A UTC is a grouping of equipment and personnel capable of carrying out a specific function. A UTC can be equipment only, personnel only, or both equipment and personnel. The UTC system allows planners to select specific UTCs based on their mission requirements. This system increases AETF rapid mobility by providing facilities and related equipment capable of independently supporting several levels of combat operations.

Personnel UTCs are teams of people with skills that are capable of serving a function. There could be a surveying UTC or a drafting UTC; also, there can be a combination of both called an execution support UTC. Should the UTC you are assigned to be requested by a combatant commander (CCDR), you will be sent to support that mission along with any required equipment. For example, a survey UTC may have four people, laptops, auto-levels, total stations, and global positioning system (GPS) equipment.

Force modules

The AETF force modules are a planning framework that provides uniform expectations to all planners. Each of the modules is part of a building-block model, and each has a goal or end state. The six force modules do not execute one after another but overlap to create a more realistic picture from which planners can work (fig. 1–1). The following paragraphs provide brief descriptions of each force module. For more information on AETF force modules, see Air Force Instruction (AFI) 10–401, *Air Force Operations Planning and Execution*.

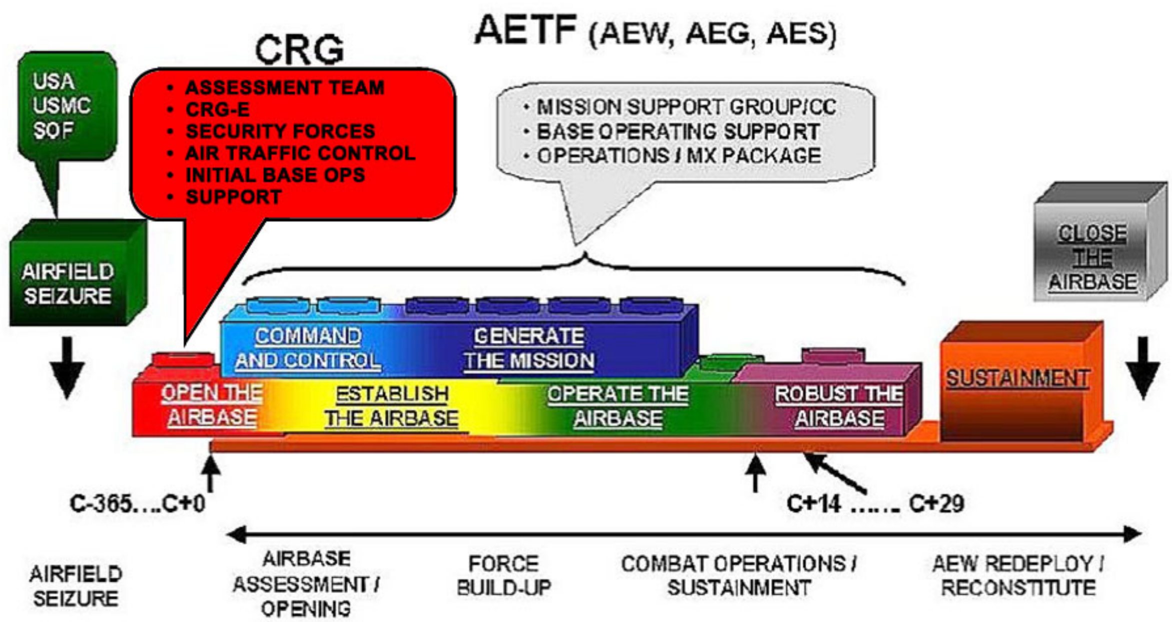


Figure 1–1. AETF force module construct.

Open the Airbase

The Open the Airbase module provides the capabilities to open an airbase and rapidly establish an initial operating capability (IOC), such as cargo or fighter operations, approximately 24 hours after forces arrive. This module will protect the forces (security forces UTCs), plan the reception and beddown of follow-on forces (civil engineering [CE] UTCs), establish communications, and prepare the airfield for initial flight operations. The CE officer and engineering craftsman, as a UTC attached to this module, assess the airfield's immediate capability to support mobility airlift operations.

Command and Control

This module establishes an air and space expeditionary wing or group command and control (C2) structure to assume responsibility from the Open the Airbase module. The C2 module includes the initial maintenance group, operations group, medical group and mission support group (MSG) leadership and staff. Secure communications and intelligence are key capabilities in this module. A field grade CE officer and an engineering craftsman tasked in the Open the Airbase module, connect with the C2 module to provide initial beddown planning and coordinate with engineer teams.

Establish the Airbase

Establish the Airbase includes the majority of deploying civil engineers and other expeditionary combat support forces, including airfield operations, logistics plans, weather, chaplain, additional medical, security forces, force protection, supply and transportation elements. Housekeeping (e.g., billeting, food service, hygiene, environmental control units (ECU), etc.), industrial operations, and flightline equipment UTCs deploy with this module.

Generate the Mission

The Generate the Mission module includes the primary aircraft and maintainer personnel and equipment UTCs. Module elements include maintenance supervision, munitions, intelligence, weather, operations support, life support, and flying squadrons.

Operate the Airbase

The Operate the Airbase force module contains the mission support forces needed to achieve full operating capability and sustain those forces for up to 30 days. Operate the airbase increases force protection, communications, cargo handling, and materiel management and distribution. It also develops robust quality-of-life activities, such as chaplain, fitness, library, healthcare, food, shelter, and mail.

Robust the Airbase

The Robust the Airbase force module provides additional expeditionary combat support to strengthen the capabilities already put in place by the previous force modules. The forces in this module will typically not arrive until 30 days after an operating location is established. After this module is complete, the installation moves into sustainment mode.

602. Bare base assets

When we occupy a location, we have to bring most of the materials for base construction with us. In order to assemble a new base quickly, we group our materials into sets, organized by UTC. There are currently two categories of construction UTCs that we use—basic expeditionary airfield resources (BEAR) and basic expeditionary airfield resources order of battle (BOB). The Air Force is currently making a transition from the older BEAR sets to the newer BOB sets.

BEAR sets were large assets, grouped into broad categories. For example, housekeeping sets had everything from sleeping quarters, latrines, and shower units to the water and electrical systems needed to support them (fig. 1–2). While this simplified planning, it also reduced flexibility. Removing or adding items to a BEAR UTC was difficult and complicated. Problems where not limited to planning. Many forward locations had too much material and equipment to track and maintain. Base construction slowed because of the time required to disassemble and distribute the materials in BEAR sets. A new way had to replace BEAR sets; therefore, we developed the BOB UTCs.

BOB is, in the simplest terms, a reorganization of the older sets. Unlike the broad categories of the BEAR UTCs, the BOB UTCs are more specific. For example, there is no housekeeping BOB UTC; instead, there is a billeting UTC, a showers/latrines UTC, and electrical and water distribution UTCs (fig. 1–2). This specificity allows the CCDR to tailor what he needs to the location. BOB UTCs save time. Management and distribution of BOB assets onsite are quicker because the materials arrive in groups by function. Meaning that the electricians/power production Airmen will get the power and power distribution UTCs, and water/fuels Airman will get the water UTCs upon arrival. The BOB structure follows four concepts: capability-based planning, dynamic positioning strategy, multimodal configuration, and modular/scalable UTCs.

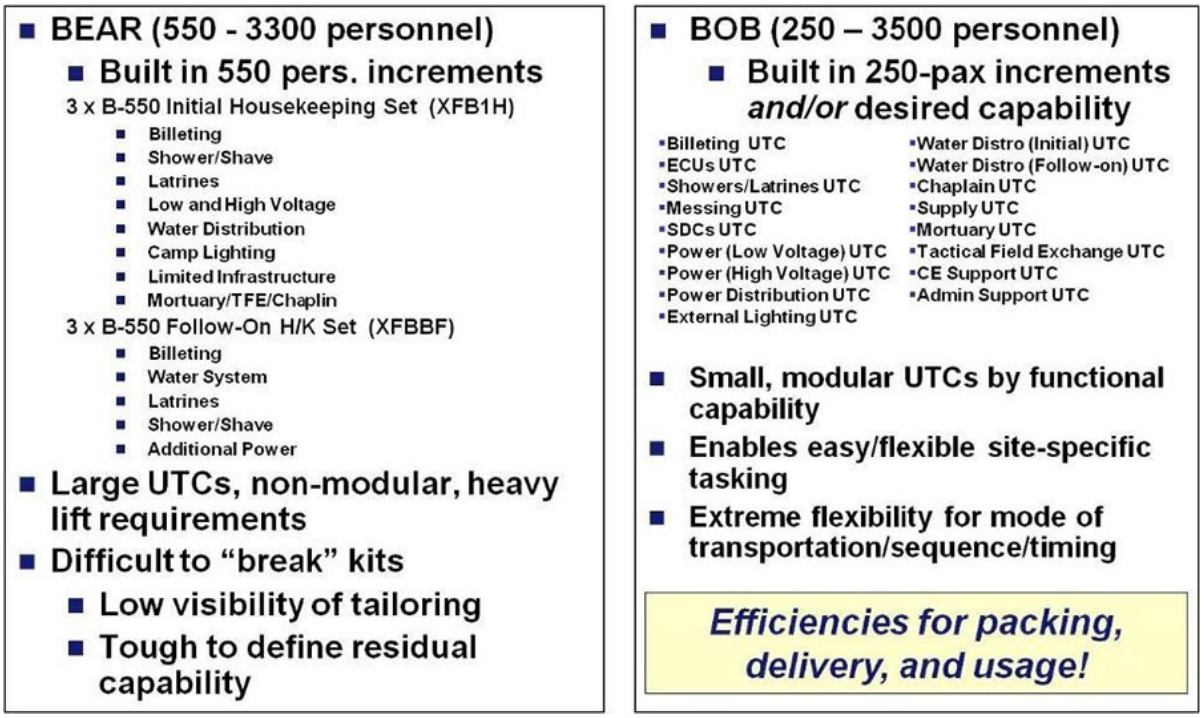


Figure 1–2. Comparison of BEAR and BOB asset management.

Capability-based planning and force presentation

Capability-based planning is the driving concept behind organizing BOB UTCs by their "effects." For example, the billeting UTC's effect is that it provides shelter from the environment; the messing UTC's effect is that it provides structures and equipment for food preparation and distribution. In contrast, the BEAR UTCs base total assets upon number of personnel, usually 550, including everything from billeting to electrical distribution. BOB assets reduce the number of supported personnel to 250 to address the wider variation of base populations during different stages of the AETF force module planning framework.

Dynamic positioning strategy

The smaller size of the BOB UTCs allows easier global positioning. If you have to build a base in Afghanistan, it is much simpler and quicker to send a UTC from Kuwait instead of from New Hampshire. The ease of movement is also important to note. BEAR UTCs were so big that it was difficult to move them without the enemies' awareness. BOB UTCs, because of their size, ship more easily both overtly, and more importantly, covertly, or in secret.

Multimodal configuration

Multimodal configuration is a critical component to the BOB UTC organization. Multimodal configuration is the characteristic of BOB UTCs that allows them transport by air, sea, and land. In figure 1–3, the list breaks down specific UTCs first by air (first column), description of the UTC (second column), and surface UTC (third column). Surface-configured UTCs include both land and sea. One BOB UTC has only one delivery method. It is the BOB 150 kit, which is air delivery only.

Modular/scalable unit type codes

The modular/scalable UTC is the cornerstone of the BOB UTCs. The Air Force organized BOB UTCs into the smallest viable sizes. This lends to better planning and tailoring to location, mission, and future expansion. Figure 1–4 shows an example of general mission personnel flow with the number of personnel in columns and the UTCs by row. Commanders can request quantities of UTCs depending on their mission. Figure 1–5 shows a humanitarian mission with unneeded UTCs grayed out, a tailoring option not available to BEAR UTCs. Further, figure 1–6 shows a tailored UTC for a location that has existing structures. The existing structures reduce the need to bring the standard amount of materials and further illustrate the scalability of BOB UTCs. You can find more information on bare base assets in Air Force Handbook (AFH) 10–222, Volume 2, *Guide to Bare Base Assets*.

Air Configured UTC	ASSET	Surface Configured UTC
XFA14	Combat Air Forces (CAF) Initial (8 Medium/8 Small Shelters)	XFS14
XFA16	Low Voltage Industrial (2 Ea. 60kW MEP-806's)	XFS16
XFA17	Water Distribution Initial	XFS17
XFA18	Water Distribution Follow-On	XFS18
XFA19	Engineering Management (2 Small Shelters)	XFS19
XFA21	Power Pro/CE Sup/Elect (3 Small Shelters)	XFS21
XFA23	TF-2 Light cart (2 TF-2's)	XFS23
XFA3C	Mobility Air Forces (MAF) Initial (6 Medium/8 Small Shelters)	XFS3C
XFAAB	4K Dome (1 Shelter)	XFSAB
XFAAC	Field-Deployable Environmental Control Unit (FDECU), 12 Ea.	XFSAC

Figure 1–3. BOB Multimodal configurations.

	PERSONNEL FLOW													
CAPABILITY UTCs	250	500	750	1000	1250	1500	1750	2000	2250	2500	2750	3000	3250	3500
Billeting (12 SSS)	2	+2 (4)	+2 (6)	+2 (8)	+2 (10)	+1 (11)	+2 (13)	+2 (15)	+1 (16)	+2 (18)	+2 (20)	+2 (22)	+1 (23)	+2 (25)
ECUs (12 ECUs)	4	+3 (7)	+2 (9)	+2 (11)	+3 (14)	+2 (16)	+2 (18)	+2 (20)	+1 (21)	+4 (25)	+3 (28)	+2 (30)	+1 (31)	+2 (33)
Showers/Latrines (1 each)	1	+1 (2)	+1 (3)	+1 (4)	+1 (5)	+1 (6)	+1 (7)	+1 (8)	+0 (8)	+1 (9)	+1 (10)	+1 (11)	+1 (12)	+0 (12)
Messing UTCs (1 SPEK, 1 MSS)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+0 (3)	+0 (3)	+0 (3)	+0 (3)
SDCs (2 SDCs)	4	+4 (8)	+4 (12)	+4 (16)	+4 (20)	+4 (24)	+4 (28)	+4 (32)	+4 (36)	+4 (40)	+4 (44)	+4 (48)	+0 (48)	+0 (48)
Power (Low Voltage)*	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+0 (3)	+0 (3)	+0 (3)	+0 (3)
Power (High Voltage)**	1	+0 (1)	+1 (2)	+0 (2)	+1 (3)	+0 (3)	+1 (4)	+0 (4)	+0 (4)	+1 (5)	+0 (5)	+1 (6)	+0 (6)	+0 (6)
Power Distribution (1 Cbl Reel)	2	+0 (2)	+2 (4)	+0 (4)	+2 (6)	+0 (6)	+2 (8)	+0 (8)	+0 (8)	+2 (10)	+0 (10)	+2 (12)	+0 (12)	+0 (12)
External Lighting	4	+0 (4)	+0 (4)	+0 (4)	+4 (8)	+0 (8)	+0 (8)	+0 (8)	+0 (8)	+4 (12)	+0 (12)	+0 (12)	+0 (12)	+0 (12)
Water Distro (Initial)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+0 (3)	+0 (3)	+0 (3)	+0 (3)
Water Distro (Follow-on)	0	+0 (0)	+1 (1)	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+1 (3)	+1 (3)
Chaplain (1 SSS)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+0 (3)	+0 (3)	+0 (3)	+0 (3)
Supply (2 SSS, MHE)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+0 (3)	+0 (3)	+0 (3)	+0 (3)
Mortuary (1 SSS, 2 ADR)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+0 (3)	+0 (3)	+0 (3)	+0 (3)
TFE (1 SSS, 1 ADR)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+0 (3)	+0 (3)	+0 (3)	+0 (3)
CE (5 SSS)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+0 (3)	+0 (3)	+0 (3)	+0 (3)
Admin (4 SSS)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+0 (3)	+0 (3)	+0 (3)	+0 (3)

Figure 1–4. Modular/scalable UTC to personnel flow matrix (expanded capability).

	PERSONNEL FLOW													
CAPABILITY UTCs	250	500	750	1000	1250	1500	1750	2000	2250	2500	2750	3000	3250	3500
Billeting (12 SSS)	2	+2 (4)	+2 (6)	+2 (8)	+2 (10)	+1 (11)	+2 (13)	+2 (15)	+1 (16)	+2 (18)	+2 (20)	+2 (22)	+1 (23)	+2 (25)
ECUs (12 ECUs)	4	+3 (7)	+2 (9)	+2 (11)	+3 (14)	+2 (16)	+2 (18)	+2 (20)	+1 (21)	+4 (25)	+3 (28)	+2 (30)	+1 (31)	+2 (33)
Showers/Latrines (1 each)	1	+1 (2)	+1 (3)	+1 (4)	+1 (5)	+1 (6)	+1 (7)	+1 (8)	+0 (8)	+1 (9)	+1 (10)	+1 (11)	+1 (12)	+0 (12)
Messing UTCs (1 SPEK, 1 MSS)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+0 (3)	+0 (3)	+0 (3)	+0 (3)
SDCs (2 SDCs)	4	+4 (8)	+4 (12)	+4 (16)	+4 (20)	+4 (24)	+4 (28)	+4 (32)	+4 (36)	+4 (40)	+4 (44)	+4 (48)	+0 (48)	+0 (48)
Power (Low Voltage)*	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+0 (3)	+0 (3)	+0 (3)	+0 (3)
Power (High Voltage)**	1	+0 (1)	+1 (2)	+0 (2)	+1 (3)	+0 (3)	+1 (4)	+0 (4)	+0 (4)	+1 (5)	+0 (5)	+1 (6)	+0 (6)	+0 (6)
Power Distribution (1 Cbl Reel)	2	+0 (2)	+2 (4)	+0 (4)	+2 (6)	+0 (6)	+2 (8)	+0 (8)	+0 (8)	+2 (10)	+0 (10)	+2 (12)	+0 (12)	+0 (12)
External Lighting	4	+0 (4)	+0 (4)	+0 (4)	+4 (8)	+0 (8)	+0 (8)	+0 (8)	+0 (8)	+4 (12)	+0 (12)	+0 (12)	+0 (12)	+0 (12)
Water Distro (Initial)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+0 (3)	+0 (3)	+0 (3)	+0 (3)
Water Distro (Follow-on)	0	+0 (0)	+1 (1)	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+1 (3)	+1 (3)
Chaplain (1 SSS)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+0 (3)	+0 (3)	+0 (3)	+0 (3)
Supply (2 SSS, MHE)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+0 (3)	+0 (3)	+0 (3)	+0 (3)
Mortuary (1 SSS, 2 ADR)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+0 (3)	+0 (3)	+0 (3)	+0 (3)
TFE (1 SSS, 1 ADR)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+0 (3)	+0 (3)	+0 (3)	+0 (3)
CE (5 SSS)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+0 (3)	+0 (3)	+0 (3)	+0 (3)
Admin (4 SSS)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+0 (3)	+0 (3)	+0 (3)	+0 (3)

Figure 1–5. BOB scaled to support 50-person humanitarian relief operation.

	PERSONNEL FLOW													
CAPABILITY UTCs	250	500	750	1000	1250	1500	1750	2000	2250	2500	2750	3000	3250	3500
Billeting (12 SSS)	2	+2 (4)	+2 (6)	+2 (8)	+2 (10)	+1 (11)	+2 (13)	+2 (15)	+1 (16)	+2 (18)	+2 (20)	+2 (22)	+1 (23)	+2 (25)
ECUs (12 ECUs)	4	+3 (7)	+2 (9)	+2 (11)	+3 (14)	+2 (16)	+2 (18)	+2 (20)						
Showers/Latrines (1 each)	1	+1 (2)	+1 (3)	+1 (4)	+1 (5)	+1 (6)	+1 (7)	+1 (8)						
Messing UTCs (1 SPEK, 1 MSS)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)						
SDCs (2 SDCs)	4	+4 (8)	+4 (12)	+4 (16)	+4 (20)	+4 (24)	+4 (28)	+4 (32)						
Power (Low Voltage)*	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)						
Power (High Voltage)**	1	+0 (1)	+1 (2)	+0 (2)	+1 (3)	+0 (3)	+1 (4)	+0 (4)						
Power Distribution (1 Cbl Reel)	2	+0 (2)	+2 (4)	+0 (4)	+2 (6)	+0 (6)	+2 (8)	+0 (8)						
External Lighting	4	+0 (4)	+0 (4)	+0 (4)	+4 (8)	+0 (8)	+0 (8)	+0 (8)						
Water Distro (Initial)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)						
Water Distro (Follow-on)	0	+0 (0)	+1 (1)	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)						
Chaplain (1 SSS)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)						
Supply (2 SSS, MHE)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+0 (3)	+0 (3)	+0 (3)	+0 (3)
Mortuary (1 SSS, 2 ADR)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+0 (3)	+0 (3)	+0 (3)	+0 (3)
TFE (1 SSS, 1 ADR)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+0 (3)	+0 (3)	+0 (3)	+0 (3)
CE (5 SSS)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+0 (3)	+0 (3)	+0 (3)	+0 (3)
Admin (4 SSS)	1	+0 (1)	+0 (1)	+0 (1)	+1 (2)	+0 (2)	+0 (2)	+0 (2)	+0 (2)	+1 (3)	+0 (3)	+0 (3)	+0 (3)	+0 (3)

Host Base Providing:
- ***Dorms for 1,000***
- ***Messing***
- ***Chapel***
- ***Storage space***
- ***Mortuary***
- ***AAFES***
- ***CE split use shops***
- ***Admin space***

Figure 1–6. BOB with partial host-base support.

603. Contingency planning factors

This lesson will provide you with general planning guidelines for expeditionary bases. These basic needs provide a starting point for deciding which UTCs will be required. Keep in mind that these are only guidelines, and subject-matter experts (SME) from career fields responsible for these functions will have complete answers. Base building is a team sport. Always seek out information from the SME.

Here, we will cover basic principles of airfield, site preparation, facilities construction, electrical power, water management, waste disposal, and fuel needs. This information's intent is to assist you in placing assets for planning purposes only. Further information regarding this section is in Air Force Pamphlet (AFPAM) 10–219, Volume 5, *Bare Base Conceptual Planning*.

Airfield

The airfield is the first priority, and the runway is the most important part of the airfield. Runways are the most important because they are the aircraft's takeoff and landing surface. The runway has a lot of requirements and considerations that we plan ahead of time.

Lighting

Runway edge and approach lighting is a mandatory requirement for an airfield. To accomplish this, we use the Expeditionary Airfield Lighting System (EALS). Plan permanent lighting as early as possible. Distance-to-go and aircraft arresting system marker lights are required for jet aircraft. Distance-to-go markers will tell the pilots, in thousands of feet, how much is remaining until the runway ends.

Parking

Parking aircraft for refueling, rearming, and maintenance is critical to the mission. The parking plan, discussed later in this volume, will include the position and arrangement of aircraft, and the accompanying revetment construction.

NOTE: Create additional parking surfaces using aluminum-plank matting called AM–2; early planning for a supply of AM–2 matting is important for parking flexibility during surge operations.

Petroleum, oil, and lubricants, munitions, and medical

Berms are barriers normally made of soil used to protect assets from attack. Petroleum, oil, and lubricants (POL) sites are required to have berms. Berms are also required for munitions storage, which will also require a grounding system. POL, munitions, and medical should be isolated from other base assets because of the risk of explosion and/or contamination. Place medical, though separated, as close as possible to billeting, showers, and laundry for medical operations efficiency.

Billeting and main base

Plan the main base area after you have established the needed items for the airfield and planned the location and protection of POL, munitions, and medical. The POL and munitions areas pose an explosive danger to surrounding structures. Quantity-distance (QD) criteria in Air Force Manual (AFMAN) 91–201, *Explosives Safety Standards,* define risk areas. This guidance will direct how far from the munitions area we place main base assets. Next, fully utilize any existing facilities outside the QD area. Using existing structures means we do not have to bring as much construction material initially.

Utilities

After making a general plan for positioning people, equipment, and structures, we can talk utilities. We need to decide how much utility line (electrical cable, fuel pipes, water pipes, etc.) we need, and any associated equipment. As an example, for electrical power, we need cable of all types, generators, and distribution panels at a minimum. There are four basic utility categories: electrical power, water treatment, waste disposal, and fuel storage/distribution.

Electrical power

Disperse mobile electric power (MEP) generators, producing either 30 kilowatts or 60 kilowatts throughout the main base area, as a protective measure. A generator "farm" located in a single area provides the enemy with a single target. A total loss of power has a major impact on installation operations. Use MEP generators until the primary 750-kilowatt units come online. Once primary power is established, the MEP generators will remain for backup power.

Remote Area Lighting Systems (RALS) are required around POL, liquid oxygen (LOX), the flight line, medical units/areas, and munitions storage. Plan primary and backup power distribution systems to provide power to the RALS units.

Water treatment

The Reverse Osmosis Water Purification Unit (ROWPU) is important in austere environments. Use the ROWPU to make non-potable (unsafe to drink) water potable. It is required for desalinization, removal of suspended solids, and chlorination control of bacteria. Since every site is different and water is a necessity for the base populace, almost every bare base will have a ROWPU. Note that the ROWPU produces water that is empty of minerals. This means that personnel need to have a well-rounded diet for sustained use of the ROWPU.

Consider burying water distribution piping to protect from high and low temperatures. This is especially important in colder areas. Frozen pipes can burst resulting in damage and can take time to repair.

Waste disposal

Seventy percent of all potable water will become waste entering the sewers for treatment. The other thirty percent will be lost through leaks, perspiration, evaporation, and food preparation. Meaning, we need to plan to manage *at least* seventy percent of the water on the base.

ROWPUs produce brine water as a byproduct of desalinizing salt water. Use this brine water on dirt roads to control dust across the installation. In contrast, incinerate solid waste when possible to reduce the amount of waste stored or removed from the installation. Incineration is also the preferred way to dispose of hazardous waste such as medical waste. If incineration is not available, use a 4- to 6-foot deep pit to bury biological waste.

Place waste disposal areas and sewage lagoons away from living quarters and downwind. This minimizes the risk of spreading disease and enables effective control of pests by concentrating their population. Plan early for the inevitable expansion of waste processing/collecting areas.

Fuels

Fuel storage is critical to electrical production. The MEP and primary generators run on diesel fuel. The 30-kilowatt (kW) MEP generator consumes three gallons of fuel per hour; the 60 kW consumes five gallons per hour; and the primary 750-kW generator consumes 55 gallons per hour. The planning factor is one 10,000-gallon bladder per 750-kW generator. This same 10,000-gallon bladder size will also fuel 18 30-kW generators and 9 60-kW generators.

Place fuel storage areas in close proximity to generators. Widely dispersed generators affect the number of bladders and their sizes based on the distance between each bladder. Expansion is also a heavy concern. If supply area is limited, then we will need more frequent fuel deliveries, which causes security and cost challenges.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

601. Air and Space Expeditionary Force force module framework

1. List the three types of UTC.

2. What are the six AEF force modules?

602. Bare base assets

1. The BOB structure is based upon what four concepts?

2. Explain the BOB concept of dynamic positioning strategy.

603. Contingency planning factors

1. When planning a bare base, what capability is the highest priority? Why?

2. List the airfield lighting types mentioned in this lesson.

3. The ROWPU is designed to provide three requirements; what are they?

4. What are the three sizes of electrical power generators? How many gallons per hour of fuel does each consume?

1–2. Site Planning

By this time, we know what and whom we are bringing to our airbase. Where and how we arrange these assets once we get there is next. Facilities need to be oriented in particular ways based on factors at the location. These factors range from force protection considerations to environmental factors. The environment is an important factor to consider when planning facility placement. Finally, how long is the base going to operate? How long can we expect these assets to last and how do we make that determination in the planning phase? These questions will drive the construction standards for our base.

604. Facility orientation

Facility orientation has two forms—force protection and energy efficiency. Protection of personnel and assets is the first and most important consideration in a high-threat planning area. If the threat is low, then energy efficiency is the primary consideration when orienting facilities. Details beyond this text, regarding force protection during base planning, can be found in Air Force Tactics, Techniques, and Procedures (AFTTP) 3–32.34, Volume 3, *Civil Engineer Expeditionary Force Protection*.

Force protection

In areas with high-threat levels, facility orientation can have a major impact on the preservation of life. The threats faced in Iraq and Afghanistan from indirect fire (IDF) and improvised explosive devices (IED) have taught us much about how facilities are damaged. Ideally, we want the shortest dimension of a facility to be facing the danger areas. Most often, explosions toward the shortest side of a facility do less damage. The opposite is also true; explosions on the longest side cause the most damage.

Vehicle-borne improvised explosive devices (VBIED) are especially dangerous because of the amount of explosives that a vehicle can carry. VBIEDs deliver damage in a predictable pattern. The front and rear of the vehicle will cause the majority of fragmentation dispersal and a relatively low explosive force. Conversely, the vehicle’s sides project greater explosive force with less fragmentation (fig. 1–7).

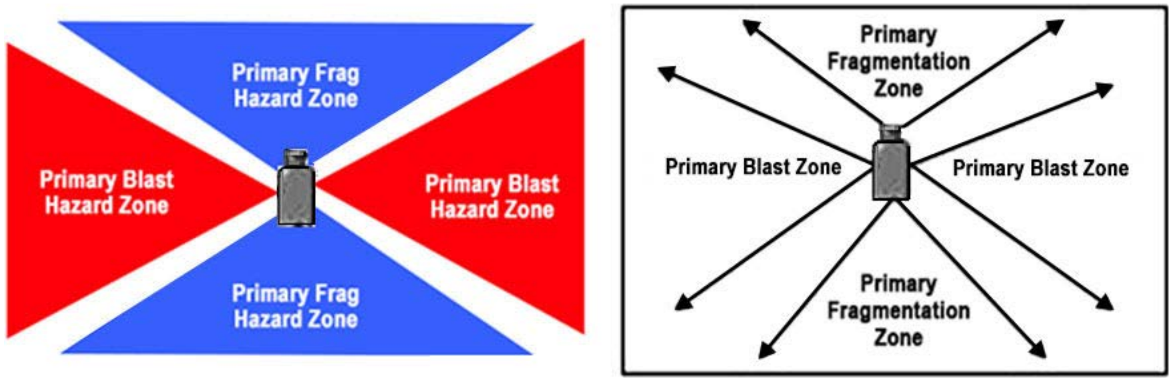


Figure 1–7. Vehicle explosion dispersal.

To reduce the risk VBIEDs, IEDs, and IDFs attacks pose, it is important to plan the orientation of facilities effectively. Facilities' shorter dimensions should face areas of exposure. Areas of exposure include, but are not limited to, parking lots, installation perimeter, road areas, the airfield, and flat, open areas. Think about ways people and vehicles will access the areas in question and orient the facilities with the shortest dimension towards the danger.

Energy efficiency

In areas where the threat of attack is low, energy efficiency will be the determining factor regarding facility orientation. Wind and climate will drive much of your decision-making.

Climate

Regarding facility orientation, we are concerned about two climates—hot and cold. In regions of the world where the climate is hot throughout most of the year, shelters should be oriented east to west. This helps to reduce the amount of surface area exposed to the sun as it moves from east to west across the sky, thereby, reducing the sun's effect on the internal temperature of the facility. In cold regions, it works the other way. If we need to heat facilities, then place them north to south to increase the surface area exposed to the sun. An increase in exposure assists in heating the facility.

Wind

When factoring wind into orientation think about the weather. In colder areas, where snow is prevalent, the structures should be oriented with the long side facing the prevailing wind. This will prevent snow buildup at the entrances. This is usually true for desert regions as well. To keep sand particles carried by the wind from the desert out of facilities, orient the long side toward the prevailing wind. In humid regions, use the winds to control the temperature in facilities. Placing the short end of the facility toward the prevailing wind can help move the hot humid air away from the building and provide a breeze through the facility. However, solar orientation in hotter areas usually takes precedence over wind orientation.

605. Site layout

Site layout involves efficiency of operations, protection of people, equipment, and supplies. Protection and efficiency are a balancing act. The closer we place facilities together, the more efficient the operation, and the more targets for the enemy in a smaller area. We can consider the environment, more specifically water, an enemy. Water completely changes the environment and threatens mobility. Therefore, it is crucial to consider drainage, functional grouping, and facility dispersal when planning site layout.

NOTE: When planning site layout utilize, AFPAM 10–219, Volume 5 for reference.

Drainage

Water can cause many problems that can negatively affect a base's mission. Water can erode roadways. Mud can slow or even stop vehicle traffic. Shallow puddling in storage facilities can ruin materials needed for construction, such as timber and cement. In some areas, standing water can attract mosquitoes that can spread disease. In a worst-case scenario, major flooding can wash away roads, clear out tents, and effectively immobilize base operations. There are two major factors associated with drainage—topography and traffic.

Topography

Topography is the variation in elevation of the site or the shape of the ground. While higher ground is typically dryer, it may not be possible to place all facilities in higher areas. Creating a suitable drainage plan is important. Use a network of ditches, pipes, and retention ponds to move water away from facilities to protect them from damage.

Traffic

In most areas, vegetation holds the soil together. Foot and vehicle traffic deteriorate vegetation and expose soil. During rainfall, these exposed areas can become difficult to travel. Mud and wet sand can slow or stop vehicles and foot traffic on a base, thus, affecting mission effectiveness. Plan a supply of coarse, well-graded gravel for roads to reduce rainfall's effect on vehicle traffic. Use AM–2 matting, wood, or other suitable material to build up walkways to protect them from pedestrian traffic.

Functional grouping

Enhance base operations by placing related functions near one another. For example, place aircraft maintenance functions next to aircraft parking areas on the airfield. Some maintenance functions, such as aircraft electrical systems (avionics), do not need to be near the airfield to operate efficiently.

Space can limit options for functional grouping. The defensive boundary of the installation limits the space for facilities. See figure 1–8, for larger, wider grouping, and figure 1–9 for limited, narrow grouping.

Place other functions, like munitions and POL, alone for safety reasons. Another consideration for site planning is allowing space for future development. Plan for each functional group to have room to expand into as the mission of the airbase evolves. A good example is below in figure 1–10.

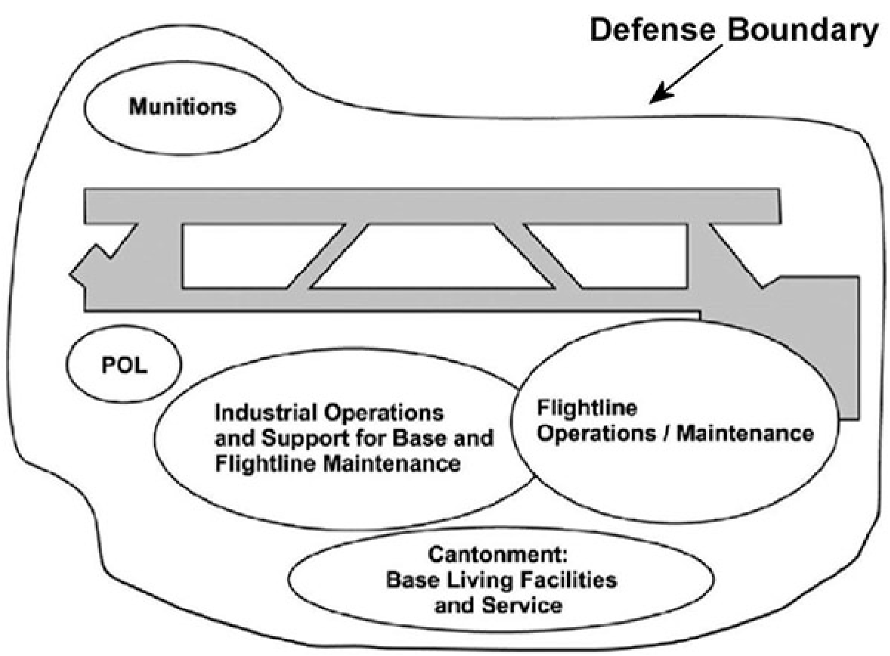


Figure 1–8. Conventional base layout.

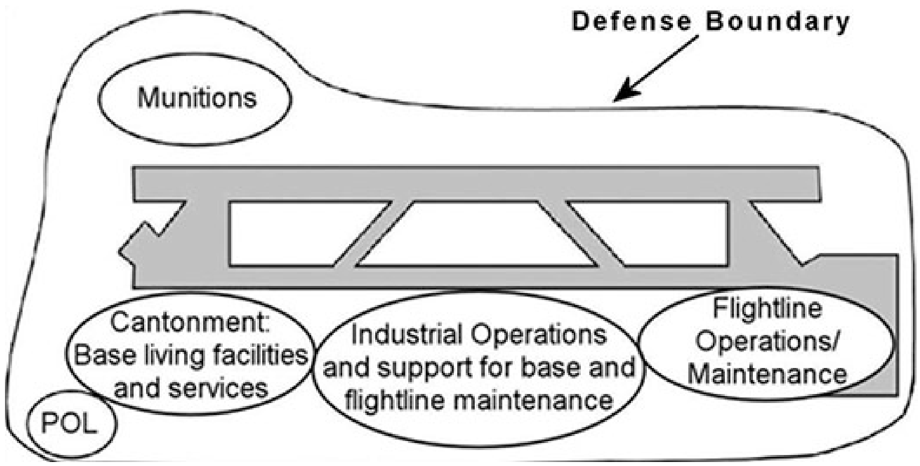


Figure 1–9. Linear base layout.

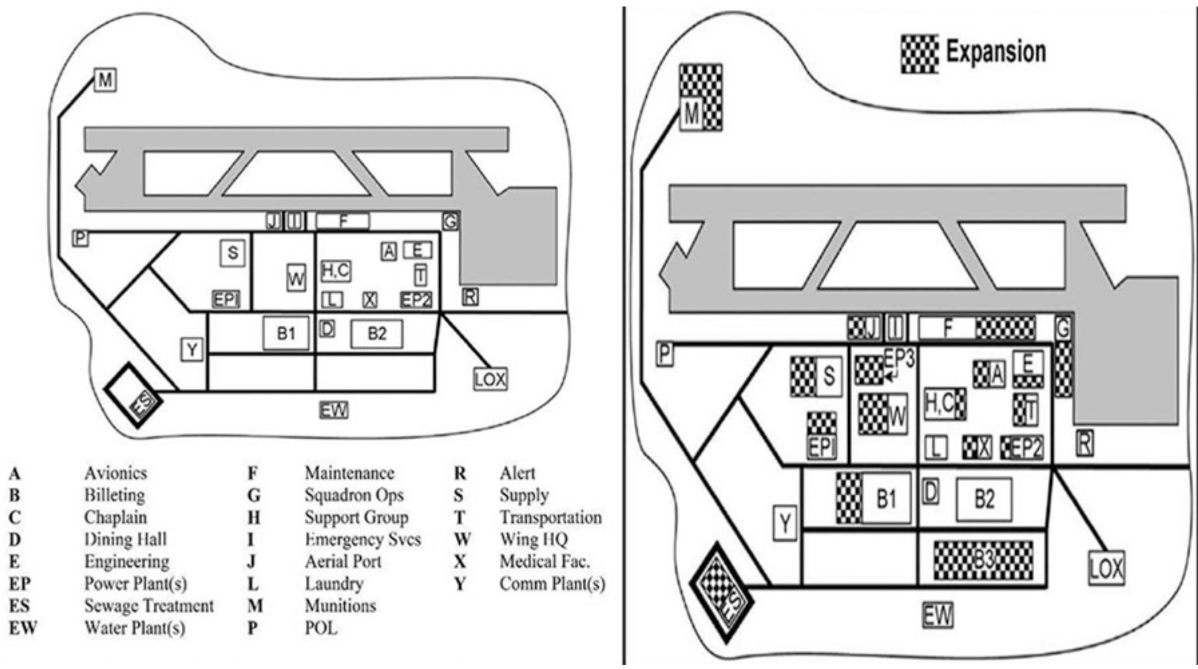


Figure 1–10. 1,100-person layout before expansion; 3,300-person layout after expansion.

Facility dispersal

The dispersal of facilities is their arrangement as a force protection measure, more specifically, how we arrange the facilities within a facility group. There are two kinds of dispersal used in the Air Force—dispersed and non-dispersed.

NOTE: When planning site layout, utilize Unified Facilities Criteria (UFC) 4–010–01, *DoD Minimum Antiterrorism Standards for Buildings*, and AFPAM 10–219, Volume 6, *Planning and Design of Expeditionary Airbases,* for references.

Dispersed layout

A dispersed layout maximizes protection by forcing the enemy to consider each facility as a single target. Pay close attention to electrical and plumbing-line lengths when planning a dispersed layout as they will be longer. In addition, because of its complexity, a dispersed layout takes longer to set up. Reserve dispersed layouts for high-threat areas. See figure 1–11 and figure 1–12 for an example of dispersed layouts.

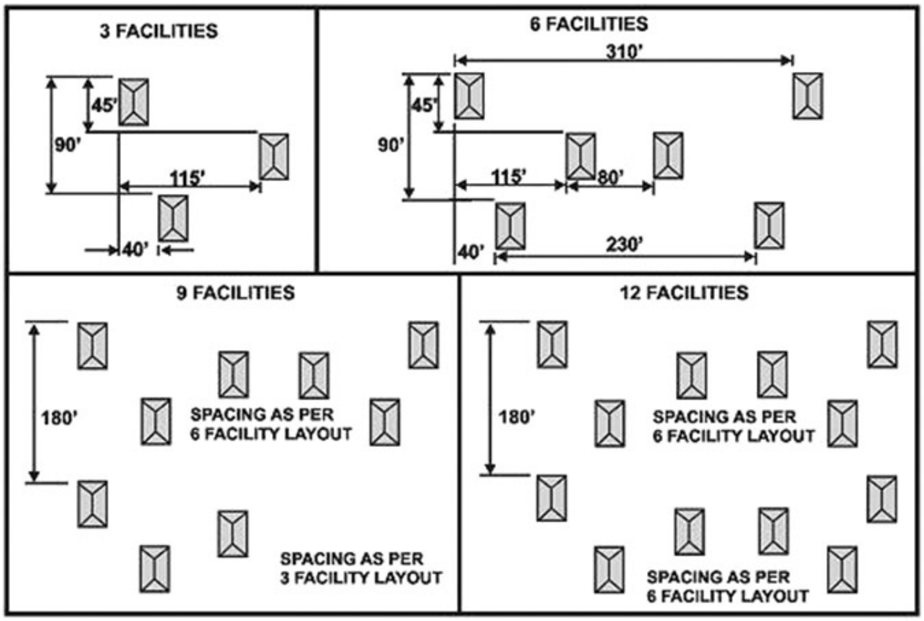


Figure 1–11. Dispersed layout for 3, 6, 9, and 12 facilities.

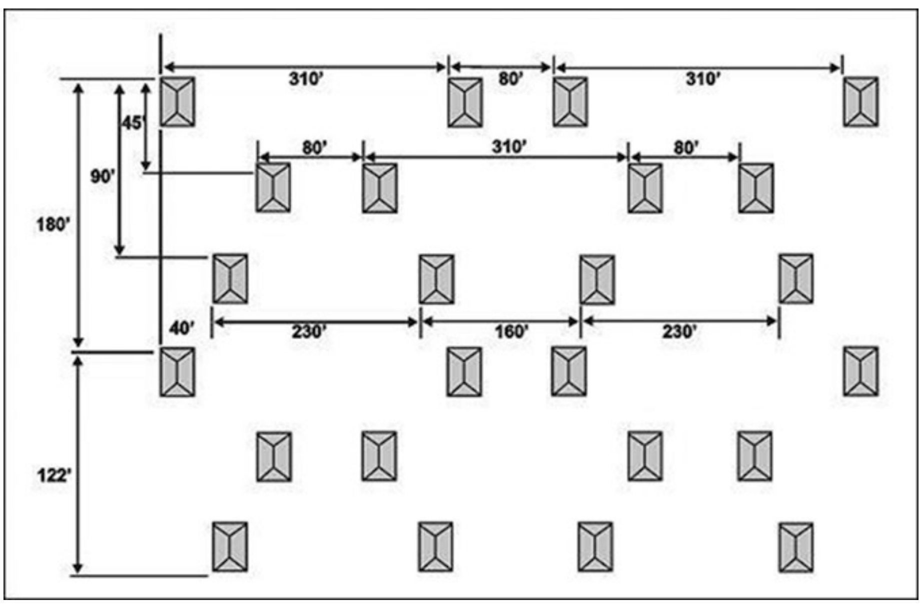


Figure 1–12. Dispersed layout for 24.

Non-dispersed layout

A non-dispersed layout is the standard layout. It places structures in a logical grouping with fire lanes between each group and utility lanes between rows within a group. Non-dispersed layouts are ideal for efficiency and general safety in low-threat areas. See an example of a non-dispersed layout in figure 1–13.

Since non-dispersed layouts are the basic layout for tents and structures, you will need to know how to plan for and setup a non-dispersed layout. Structure groups range from six to ten buildings on the even number. Divide each group into two rows with a “utility lane” between rows. The utility lane is for the power distribution panels, and heating, ventilation, and air conditioning (HVAC) systems servicing the buildings in the structure group. The minimum distance for the utility lane is 30 feet. The distance between each building in a row is 12 feet.

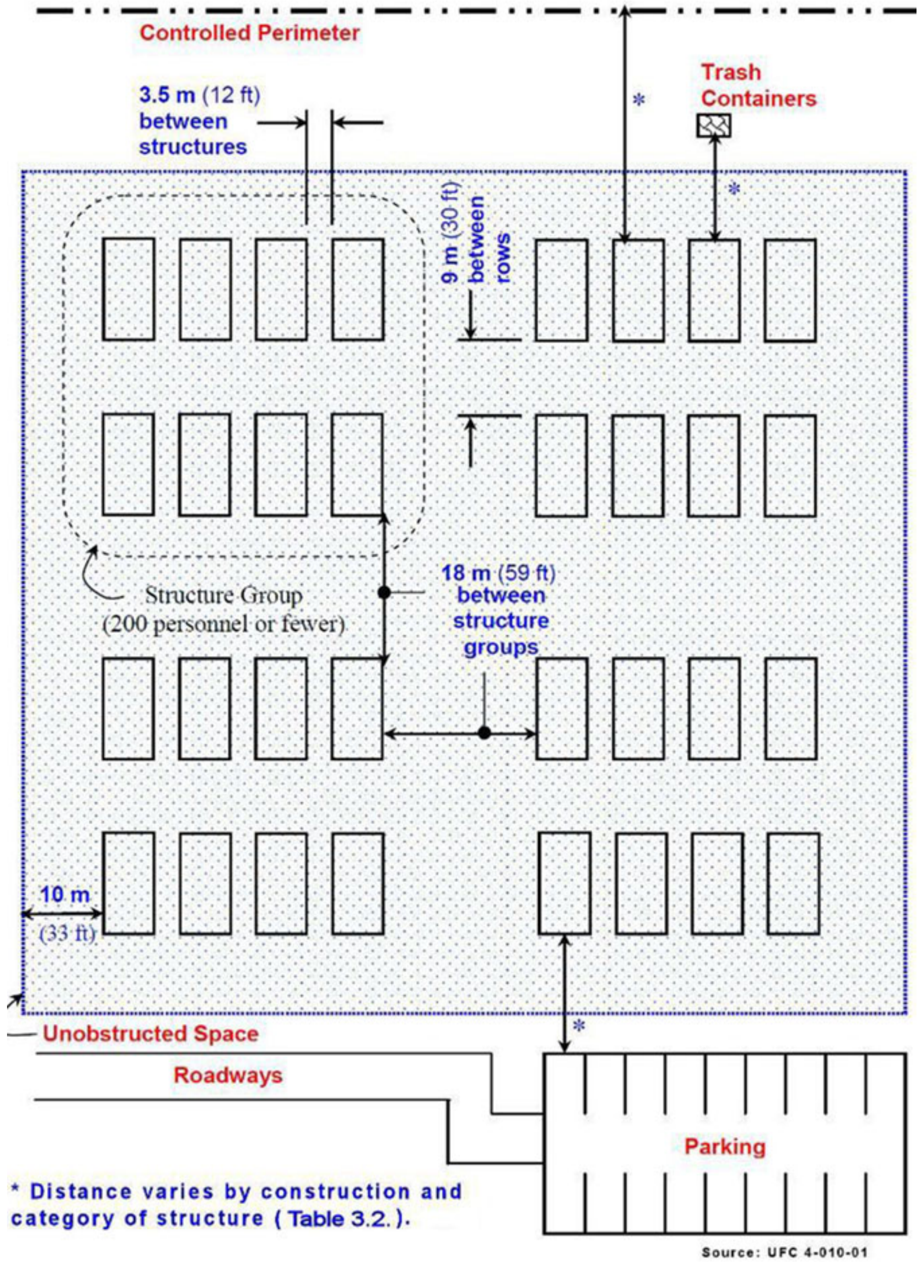


Figure 1–13. Non-dispersed layout for 24.

As shown in figure 1–13, place each structure group a minimum of 59 feet from the others. The lanes between structure groups are referred to as a "fire lane" because it provides access for emergency vehicles such as fire trucks, police cars, and ambulances.

Finally, distances between the edge of the functional area and the outermost tents should measure a minimum of 30 feet. Objects outside of the functional area are at variable distances based upon the method of construction used for the buildings in the structure groups. References for determining the variable distances are in the UFCs mentioned in the note above.

606. Standards of construction

Engineering is always a balancing act between time and quality. If we build something fast, it may not meet our needs. If we build something perfect for our needs, we may not finish it by the time we need it. Standards of construction provide base commanders with levels of expectation for speed and quality of construction. These standards are broken into two categories based upon mission requirements—contingency and enduring construction.

Contingency construction standards

Contingency construction standards are those criteria for initial force beddown. We build facilities quickly but do not expect them to last more than two years. Contingency construction is broken into three types: organic, initial, and temporary.

Organic construction standard

Organic construction is a combination of field conditions and existing structures at the location. Field conditions include tents and pit latrines (fig. 1–14). Field conditions have no electricity and meet basic needs. These conditions are intended to last up to 90 days but can go on for as long as of six months. This type of contingency construction requires little to no site work and requires the lowest amount of labor and resources.

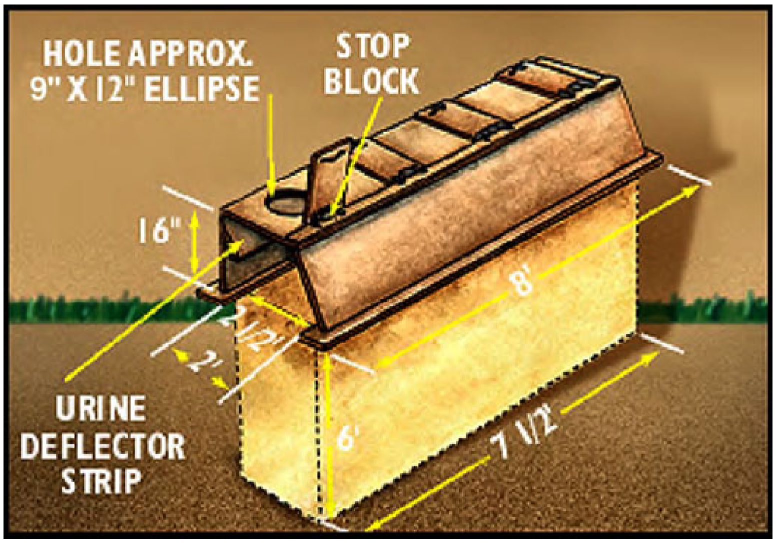


Figure 1–14. Typical pit latrine.

Initial construction standard

Examples of the initial construction standard include wood-framed tents with flooring, latrines with lift stations, and MEPs for electrical distribution. Most expeditionary equipment UTCs fall into this category of construction. Expect facilities in this category to last approximately six months.

Temporary construction standard

Substantial construction characterizes this type of construction. Wood-framed buildings, running water, commercial-electric power, and paved roads are some examples. The defining qualities of temporary construction are the introduction of energy efficiency and an expected 2- to 5-year lifespan.

Enduring construction standards

Enduring construction involves the design, award, and management of professional construction. This standard includes the contracting officer, finance officer, and staff judge advocate who develop a business agreement with contractors to fulfill long-term needs. Expect construction in this category to last from 2 to 10 or more years. Enduring construction splits into two types: semi-permanent and permanent.

Semi-permanent standard

Facilities designed and constructed in the semi-permanent standard are to have moderate energy, maintenance, and life-cycle costs. Semi-permanent structures are quicker to build and cheaper than those built under permanent construction standards. Semi-permanent construction lasts over two years but less than 10 years.

Permanent standard

Permanent standard facility designs and construction have lower energy, maintenance, and life-cycle costs compared to semi-permanent construction. Permanent structures are slower to build and are initially more costly but of higher quality. Expect these facilities to be sustainable for over 10 years.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

604. Facility orientation

1. How can we orient our facilities to reduce the damage caused by IDF and IED?

2. In what pattern do VBIED explode?

605. Site layout

1. In what ways can water, shallow pooling, standing, or extreme flooding, impact construction and mission operations?

2. Why is it important that we group our facilities by function?

3. What are the two types of facility layout, and what is the driving factor in deciding which to use?

606. Standards of construction

1. How long are facilities constructed using contingency construction standards expected to last?

2. Aside from the life expectancy, what is the difference between the semi-permanent and permanent enduring construction standards?

1–3. Aircraft Siting

Since aircraft is the primary mission, its defense, when on the ground, is critical. If needed, we should consider building berms designed for aircraft, called revetments, or placing aircraft in ways that reduce the enemies' abilities to hit more than one with a single explosion. We need to know how to park the aircraft, how to protect the aircraft, and how to do it efficiently. You can find details on aircraft siting in *UFC 3–260–01, Airfield and Heliport Planning and Design*.

607. Aircraft parking planning

Park aircraft in rows on an apron spaced according to their dimensions and specific clearance requirements (fig.1–15). This spacing permits aircraft to move in and out of parking spaces under their own power. Figure 1–16 illustrates a typical parking arrangement. Study parking arrangements carefully to achieve the parking layout that requires the least amount of pavement per parked aircraft.

Aircraft[1]	Wingspan		Length		Height	
Type	Meters	Feet	Meters	Feet	Meters	Feet
B-1	22.7 to 41.7	77.8 to 136.7	46.0	150.7	10.3	33.6
B-52	56.4	185.0	47.8	156.6	12.4	40.8
C-5	67.9	222.7	75.6	247.8	19.9	65.1
C-9	28.5	93.4	36.4	119.3	8.4	27.5
MC-12	17.6	57.9	14.8	48.7	4.3	14.3
C-17	51.8	170	52.7	173	16.8	55.1
C-130	40.4	132.6	30.4	99.5	11.7	38.5
KC-135	39.9	130.8	41.5	136.2	12.7	41.7
KC-10	50.4	165.3	55.5	182.1	17.7	58.1
C-137	44.4	145.7	45.1	147.7	12.8	41.8
E-3	44.4	145.7	46.6	152.9	12.9	42.2
E-4	59.7	195.7	70.7	231.8	19.6	64.3
A-10	17.5	57.5	16.2	53.3	4.5	14.9
F-15	13.0	42.8	19.4	63.8	5.9	19.2
F-16	10.0	32.8	14.5	47.6	5.0	16.4
F-22	13.6	44.5	18.9	62.1	5.1	16.6
F-35	10.7	35	15.4	51.1	4.6	15
Note 1: Dimensions vary between different models and configurations of aircraft.						

Figure 1–15. Fixed-wing aircraft dimensions.

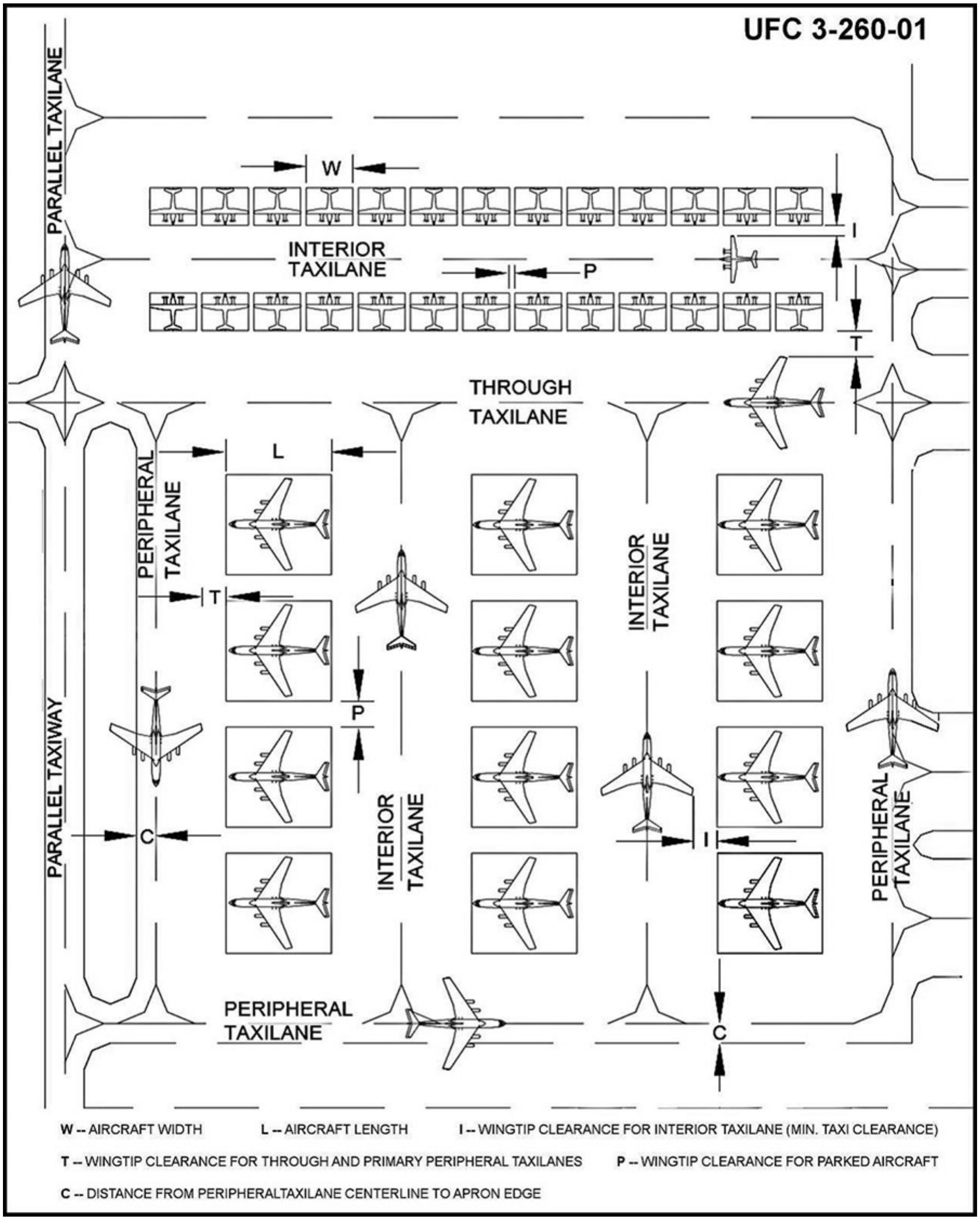


Figure 1–16. Typical aircraft parking arrangement.

Fighter aircraft

We can park fighter-type aircraft at 45-degree (°) angles (fig. 1–17). This is an efficient way to achieve adequate clearance to dissipate the temperature and velocity of jet blast to levels that endanger aircraft or personnel; that is, about 100° Fahrenheit (F), and 56 kilometers per hour.

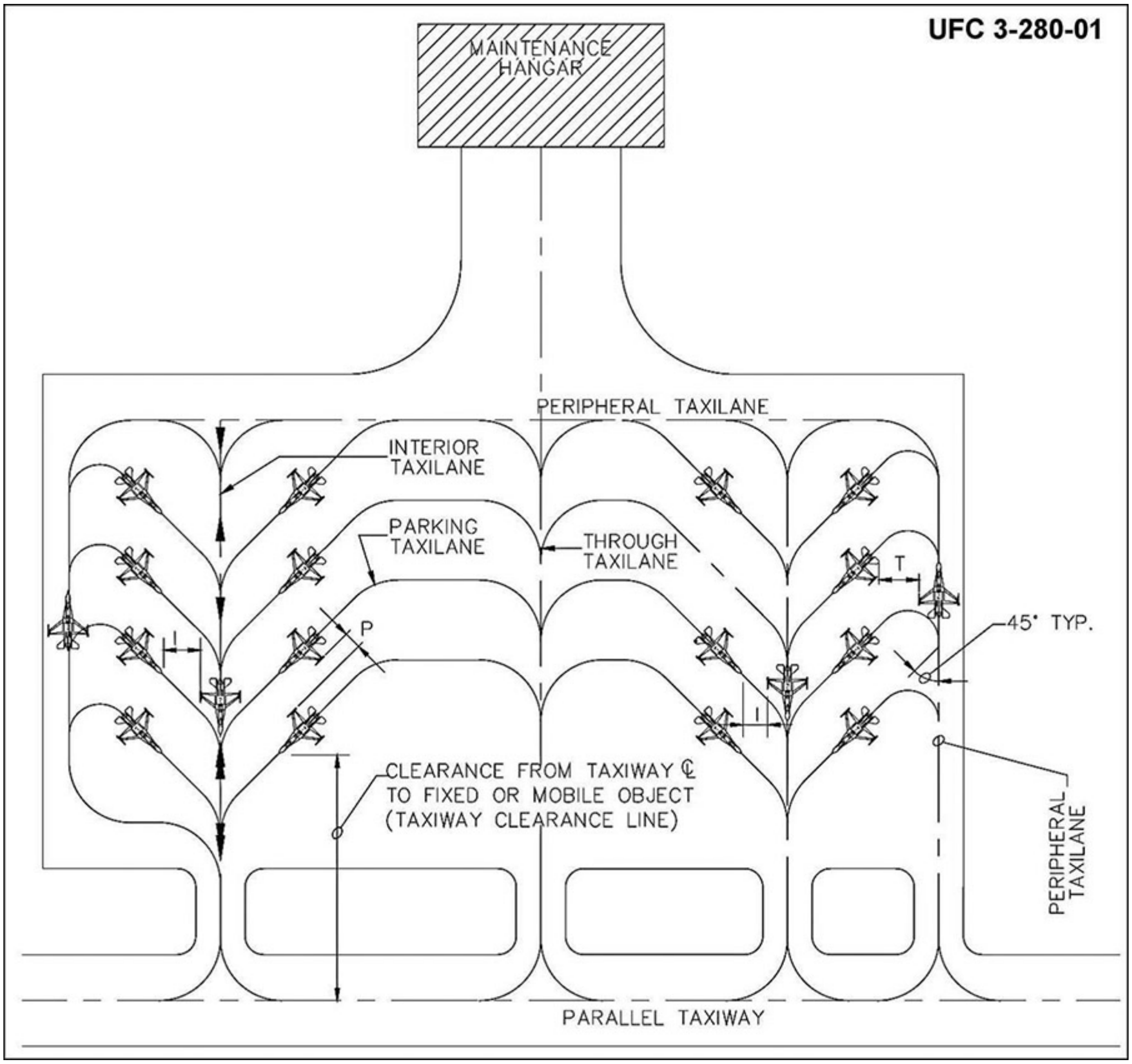


Figure 1–17. Fighter aircraft parked diagonally on apron.

Rotary-wing aircraft

Mass parking of rotary-wing aircraft, commonly referred to as helicopters, will require an apron designated for rotary-wing aircraft (fig. 1–18). Rotary-wing aircraft may be located on aprons for fixed-wing aircraft. As with fixed-wing aircraft aprons, there is no standard size for rotary-wing aircraft aprons. Park rotary-wing aircraft at Air Force facilities in a layout similar to that of fixed-wing aircraft. Base parking spaces, taxi lanes, and clearance dimensions on the diameter of the rotor of the aircraft assigned to the apron.

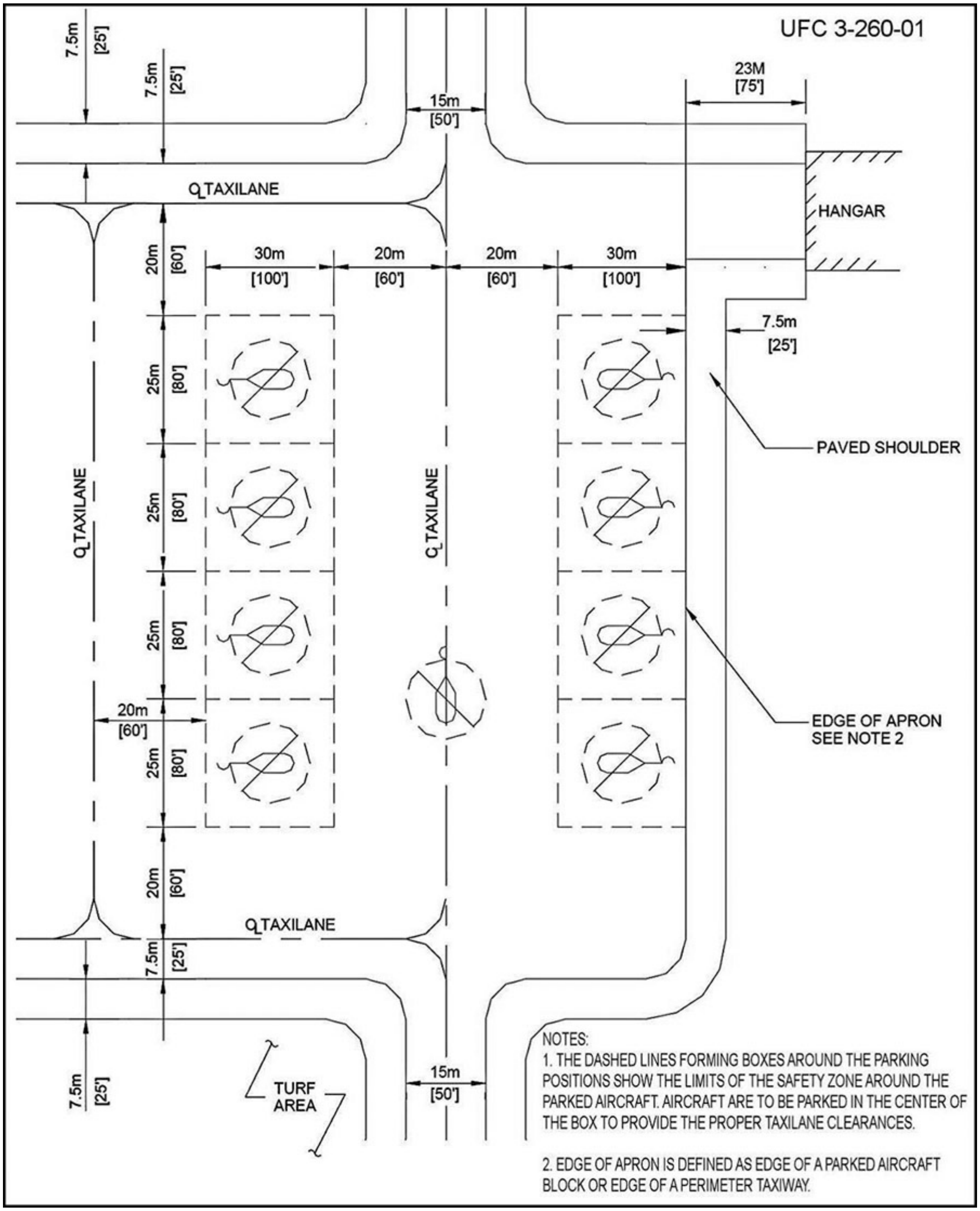


Figure 1–18. Army Criteria for Type 1 Rotary-Wing Parking Apron (except CH–47).

Taxi lanes

Interior and peripheral taxi lanes must exceed the required width for the largest aircraft parked in the area. Larger aircraft taxiing through en route to docks, hangars, or pads will need large taxiways.

Parking spacing

Safe aircraft parking and movement requires certain distances between aircraft. Measure these distances from the wingtips, nose, and tail of the aircraft. Aircraft type, size, and activity affect the varying safe distances. Figures 1–19 through 1–22 show general operational distances for a C–17 at a bare base location. For aircraft specific information, see UFC 3–260–01.

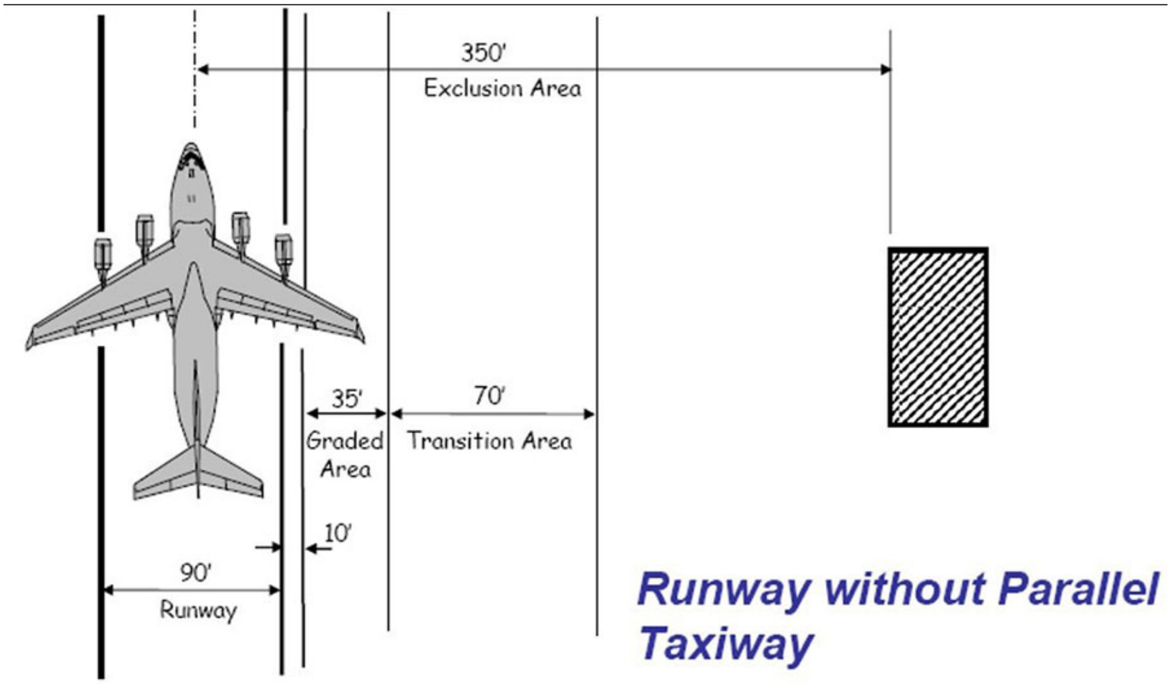


Figure 1–19. Runway without parallel taxiway.

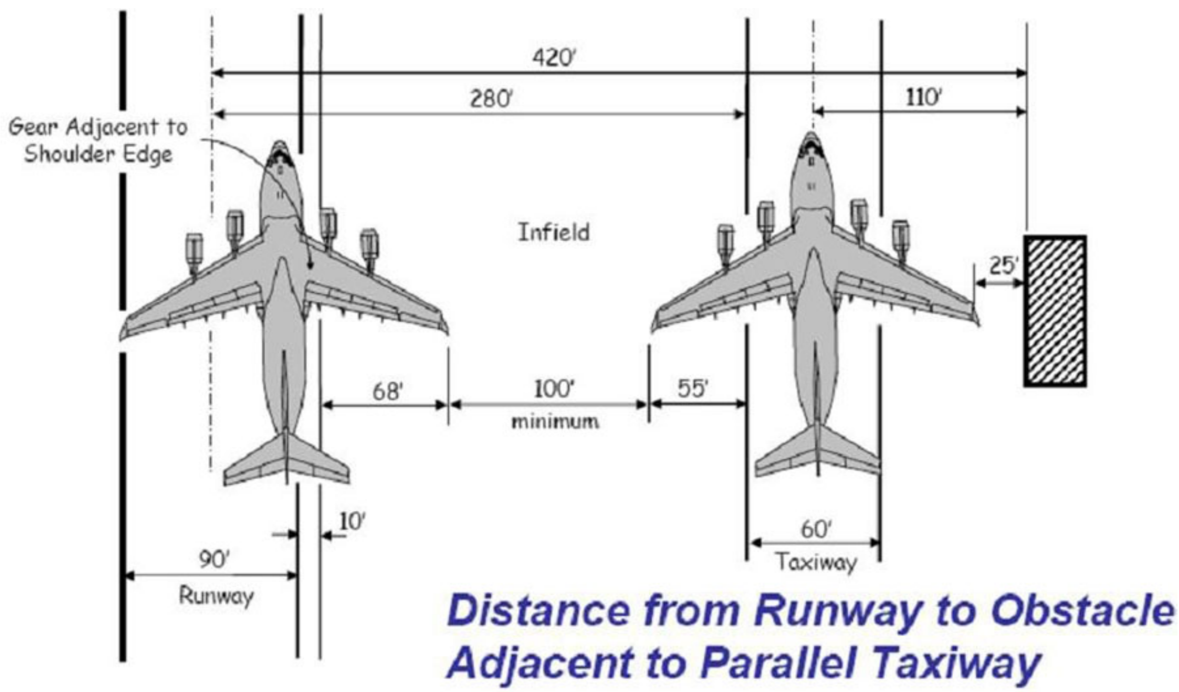


Figure 1–20. Distance from runway to obstacle adjacent to parallel taxiway.

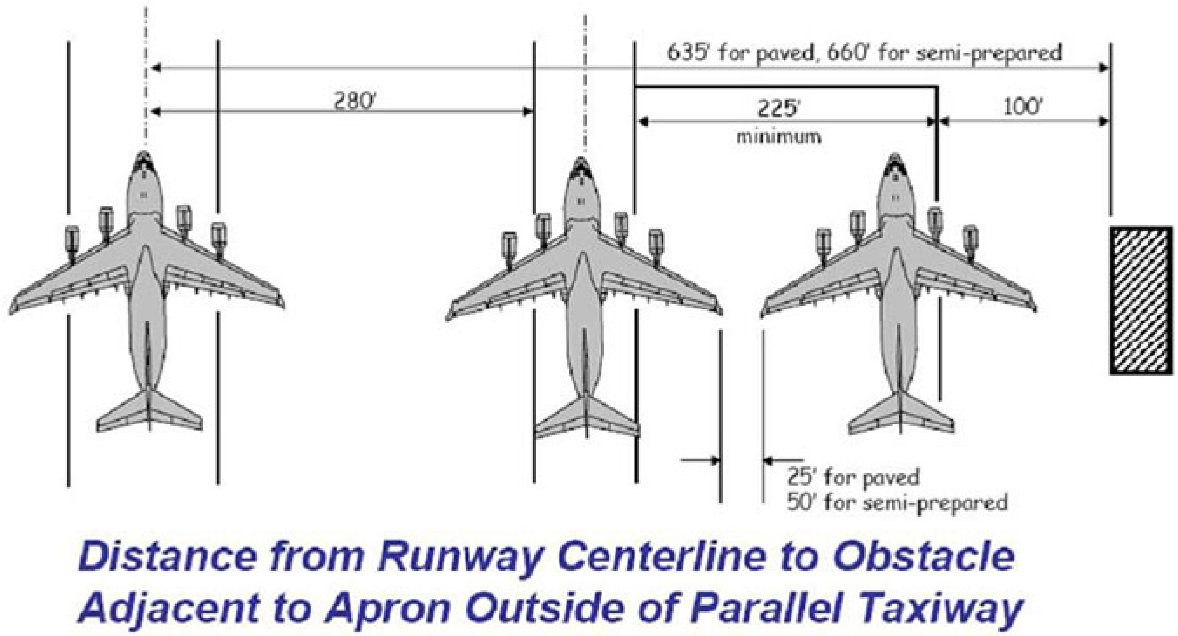


Figure 1–21. Distance from runway centerline to obstacle.

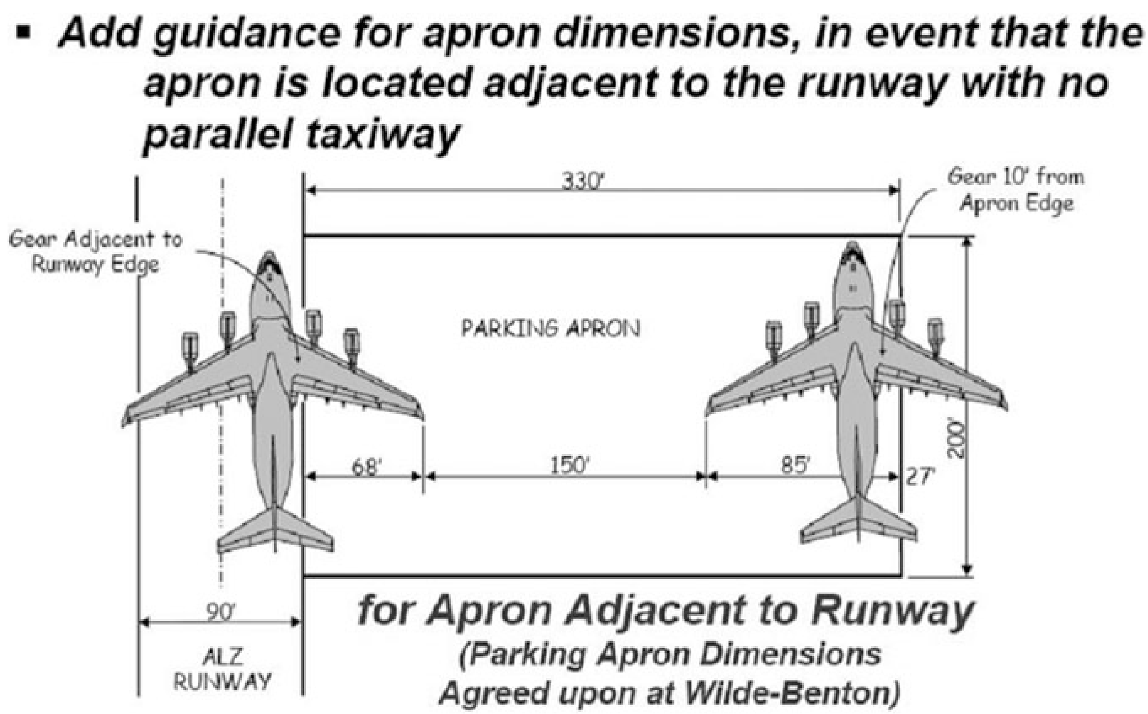


Figure 1–22. Distance for an apron adjacent to a runway.

608. Aircraft revetment siting

Like site layout, aircraft revetment siting involves dispersion principles and positioning based upon threat. Revetments are protective walls constructed around parked aircraft. The intention is to protect the aircraft against three things—indirect fire (including shrapnel), direct fire, and chain explosions. Like site layout, arrange revetments in either a dispersed or a non-dispersed layout. Within the non-dispersed layout, there are three common arrangements—drive-through, U-shaped, and H-shaped. You can find further information concerning aircraft revetment positioning in AFPAM 10–219, Volume 5.

Dispersed layout

If the enemy has the ability to attack our base from the air or frequent indirect fire attacks are a concern, then a dispersed layout is used. A dispersed layout limits the enemies' abilities to cause damage by making each aircraft a single target. This means that if the enemy wants to damage our parked aircraft, they have to target each aircraft separately. This also protects aircraft from shrapnel, not only because of the barriers, but also because of the distance between each aircraft. Chain explosions are also a smaller concern because of the distance. Figure 1–23 shows a comparison between a dispersed and non-dispersed layout.

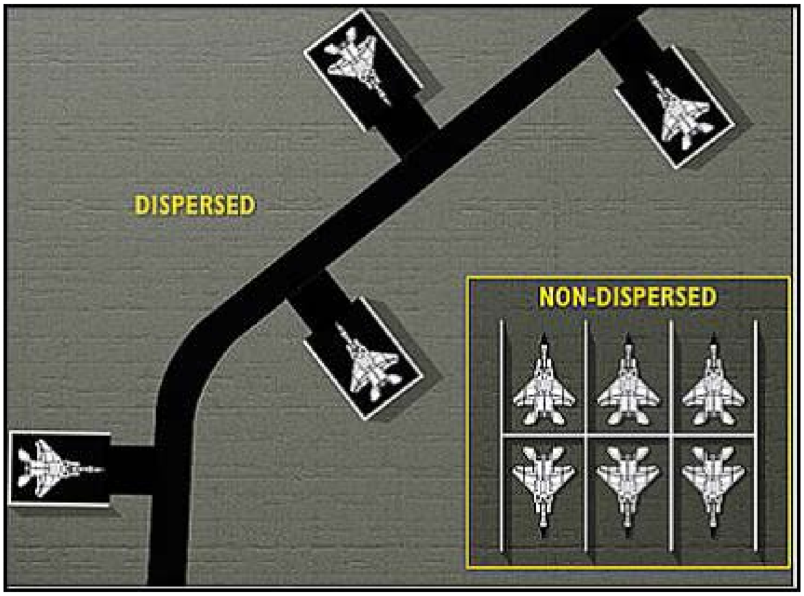


Figure 1–23. Dispersed and non-dispersed revetment cells.

Non-dispersed layout

If infrequent indirect fire and small-arms fire are prevalent in the area, we use a non-dispersed layout. Unlike dispersed layouts, non-dispersed layouts group aircraft together making a single target. The advantage is that for the same amount of aircraft we need less construction materials for non-dispersed revetments. In addition, non-dispersed layouts protect aircraft from chain explosions, and the revetment walls provide protection against small arms fire. There are three common kinds of non-dispersed layouts: U-shaped, H-shaped, and drive-through (fig. 1–24).

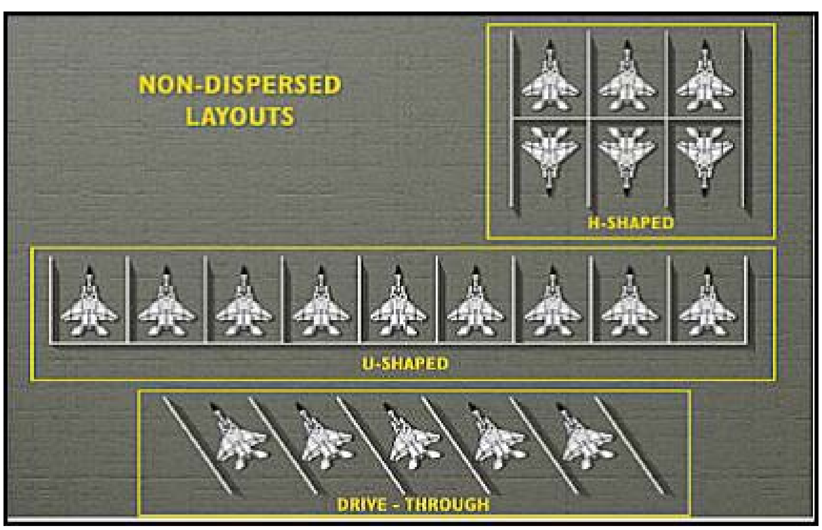


Figure 1–24. Non-dispersed arrangements.

H-shaped

The H-shape layout uses the least amount of material. It also provides protection on three sides and blocks line-of-sight to other parked aircraft. Line-of-sight is an issue because during an explosion, aircraft weapons can discharge, damaging aircraft in their line-of-sight.

U-shaped

If AM–2 matting is available for parking pads, we can create a U-shaped layout along a taxiway. This is an efficient way to add space when little is available on the aprons, or if no aprons are available. In addition, each aircraft has protection on three sides and has no line-of-sight to other parked aircraft.

Drive-through

The advantage of drive-through revetments is quick parking. The disadvantage of other arrangements is that aircraft have to back into their cells, taking valuable time. The disadvantage is that drive-through parking protects aircraft on just two sides but retains protection from chain explosions. Place multiple rows at opposing angles to avoid line-of-sight issues.

609. Using the Geospatial Expeditionary Planning Tool

The majority of our planning responsibilities involve translating planning ideas into maps. The tool that the Air Force has provided us is the Geospatial Expeditionary Planning Tool (GeoExPT). The GeoExPT software works within Air Force-approved geospatially-enabled computer-aided drafting (CAD) software to provide engineering, you, with a familiar environment in which to develop maps, analyses, and reports. The program comes pre-loaded with equipment and personnel UTC information, and aircraft parking and spacing regulations. This reduces the time used in gathering information and allows you, as the technician, to focus on developing plans and reports.

The basic use of GeoExPT can be broken into a three-part process—building a scenario, parking aircraft, and beddown layout. We will approach the use of the GeoExPT in the same order beginning with building a scenario.

Building a scenario

In the upper left-hand corner of the Home tab is a button labeled “New Scenario.” Selecting this button displays the New Scenario window (fig. 1–25). This window has a number of items that you can modify to fit your situation. The first is the file text box and icon which are used to designate the location where file is stored and what that file will be named; after that, is the coordinate system. It is important to set the coordinate system to match the data that you intend to import. If the coordinate systems do not match, then GeoExPT may display an error, and you will have to set the coordinate system after creating the scenario. It is much easier to configure the coordinate system when starting a new scenario. The properties text boxes are self-explanatory and are for you and your organization’s administrative purposes.

After you have adjusted the text boxes, select the OK button, and the program will create and open the scenario. The next step is to fill our scenario with data and imagery of the base location.

Connecting to data

Your new scenario should look like figure 1–26. On the right is the task pane, which lists and organizes all the feature layers. At the top will be a series of tabs each of which has a ribbon with different functions and tools. This should be very familiar because it is organized the same as the CAD environments. The first function we are concerned with is the Data function in the Home ribbon, which is the fourth from the left.

Selecting the Data button will open the Data Connection window (fig. 1–27). The left column has a list of data formats and types to which the CAD software can connect. The two we are going to focus on are the spatial data file (SDF) and raster image types.

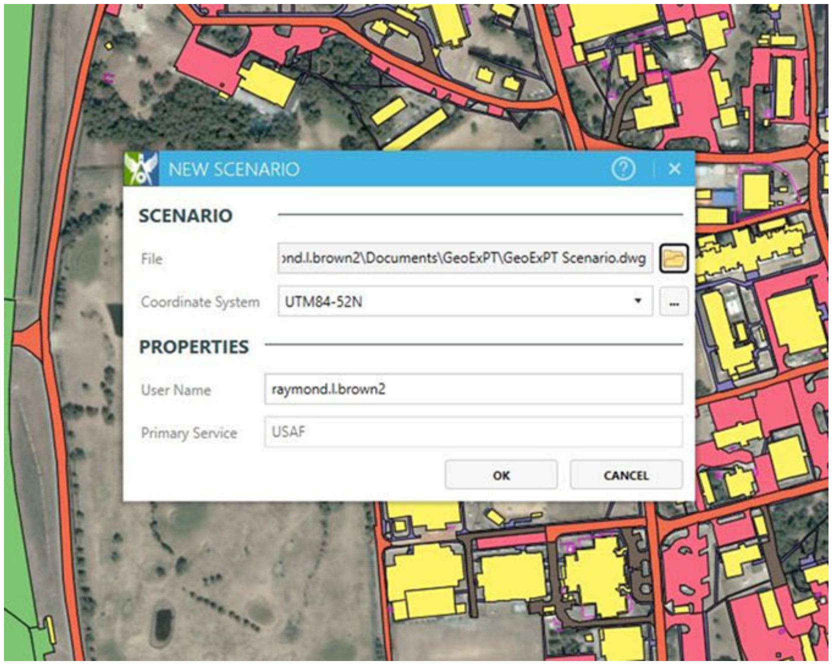


Figure 1–25. New Scenario window.

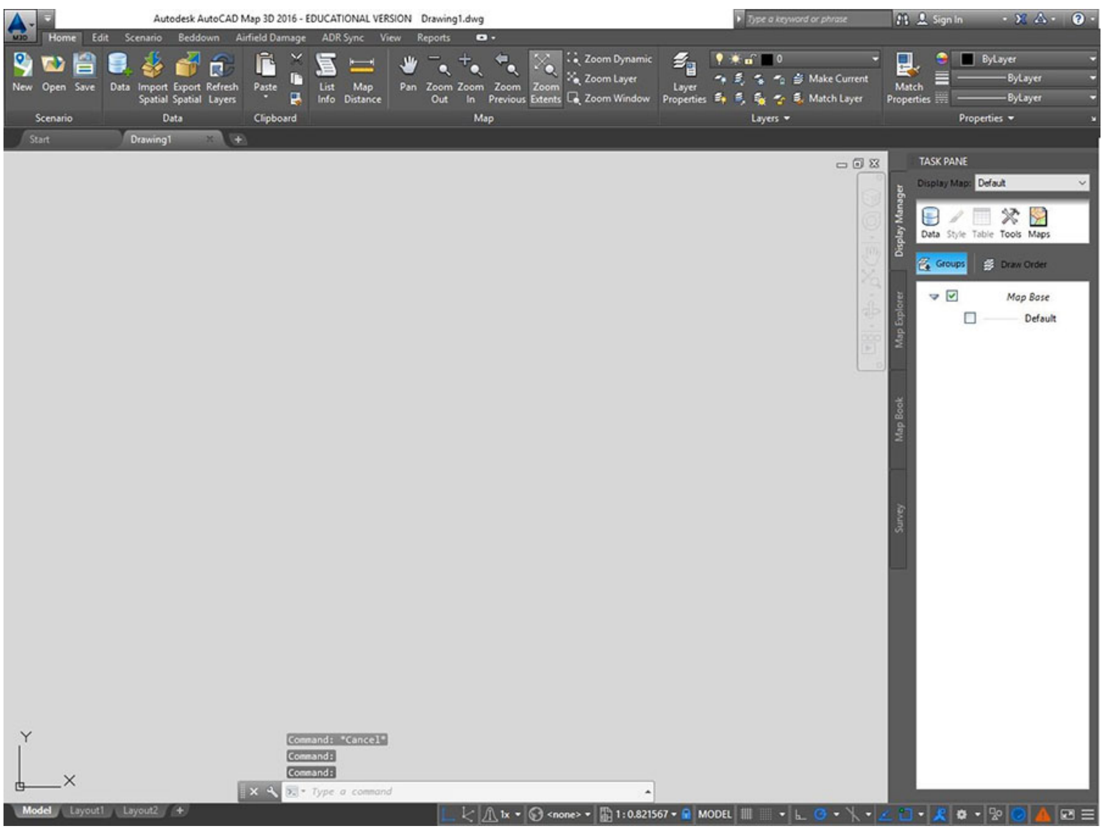


Figure 1–26. GeoExPT CAD Layout.

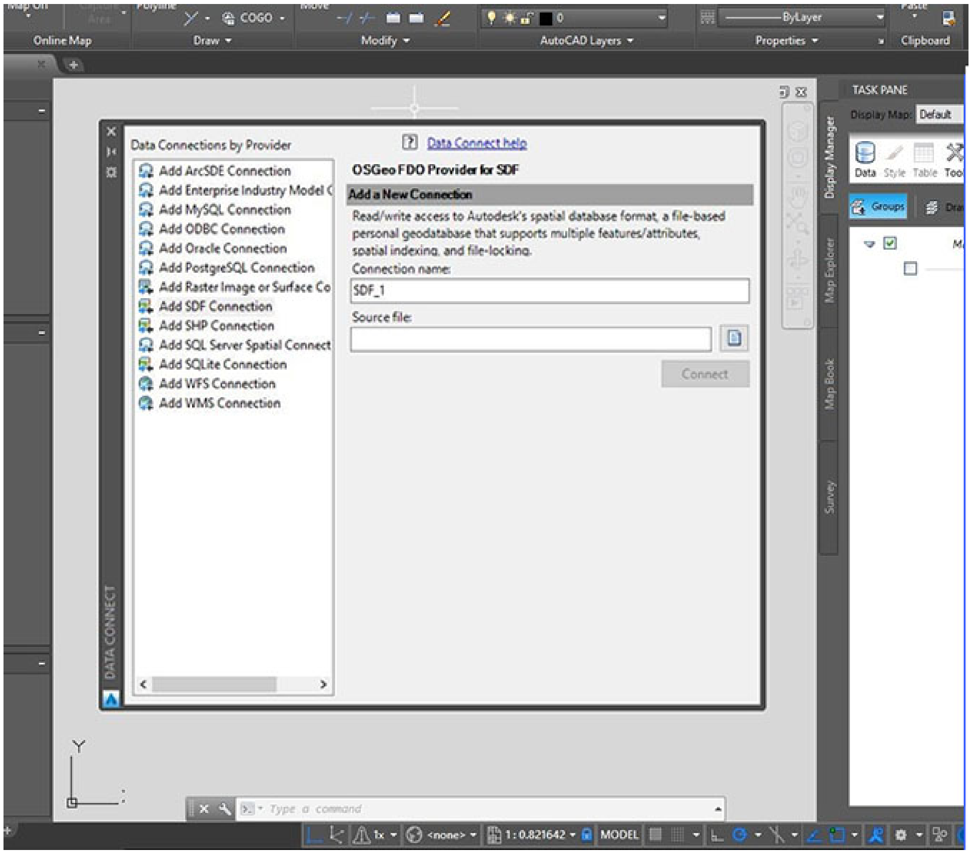


Figure 1–27. Data connection window - SDF.

Spatial data file connection

After highlighting the SDF file type, the right side of the Data Connection window will display options concerning the SDF file type (fig. 1–28). To the right of the of the Source File text box is a button with the symbol of a sheet of paper. Selecting this button allows you to navigate to the SDF file location. After we have selected the file, in our example, we will change the connection name in the text box from SDF_1 to common installation picture (CIP). When we see that everything is organized the way we desire, we can select the connect button below the Source file text box.

After connecting to the SDF, the Data Connection window will change to figure 1–28. Here, we can see which *feature layers* are included in the SDF we connected to, and select the ones that we need. Notice that each layer has its own coordinate system reference in the coordinate system column. The CAD-mapping software can convert different coordinate systems to the one that the drawing files. If we needed to change a layer or a group's coordinate system, we could select the Edit Coordinate System button above the Schema column. This will open the Edit Spatial Contexts window where we can modify the coordinate systems (fig. 1–29). After closing the Edit Spatial Contexts window, we can double check that we have selected the features we need and select the Add to Map button. Now, we can close the Data Connection window.

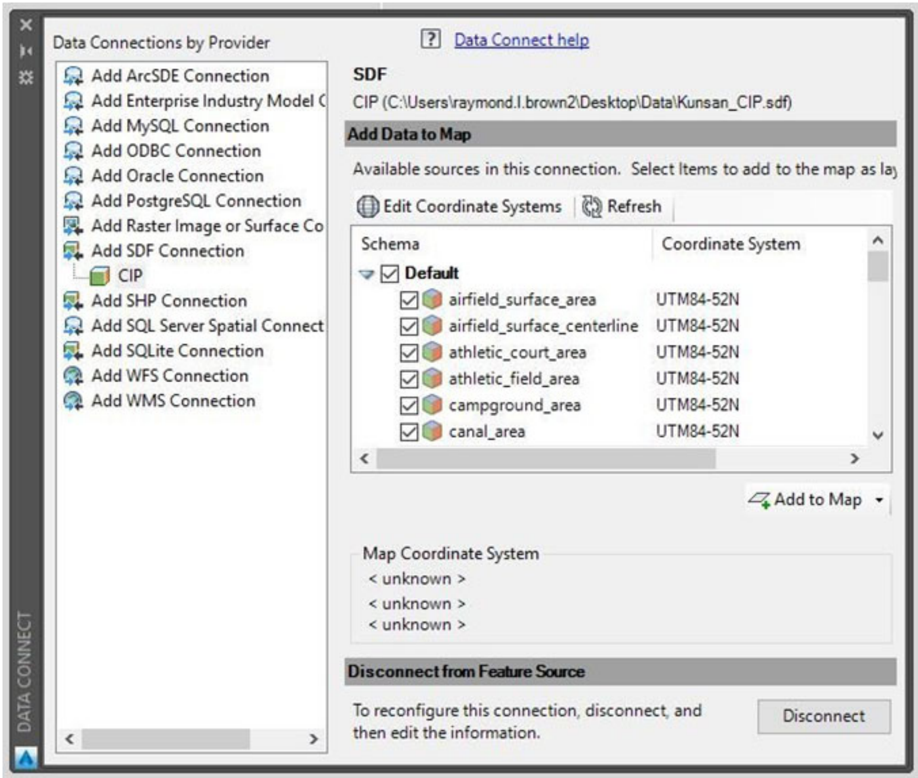


Figure 1–28. Add data to map.

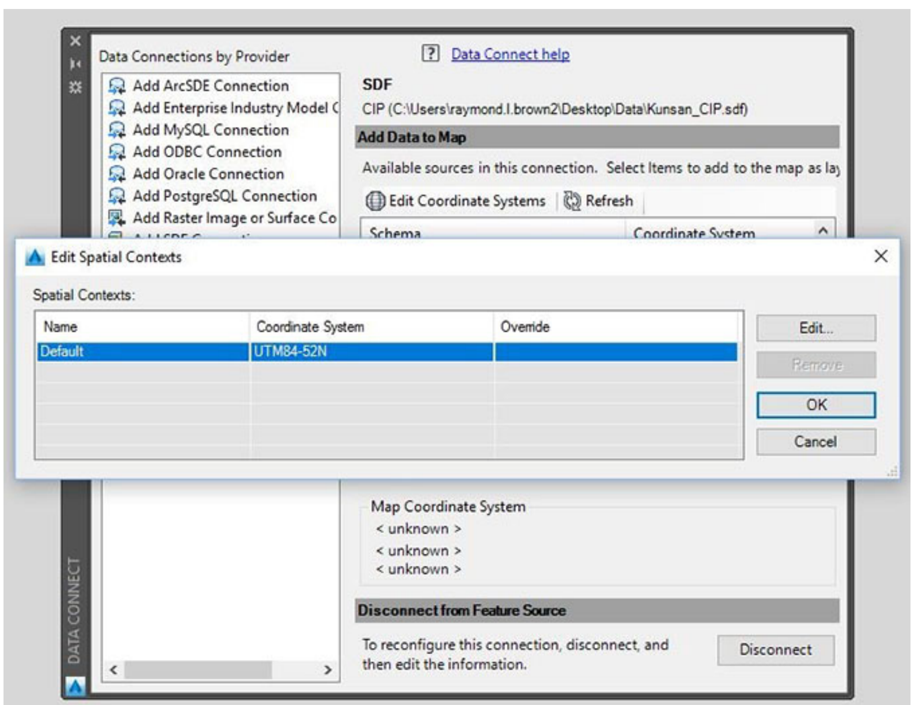


Figure 1–29. Edit spatial contexts window.

Now that we have a connection to our data, let us look at how it is organized and displayed. After closing the Data Connection window, we see the standard CAD layout. The right-hand side displays the Task Pane (fig. 1–30). The Task Pane now shows a folder icon with the label “CIP.” We connected to this data. If we select the arrow next to the folder, we can expand the “CIP” *Group* and view its various *feature layers*. There are two things to note about the Task Pane—the draw order and the display styles.

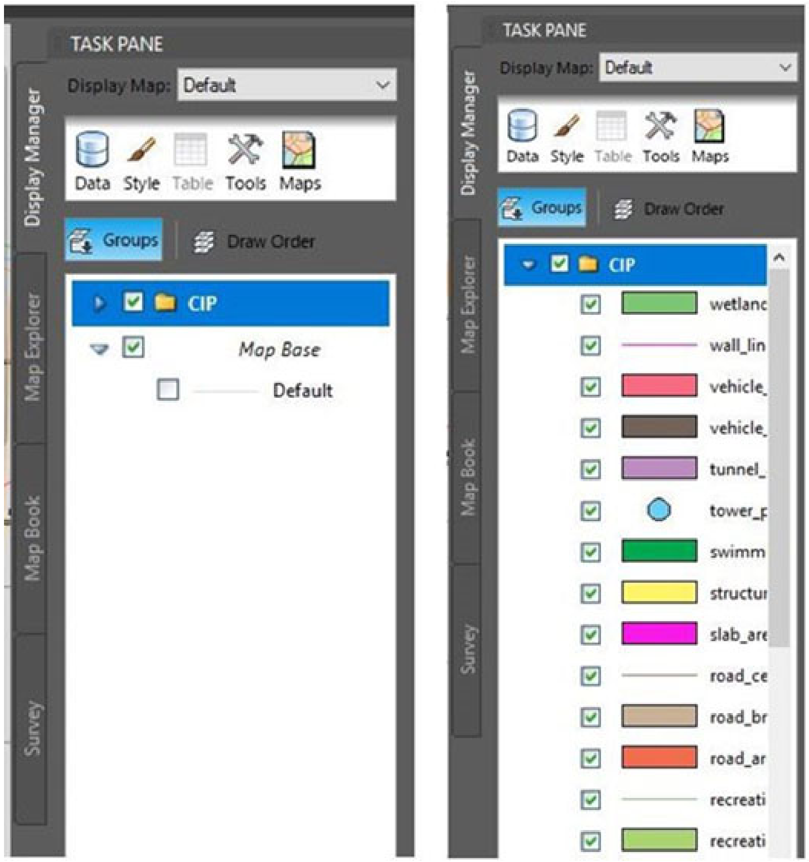


Figure 1–30. Task Pane.

The *feature layers* list does not determine the draw order, like in the normal CAD map layout. Just above the list of *feature layers* and *groups* are two tabs called “Groups” and “Draw Order.” To change the order, we have to be in the Draw Order tab. Within the Draw Order tab, the top most layer draws on top of the layers listed below. The last layer on the list, therefore, will be the layer behind the others above it in the list. To move a layer up and down the list, simply click and hold, then drag the layer to the desired position. Turn layers on and off using the check boxes to the right of the layer symbol.

To access the Style Editor, double click the feature layer, or select the layer to modify and select the Style button above the list, next to the Data button in the task pane. Taking either of these routes will open the Style Editor window where you can modify how the layer data displays in the drawing file (fig. 1–31).

Raster image or surface connection

The process of adding raster data to the drawing file is almost the same as adding SDFs. If we return to the Data Connect window instead of selecting “Add SDF Connection,” we will select “Add Raster Image or Surface Connection.” This will display the window shown in figure 1–32. To the right of the “Source File or Folder” text box are two buttons. The button that resembles a photo is for connecting to single images. Use the button resembling a folder to connect to a file folder. Using the folder option allows you to select which images in the folder to display in the drawing file, thereby, adding multiple images at the same time.

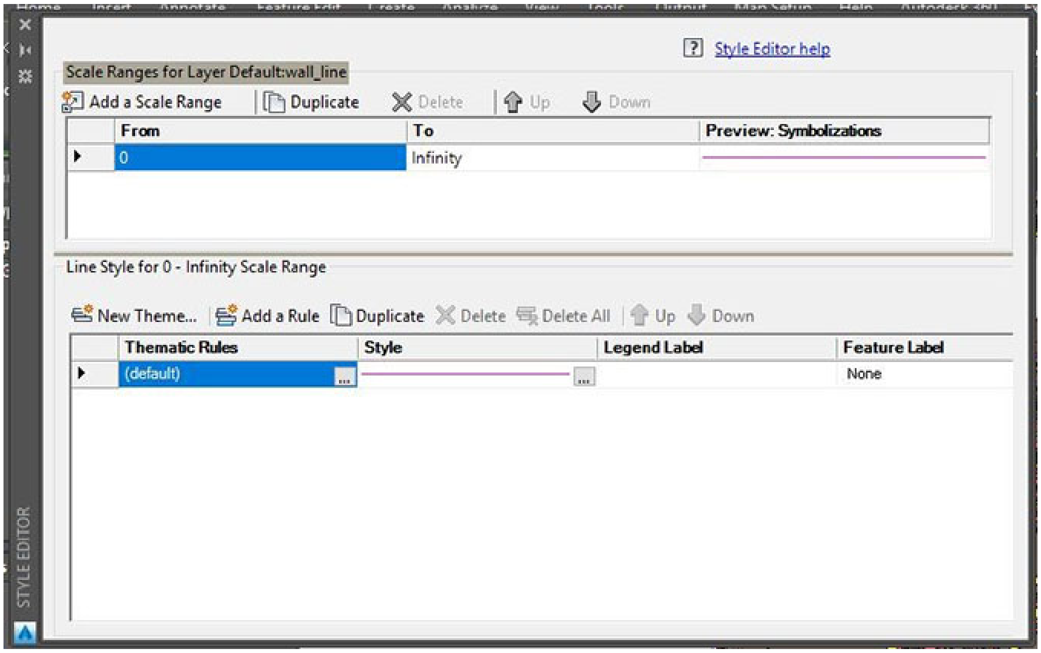


Figure 1–31. Style Editor window.

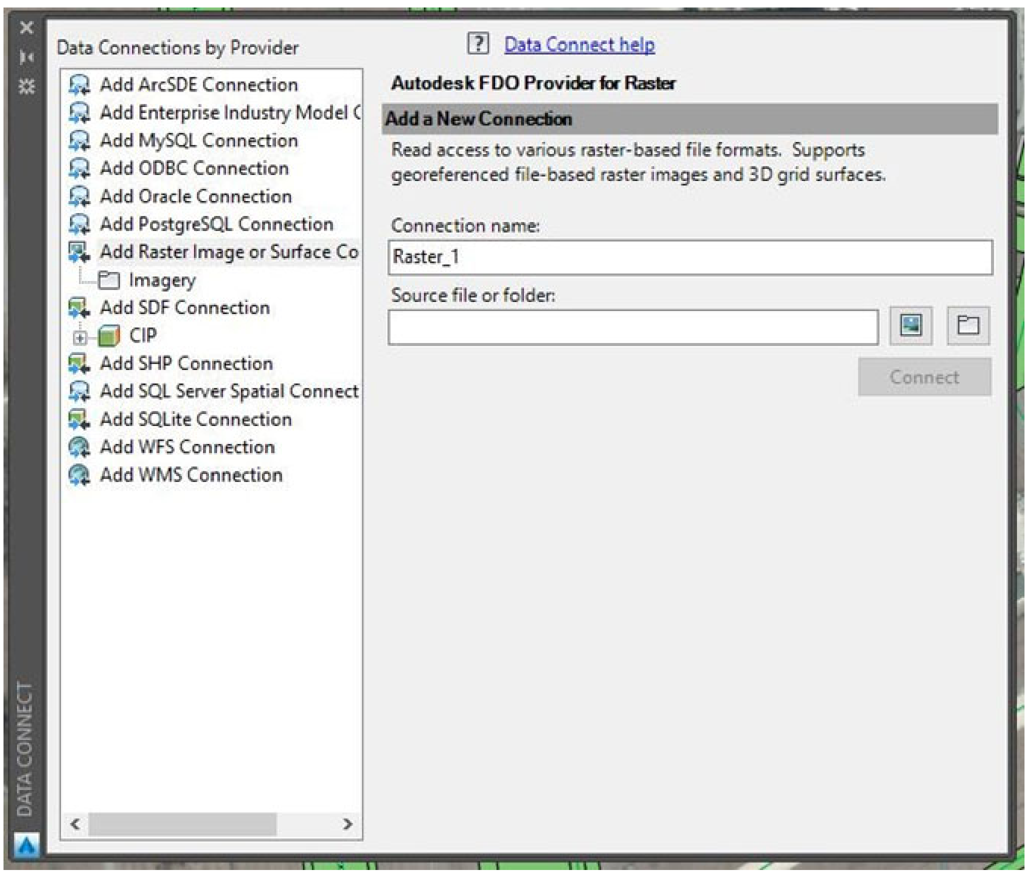


Figure 1–32. Data connection window - Imagery.

We have added our *feature layers* to the map, drawn in the correct order, and stylized the feature layers as desired. Additionally, we have imagery of the site to represent the physical conditions. The next step is to define our GeoExPT surfaces.

Defining surfaces

Now that our airfield data and imagery are in the scenario, we will define our surfaces. Defining surfaces tells GeoExPT how to treat certain areas and how to behave when certain objects interact with those surfaces. An example is a surface defined as a parking area. If we try to place an aircraft on a parking area surface, the aircraft object will not break any parking rules as far as wingtip clearances, taxiway clearances, placement outside the parking area, and so on. The surfaces we need at a minimum are the runway, the parking areas, and the taxiways. Let us begin by defining the runway surface.

Runway surface

At the top of the screen open, the “Beddown” tab. On the ribbon is the “Convert” tool. The Convert tool will add a defined surface to the scenario using an existing polygon. If we select the convert tool and select polygon representing the runway, a window with a dropdown list will appear. This dropdown list will have two options—surface and parking area. To define our runway surface, we select the surface option. This will open another window with another dropdown list. This dropdown list will have dozens of surface types. Here we select “Runway” and select OK.

The runway is not yet complete. While we have a surface area defined as a runway, we have no information describing the rules of this runway. We must add a centerline to make the runway useful and to give it behavior. The centerline will define the left and right as well as the threshold and departure ends for the pavement reference marking system (PRMS). If we move to the “Scenario” tab (fig. 1–33), we can see a tool toward the right called “Runway Centerline.” If we select the Runway Centerline tool and then select the runway surface, a dashed line will appear. This dashed line represents the centerline. The program then prompts us to manually select or automate the selection of the threshold and departure. After we define our threshold and departure ends, a red line and a green line appear to the runway surface at opposite ends of the runway. The green line represents the threshold and the red line represents the departure end of the runway.

Two other tools regarding the thresholds are important to be aware of—the flip and move threshold tools. We can switch the threshold to the other side of the runway using the “Flip Thresholds” tool on the scenario ribbon. If we need to resize the runway or create a displaced threshold, we use the “Move Thresholds” tool to adjust the position of the threshold or departure end on the runway surface.

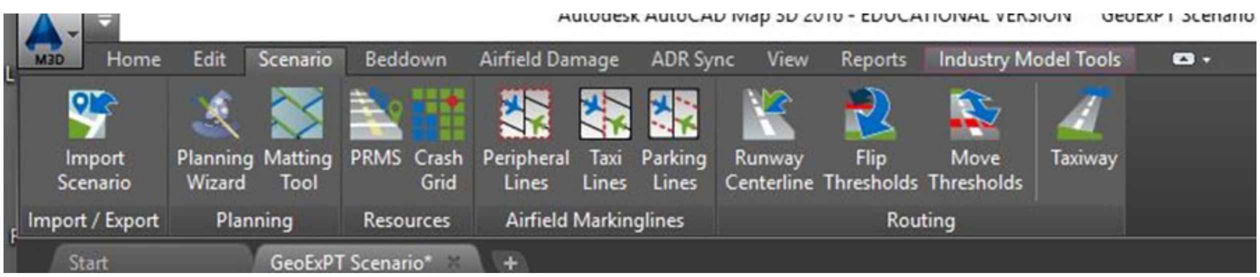


Figure 1–33. Scenario tab.

The next change we make to the runway surface is the addition of a PRMS. Under the Scenario tab, select the PRMS tool and select the runway surface. The PRMS will auto-generate based on how we defined the thresholds and centerline. Next, we can define the parking areas for our aircraft.

Parking areas

Parking areas are surfaces that define the area GeoExPT will use to assist in parking aircraft. A parking area provides the constraints needed to place aircraft by parking regulations provided as part of the program. We will use the “Convert” tool again to define a parking area. This time instead of selecting “Surface” from the first dropdown list, we will select “Parking Area.” We have now defined our parking area surface.

We can also create parking areas by drawing, dimensioning, or defining them by aircraft (fig. 1–34). Drawing a parking area surface is the same as drawing any other polygon. Defining a parking area by dimensions shows a window asking for length and width of a rectangle. The parking area by dimensions is limited only to rectangle shapes. Defining parking areas based on aircraft is accomplished in much the same as by dimension, except that the number of aircraft, their rows, and columns will define the rectangle (fig. 1–35). In both cases, we place the rectangle in the same way as a CAD-block object.

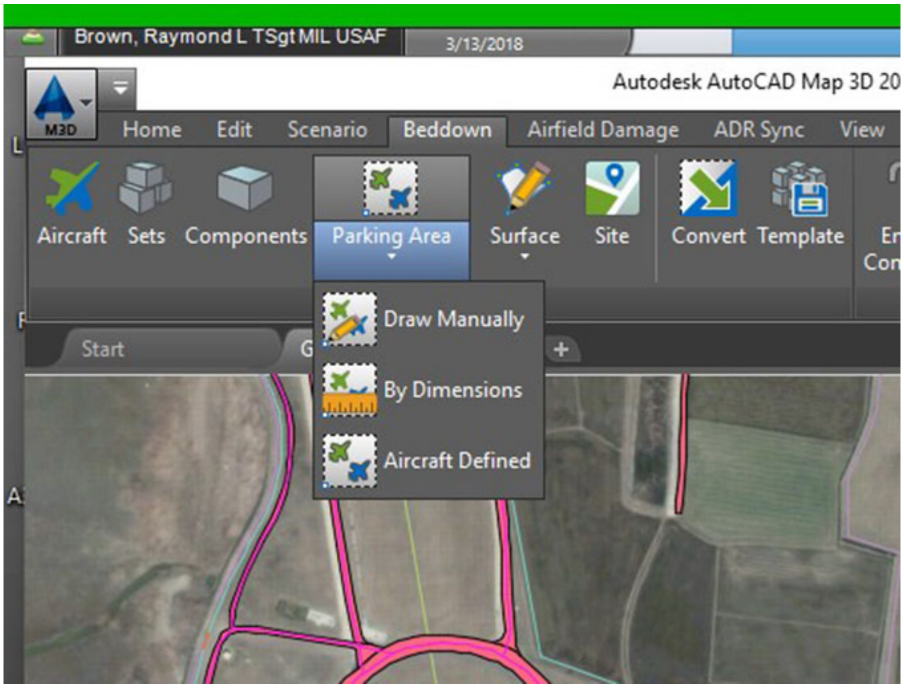


Figure 1–34. Ways to define parking areas.

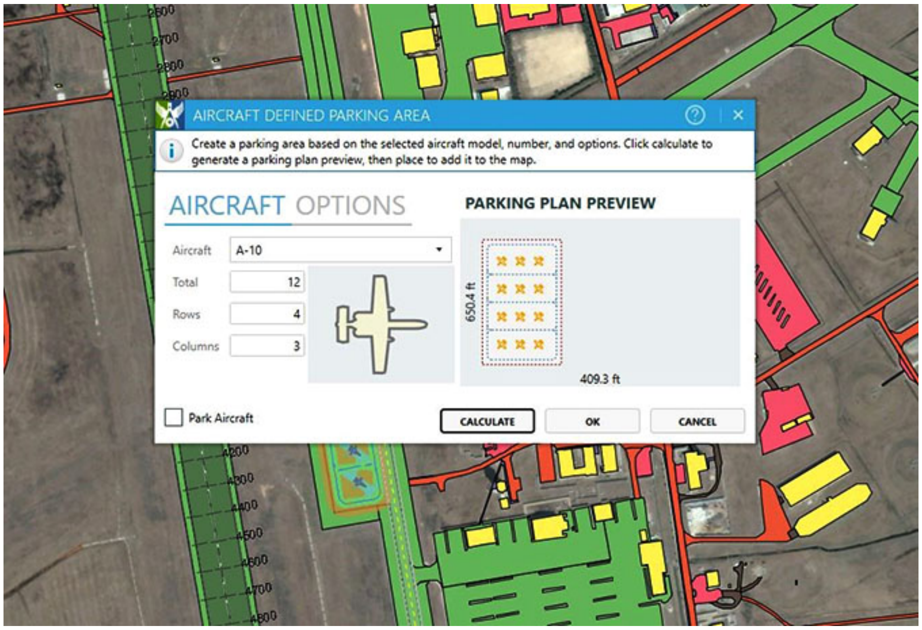


Figure 1–35. Aircraft defined parking area window.

Taxiways

Taxiway surfaces will allow us to create routes for aircraft to and from the runway. To create a taxiway surface, we find the "Taxiway" tool to the far right on the Scenario tab (fig. 1–33). The program will then prompt you to define a taxiway width. After selecting a width and pressing the ENTER key, we can draw the taxiway centerline like any other line in CAD.

Our drawing now looks something like figure 1–36. We are now prepared to add aircraft and park them on our parking surfaces.

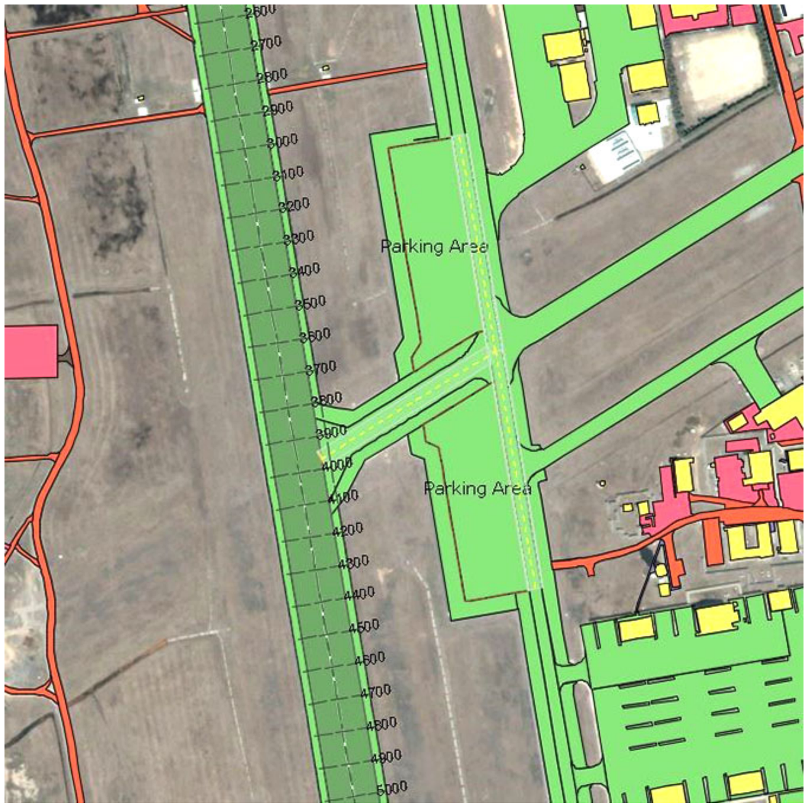


Figure 1–36. Runway and parking area surfaces.

Aircraft parking

GeoExPT uses recent aircraft parking instructions to allow accurate aircraft parking. The program has two different ways to park aircraft—manually or automatically. Manual parking requires a working knowledge of aircraft distance tolerances and is best when developing custom aircraft parking plans. The auto-park tool will be our most expedient aircraft-parking tool. However, we need to add aircraft to the scenario before we can tell them how to park.

Adding aircraft to the scenario

On the Beddown ribbon at the far left is a tool labeled "Aircraft." The Aircraft tool will open the "Add Resource - Aircraft" window (fig. 1–37). Use this window to search for, and to select the type and quantity of aircraft for your scenario. The window organizes aircraft by type in alphanumeric order. In the upper right of the window is a search box easing the search of aircraft models.

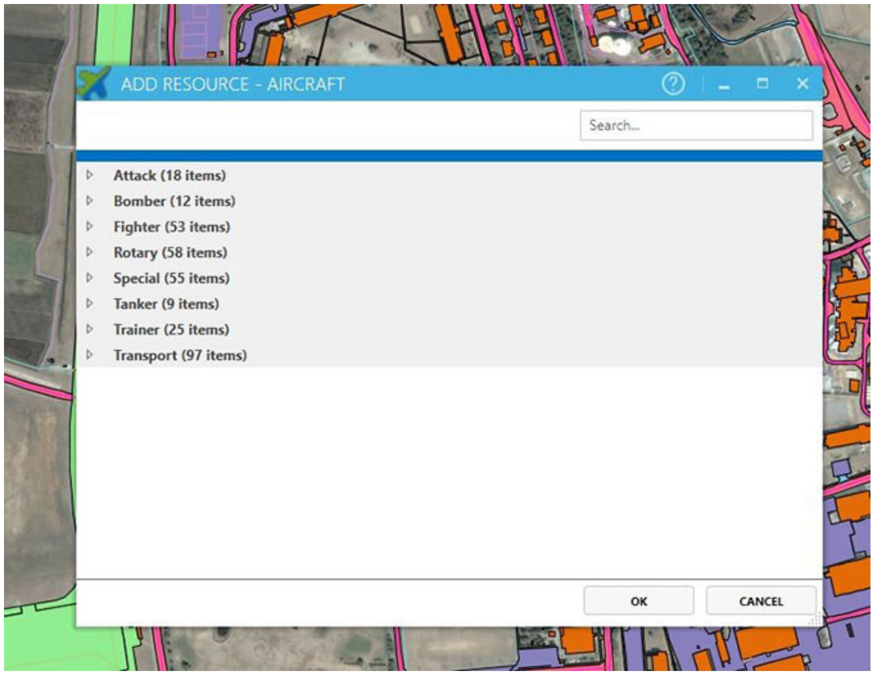


Figure 1–37. Add resource - Aircraft window.

When we are finished adding aircraft to the scenario, we can open the Table of Contents (ToC). The ToC is located on the View ribbon, and opens a window as in figure 1–38. The ToC organizes components, such as aircraft, that we have added to the map. Like the surfaces we defined earlier, the components in the ToC follow rules defined by the instructions and regulations programmed into GeoExPT. The ToC is the Task Pane for GeoExPT components. Components behave as if they have the same limitations as the real-world materials. Keep this in mind as we move through this section.

Parking aircraft

In the View tab, next to the ToC button is the “Aircraft Parking” button. This button opens the Aircraft Parking panel. The parking panel has three tabs on its right side, Parking Area, Obstacles, and Autopark. The parking area tab allows you to auto-generate linework as either specified or aircraft defined. The Obstacles tab identifies any objects that exist on the surface that we need to address. The Autopark tab is most important for expedient planning. This tab is broken into two parts listed at the top of the panel—Aircraft and Layouts.

The Aircraft tab shows the aircraft included in the scenario. Each aircraft type has a series of settings (fig. 1–39). The *Include* setting tells the program which aircraft types to park on the selected surface (if green) and which to leave out (if red). The *Park* setting allows you to adjust how many of that type of aircraft to include. *Parking Angle* sets the parking angle at 45˚ right of, left of, or perpendicular to the taxi lines. Setting the *Toward* or *Away* options designate the direction of the aircraft nose, either toward or away from the taxi line. If the aircraft need to alternate directions, then the *Alternate Directions* checkbox will do that. The tiny gear wheel in the bottom right of the aircraft type box has advanced settings if needed.

Under that LAYOUTS tab, we generate and choose which parking layouts we want. After selecting our aircraft type, we can select the “Calculate Parking Plans” button next to the red X at the top of the parking panel. This will list possible parking configurations for the selected parking area (fig. 1–40).

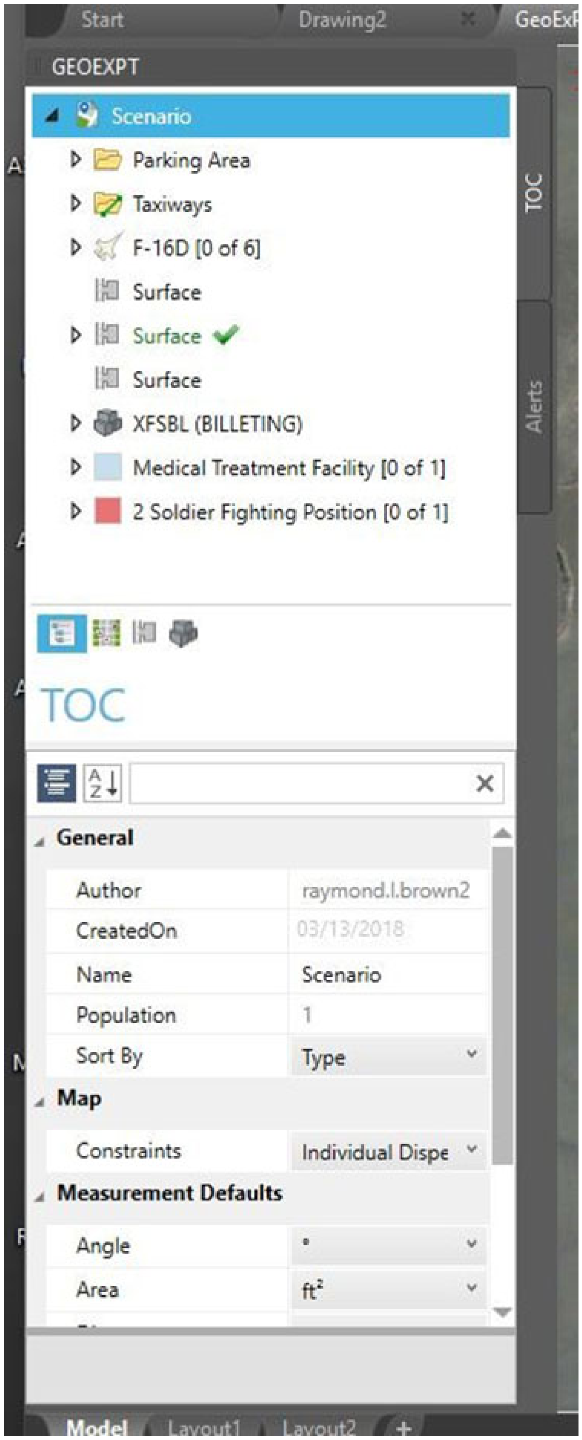


Figure 1–38. ToC.

Figure 1–39. Aircraft parking panel - Autopark tab.

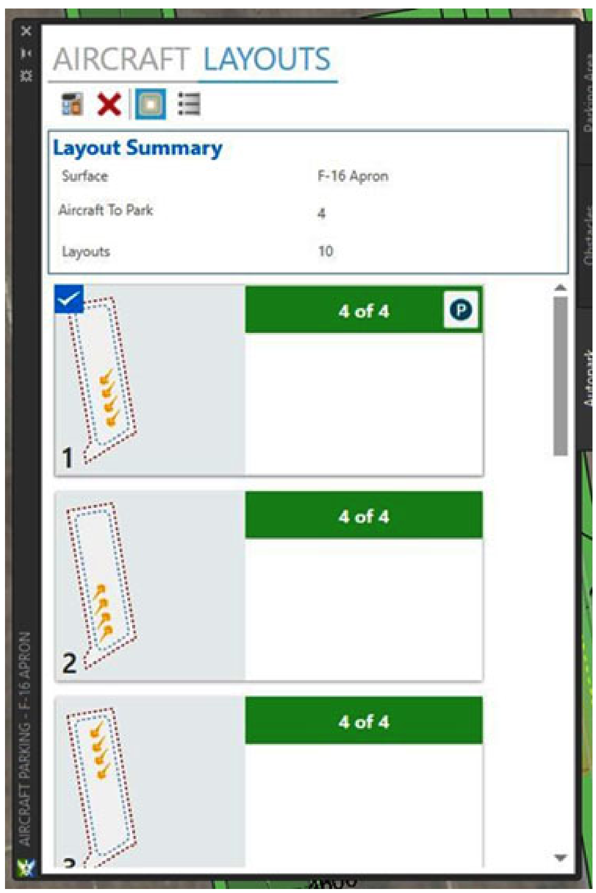


Figure 1–40. Layouts parking panel.

The final step in parking aircraft using the Autopark function is to select a layout. Once we have one selected, we can select the blue "P" icon in the upper right of the selected layout. This will apply our parking plan to the parking area. Our parking area now resembles figure 1–41.

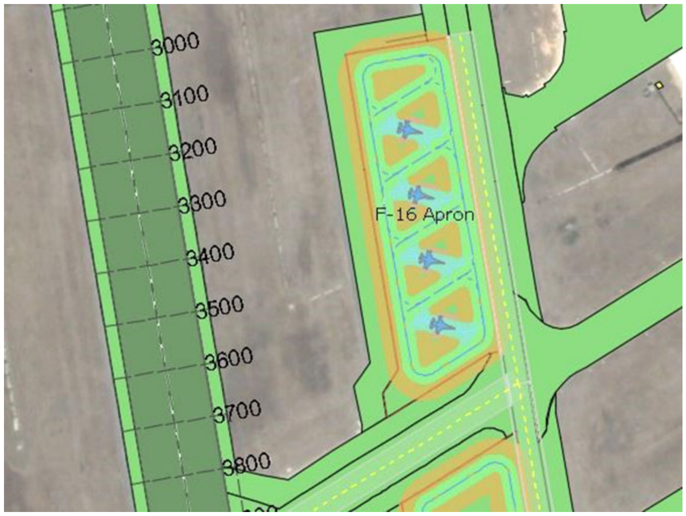


Figure 1–41. Parked aircraft.

Beddown layout

So far, we have set up our runway, taxiways, and parking areas. We have also populated our parking areas with aircraft. The next thing we need to be concerned about is the layout of the rest of the base assets. Earlier, we talked about UTCs. Those UTCs are groups of equipment by function and are stored in GeoExPT by "component" or groups of components called "sets."

Adding sets and components

On the Beddown ribbon next to the "Aircraft" button is the "Sets" button. The "Sets" button opens the "Add Resource – Set" window (fig. 1–42). This window has equipment sets organized by military branch. If we expand one of the branches, we will find a list of available equipment sets in alphanumeric order. A set is a group of equipment components. If we add one to our scenario, the ToC populates with each of the components within that set.

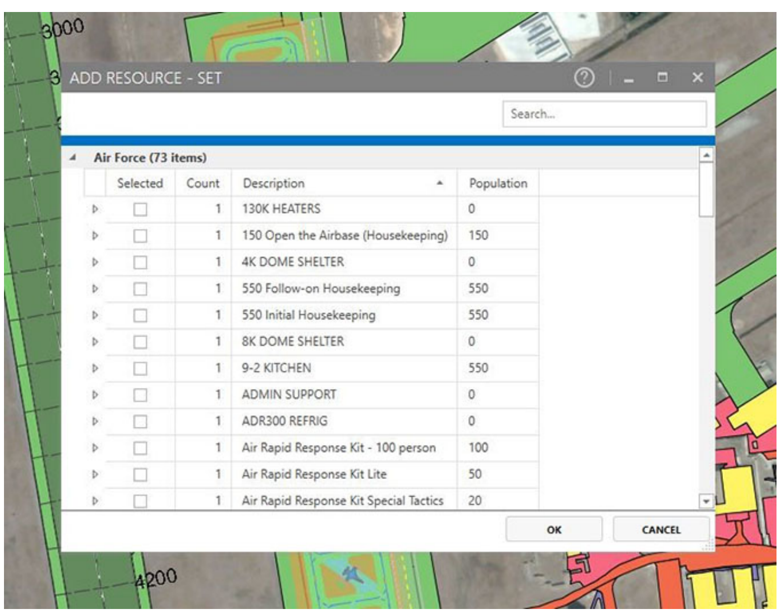


Figure 1–42. Add resource – Set window.

We can also find equipment listed by component. Next to the “Sets” button on the Beddown ribbon is the “Components” button. This tool will list all equipment in alphanumeric order by type, those being point, line, multiline, or polygon (fig. 1–43). This means if we were looking for a tent component, we would look in the polygon list. If we were looking for an electrical cable, we would look in the line or multiline categories.

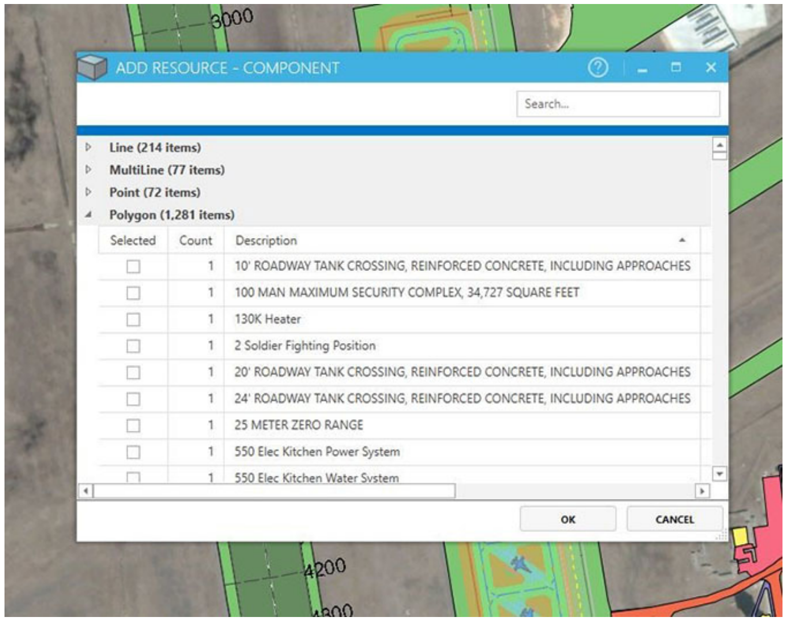


Figure 1–43. Add resource – Component window.

Let us add a few things to our scenario. We will add the “XFSBL (Billeting)” set and a single medical-treatment facility component. If we look in our ToC, our Billeting set will list 12 small shelter systems, 12 distribution panels, and 12 each of both 50- and 100-foot cables. Our medical-treatment facility, on the other hand, includes only one polygon.

Placing components

The assets, the sets, and components we need are now a part of the scenario. The next step is to place them where we need them. There are two primary types of components we place—polygon and linear. Let us begin with polygon placement.

Polygon components

If we go back to the ToC, we can see that our “XFSBL (Billeting)” set expands. Listed within the billeting set are the components that are a part of that UTC. The “Small Shelter System” (SSS) lists with a quantity of 12, and we place them in two different ways, one-by-one or by array. If we select the SSS in the ToC and move our cursor over the map, a polygon superimposes on our cursor. Right clicking will give you a list of options for the component. There are two options to note: the *rotate* option will allow you to set the placement angle, and the *snap overrides* will allow you to choose snaps on the fly. After we have adjusted the rotation and snaps, we left-click on the map to place the component.

Arrays are the most efficient way to place most assets. To access the array tool, right-click on the component in the ToC (fig. 1–44). If we select the “Area Array” types, the “Area Array Window” will open (fig. 1–45). This window allows us to set the number of columns and rows in our array. Additionally, we can adjust the separation distances between the components in the array. For our example, we will use six columns and two rows. While the “Area Array” places components in columns and rows, the “Linear Array” places objects in a line at a specified separation distance.

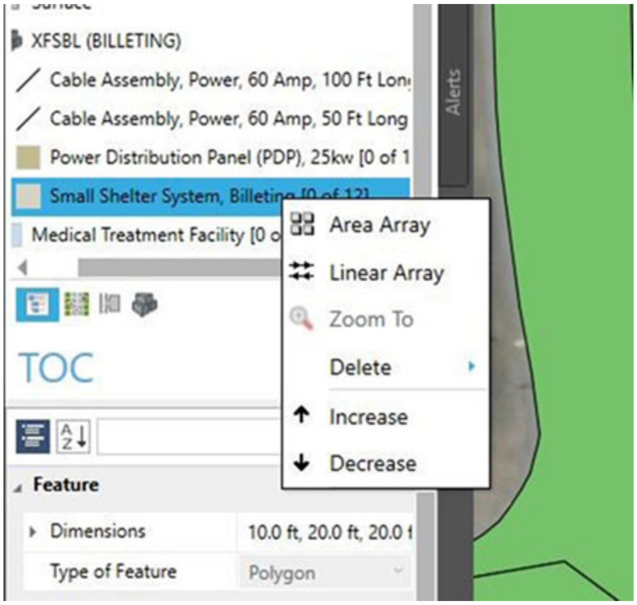


Figure 1–44. Array types.

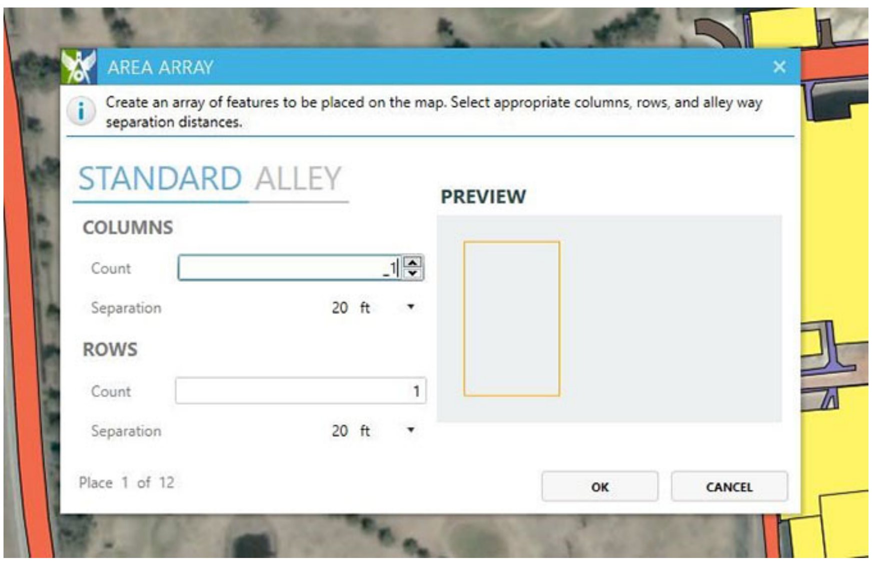


Figure 1–45. Area array window.

There is one last thing to note regarding polygon components. Let us say we add the “Power Distribution Panel” components to the map in the alley between the SSS rows. These panel components can have the “Cable Assembly” linear component attached to them. However, they can only have the number of connections that the real panel would allow. This behavior is a good illustration of the difference between a graphic CAD object and the GeoExPT components.

Linear components

Linear components behave differently than polygon components. If we select the 100-foot cable assembly and try to put it on the map, a red-dashed circle will appear (fig. 1–46). The red circle represents the length limitation of the component. If you place 50 feet of a 100-foot component, then the red circle will adjust to a 50-foot radius. This is another feature representing the difference between CAD objects and GeoExPT components.

Figure 1–46. Linear component limit.

Unit 1 Summary

Planning begins with basic information on the location's climate, the number of personnel, and the nature of the mission. This information drives which UTC to request. It is not enough to know who and what to bring, we need to know when or at which phase of the AEF force module framework, they will arrive. Once we know how many, what function, and when personnel and equipment arrive, we can plan our facility grouping and layout planning. While the length of the overall mission will determine which standard of construction to use, the threat level and climate will drive our facility orientation and dispersal type within functional groups. At the same time, we have to park our aircraft. The threat level at the site will determine where, in what pattern, and in what way we protect our aircraft. The most critical element of planning is you. Your attention to detail and knowledge of planning elements and tools will directly affect the quality of the plan.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

607. Aircraft parking planning

1. What are the two characteristics of fighter jet blast that endanger personnel and equipment?

2. Where can we find more information on rotary and fixed wing aircraft parking requirements?

608. Aircraft revetment siting

1. What are the three non-dispersed parking layouts? Which is used for quick parking?

2. What are the advantages and disadvantages of a drive-through revetment layout?

609. Using the Geospatial Expeditionary Planning Tool

1. Basic use of GeoExPT is a three-part process. What are the three parts?

2. What is the purpose of the Edit Spatial Contexts window?

3. The Convert tool can make a polygon into what two primary types of surfaces?

4. List the settings for each aircraft type in the Aircraft Parking Panel under the Aircraft tab.

5. What is the difference between an Area and a Linear array?

Answers to Self-Test Questions

601

1. (1) Personnel.
   (2) Equipment.
   (3) Personnel and equipment.
2. (1) Open the Airbase.
   (2) Command and Control.
   (3) Establish the Airbase.
   (4) Generate the Mission.
   (5) Operate the Airbase.
   (6) Robust the Airbase.

602

1. (1) Capability-based planning and force presentation.
   (2) Dynamic positioning strategy.
   (3) Multimodal configuration.
   (4) Modular/scalable UTCs.
2. Positioning assets globally to increase the speed and simplicity of deploying UTCs.

603

1. The runway or airfield; aircraft are the mission.
2. (1) Distance-to-go.
   (2) Arresting system.
   (3) Runway edge.

(4) Runway approach.

3. (1) Desalinization.
   (2) Removal of suspended solids.
   (3) Chlorination control of bacteria.
4. 30 kW, 60 kW, and primary 750 kW using 3, 5, and 55 gallons per hour respectively.

604

1. Orient the shortest dimension toward the danger areas.
2. Front and rear project most of fragmentation while the sides project most of the explosive force and less fragmentation.

605

1. Ruins construction materials, attracts mosquitoes, wash away roads, and clear out tents.
2. This enhances/improves efficiency by keeping related functions close together.
3. Dispersed, and non-dispersed. Force protection or threat/risk.

606

1. Up to two years.
2. The life cycle cost. Semi-permanent has moderate costs, while permanent has low costs.

607

1. Temperature and velocity. 100° F and 56 kilometers per hour.
2. UFC 3–260–01, *Airfield and Heliport Planning and Design.*

608

1. H-shaped, U-shaped, and drive-through. Drive-through is used for quick parking.
2. It is easier and/or quicker to park aircraft, and uses less construction material but only protects aircraft on two sides.

609

1. (1) Building a scenario.
   (2) Parking aircraft.
   (3) Beddown layout.
2. To modify the data's coordinate system.
3. Surface and parking area.
4. Include, park, parking angle, toward or away, and alternate directions.
5. An area array arranges components into columns and rows, while a linear array arranges components into a single row with a specified separation distance.

Complete the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field-Scoring Answer Sheet.

Do not return your answer sheet to the Air Force Career Development Academy (AFCDA).

1. (601) What code is defined as a grouping of equipment and personnel capable of carrying out a specific function?
   a. Unit type code.
   b. Work unit code.
   c. Purpose identifier code.
   d. Aircraft maintenance status code.

2. (601) During which force module do we establish communications and prepare the airfield for initial flight operations?
   a. Open the Airbase.
   b. Operate the Airbase.
   c. Establish the Airbase.
   d. Generate the Mission.

3. (601) Which force module provides the primary aircraft and maintainers?
   a. Open the Airbase.
   b. Operate the Airbase.
   c. Establish the Airbase.
   d. Generate the Mission.

4. (602) What personnel increments are the basic expeditionary airfield resources order of battle (BOB) assets broken into?
   a. 100.
   b. 250.
   c. 500.
   d. 550.

5. (602) What basic expeditionary airfield resources order of battle (BOB) unit type code (UTC) characteristic allows them to be transported by air, sea, and land?
   a. Modular/scalable UTCs.
   b. Multimodal configuration.
   c. Dynamic positioning strategy.
   d. Capability-based planning and force presentation.

6. (603) Which system provides runway edge and approach lighting upon aircraft arrival?
   a. Communications array (CA).
   b. Navigational aids (NAVAIDS).
   c. Emergency Lighting System (ELS).
   d. Expeditionary Airfield Lighting System (EALS).

7. (603) Which two marker light types are required for jet aircraft?
   a. Edge and approach.
   b. Edge and arresting system.
   c. Distance-to-go and approach.
   d. Distance-to-go and arresting system.

8. (603) In what publication can the quantity-distance (QD) criteria be found?
   a. Air Force Instruction (AFI) 36–2903, *Dress and Appearance.*
   b. AFI 10–401, *Air Operations Planning and Execution*.
   c. Air Force Manual (AFMAN) 91–201, *Explosives Safety Standards*.
   d. Air Force Pamphlet (AFPAM) 10–219 Volume 5, *Bare Base Conceptual Planning*.

9. (603) What system do we use when the water at an austere location is non-potable?
   a. Remote Area Lighting System (RALS).
   b. Rapid Water Purification Unit (RWPU).
   c. Remote Area Liquid Processing System (RALPS).
   d. Reverse Osmosis Water Purification Unit (ROWPU).

10. (603) How much fuel in gallons per hour does one 60 kilowatt (kW) mobile electric power generator (MEP) use?
    a. 3.
    b. 5.
    c. 20.
    d. 55.

11. (604) Where can you find details regarding facility force protection?
    a. Air Force Tactics, Techniques, and Procedures (AFTTP) 3–32.34, Volume 3.
    b. Air Force Manual (AFMAN) 10–222.
    c. AFTTP 3–10.10, Volume 1.
    d. AFPAM 10–219, Volume 5.

12. (604) Less damage is dealt if an explosion occurs toward which side of a facility?
    a. Top.
    b. Bottom.
    c. Longest side.
    d. Shortest side.

13. (604) Regarding vehicle-borne improvised explosive device (VBIED) explosions, which part(s) cause(s) the majority of fragmentation dispersal?
    a. Top.
    b. Sides.
    c. Bottom.
    d. Front and rear.

14. (605) When planning site layout, which Air Force Pamphlet (AFPAM) will you utilize?
    a. AFPAM 10–100.
    b. AFPAM 10–1043.
    c. AFPAM 10–219, Volume 5.
    d. AFPAM 10–219, Volume 7.

15. (605) What two primary reasons make shallow or standing water undesirable?
    a. Develops odors and ruins combat boots.
    b. Develops odors and attracts mosquitoes.
    c. Ruins construction material and attracts mosquitoes.
    d. Ruins construction material and creates a slipping hazard.

16. (605) Considering a non-dispersed layout, what number of feet is the minimum width of the utility lane?
    a. 10.
    b. 20.
    c. 30.
    d. 40.

17. (605) In a non-dispersed layout, how many feet is the distance between buildings in a row?
    a. 4.
    b. 6.
    c. 8.
    d. 12.

18. (605) How wide is the fire lane when planning a non-dispersed layout?
    a. 12 feet.
    b. 30 feet.
    c. 59 feet.
    d. 75 feet.

19. (606) What three categories of contingency construction standards are used for initial force beddown?
    a. Initial, secondary, and permanent.
    b. Organic, initial, and temporary.
    c. Initial, organic, and permanent.
    d. Organic, synthetic, and conventional.

20. (606) What two standards are used for enduring construction?
    a. Initial and organic.
    b. Initial and permanent.
    c. Semi-permanent and temporary.
    d. Semi-permanent and permanent.

21. (607) Why is parking aircraft fighters at 45-degree angles an efficient way to achieve safety?
    a. Improves pilot visibility.
    b. Provides jet blast clearance.
    c. Fits more aircraft on the apron.
    d. Increases room for vehicles on apron.

22. (607) Where are aircraft parking spacing distances measured from with regard to the aircraft?
    a. Front to rear only.
    b. Wingtip to wingtip only.
    c. Front to rear and wingtip to wingtip.
    d. Front to rear, wingtip to wingtip, and top to bottom.

23. (608) Which kind of aircraft non-dispersed layout uses the least amount of construction materials?
    a. C-shaped.
    b. H-shaped.
    c. U-shaped.
    d. Drive-through.

24. (608) Which kind of aircraft non-dispersed layout protects an aircraft on only two sides?
    a. C-shaped.
    b. H-shaped.
    c. U-shaped.
    d. Drive-through.

25. (609) Which button in the data connection window opens the Edit Spatial Contexts window?
    a. Refresh.
    b. Add to Map.
    c. Data Connect help.
    d. Edit Coordinate System.

26. (609) Which tool allows you to change a polygon into a Geospatial Expeditionary Planning Tool (GeoExPT) airfield surface, such as a runway?
    a. Pavement reference marking system (PRMS).
    b. Runway centerline.
    c. Taxiway.
    d. Convert.

27. (609) The threshold and departure ends of the runway are marked by what color lines, respectively?
    a. Blue and red.
    b. Green and red.
    c. Blue and yellow.
    d. Green and yellow.

28. (609) With the exception of the “Convert” tool, what three ways can parking aprons/areas be added to the scenario?
    a. Drafting, drawing, or dimensioning.
    b. Drawing, dimensioning, or defined by shape.
    c. Drafting, dimensioning, or defined by aircraft.
    d. Drawing, dimensioning, or defined by aircraft.

29. (609) Which setting in the Aircraft Parking Panel, in the Aircraft tab, allows you to adjust the number of aircraft to be parked on the parking area?
    a. Park.
    b. Include.
    c. Alternate rows.
    d. Parking angle.

30. (609) Which two types of arrays can we use to quickly layout beddown components?
    a. Area and linear.
    b. Area and square.
    c. Rapid and offset.
    d. Dimension and relationship.

Please read the unit menu for unit 2 and continue ➔

Student Notes

Unit 2. Employment Operations

AFTER PLANNING IS COMPLETE and we arrive at the location, or when the base is attacked or subject to a natural disaster, we have to make the base operational. An operational base can launch and recover aircraft. Most often, after an attack/natural disaster, the airfield has taken damage. Repairing that damage is the first priority of the installation commander and, therefore, our first priority. We organize differently during contingencies like attacks and natural disasters. New teams assemble each with a specific task. The mission depends on our ability to execute these tasks. That ability is directly proportional to the amount of effort we put into training. With that in mind, let us begin with an overview of organizational structure during contingencies.

2–1. Organization

In the event of natural disaster, enemy attack, or as we get a bare base up and running, we need a clear and uniform way to operate and organize. Engineering will be a part of both the emergency operations center (EOC) and the civil engineer unit control center (UCC). The first step in performing your duties is to collect information. The best places to collect that information are the EOC and UCC.

610. Emergency operations center

When a natural disaster or an attack occurs on an airbase, the installation commander will activate the EOC. The EOC is the command center for base recovery before, during, and after a disaster or attack. It decides alarm conditions, mission-oriented protective posture (MOPP) levels, and recovery team release. Through its emergency support function (ESF) personnel, the EOC coordinates and combines functions across the installation. These ESFs are conduits to each UCC and are SMEs in their specialties. The EOC also manages smaller scale incidents such as chemical spills, hostage situations, and terrorist bombings through incident commanders (IC). ICs manage forces at the incident location, receive direction from, and communicate back to the EOC.

Emergency operations center director

The EOC director is the MSG commander or other representative designated by the installation commander (usually the CE commander). The EOC director is responsible for unity of efforts between ESFs in order to recover the installation from disasters, enemy attacks, and dangerous incidents. The EOC director focuses ESFs toward a shared goal.

Emergency support functions

The ESFs are grouped capabilities that stand up based upon the needs of the incident (fig. 2–1). Personnel assigned to ESFs provide situational awareness (SA) and decision authority over personnel and supplies within their function. Refer to AFI 10–2501, *Air Force Emergency Management Program*, for ESFs' definitions and responsibilities.

Emergency Support Functions			
ESF-1	Transportation	ESF-9	Urban Search and Rescue
ESF-2	Communications	ESF-10	Oil and HAZMAT Response
ESF-3	Public Works and Engineering	ESF-11	Agriculture and Natural Resources
ESF-4	Fire Fighting	ESF-12	Energy
ESF-5	Emergency Management	ESF-13	Public Safety and Security
ESF-6	Mass Care, Housing and Human Services	ESF-14	Long-Term Community Recovery and Mitigation
ESF-7	Resource Support	ESF-15	External Affairs
ESF-8	Public Health and Medical Services		

Figure 2−1. Emergency support functions.

Emergency operations center manager

The installation commander appoints the readiness and emergency management officer, or superintendent as the EOC manager. Choosing readiness and emergency management personnel for this position is common because of their training and certification in disaster response force (DRF) and Federal Emergency Management Agency (FEMA) procedures. The EOC manager is selected based on their knowledge of EOC operations and policy and is the administrative arm of the EOC. Each ESF provides a log of activity and a report on status, such as personnel and supplies. The EOC manager combines all ESF reports into a single report for the director and base commander. This allows the EOC director to focus on incident recovery rather than paperwork.

Incident commander

The IC is a trained and experienced responder who provides on-scene tactical control. The first IC on-scene is normally from the fire, medical, or security forces (SF) response element. Personnel designated as ICs must have received certification for the specific type of incident. For example, the IC must meet fire and emergency service training requirements for hazardous materials (HAZMAT) and suspected chemical, biological, radiological, nuclear, and explosives (CBRNE) responses.

First responders

First responders are members of the DRF that deploy immediately to the disaster scene to save lives and control hazards. Firefighters, law enforcement, security personnel, and emergency medical personnel provide immediate response to major accidents and natural disasters. All first responders are emergency responders, but not all emergency responders are first responders. First-responder duties have priority over other assigned duties.

Emergency responders

Emergency responders are members of the DRF that deploy after the first responders to provide additional support. Emergency responders include follow-on firefighters, law enforcement personnel, and emergency medical technicians. Emergency responders also augment the incident by adding emergency management personnel, explosive ordnance disposal (EOD) personnel, physicians, nurses, medical treatment providers, public health officers, bioenvironmental engineers, mortuary affairs personnel, and other specialized team members. Emergency-responder duties have priority over other assigned duties.

611. Unit control center

Unit control centers provide expertise, personnel, and supplies during and after attacks or natural disasters. The UCC supervises teams by tracking personnel, supplies, and assigned tasks. The EOC director decides which UCCs are necessary for base recovery and recalls those needed. You can find further tactical guidance for UCC operations in AFPAM 10–219, Volume 3, *Civil Engineer Contingency Response and Recovery Procedures*.

Staff

A UCC usually has 7 to 11 members. The CE UCC always has operations management personnel and will be commanded by the chief of operations. The chief of operations selects the remaining personnel depending on the nature of the incident. For example, if the base has lost power due to a tornado, then the UCC will have a supervisor and repair team from the electrical element. In the same situation, the UCC may need supervision and repair crews from the structures element, depending on the level of physical damage to facilities.

Operation

Administratively, the UCC will track personnel accountability, task completion, priorities, and supplies. Mission need decides personnel recall. Personnel are tracked and reported as part of the CE ESF to the EOC. Monitoring task completion is the responsibility of the Air Force specialty code (AFSC) supervision in the UCC.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

610. Emergency operations center

1. What are the EOC director's responsibilities?

2. The EOC manager creates a single report for the EOC director, which is a combination of what information?

611. Unit control center

1. The UCC will *always* have what specialty of personnel?

2. Administratively, what does the UCC do?

2–2. Engineering Response after Attack/Natural Disaster

Immediately following an attack or natural disaster, the EOC recalls you. You will collect information as part of the airfield damage assessment team (ADAT). You will select minimum operating strip (MOS) candidates as part of the minimum airfield-operating surface (MAOS) team. The MAOS team is also responsible for calculating the repair quality criteria (RQC) for crater repair on the runway. These teams are critical, and your expertise in each can help or hinder the installation's capability to launch and recover aircraft.

612. Airfield damage assessment team

The ADAT records and reports damage on the airfield to the MAOS selection team in the EOC. The ADAT usually consists of one member of engineering, two EOD technicians, and one or more augmentees. There are normally two ADATs per airfield or installation. The ADATs record the location and type of damage on airfield surfaces. Damage types include craters, spall fields, bomblet fields, and damage to airfield infrastructure (i.e., lighting, signage, navigational aid [NAVAID]). The ADAT must be accurate in their damage reports because their information is critical to MOS selection. You can find additional details on ADATs in AFTTP 3–32.11, *Airfield Damage Assessment after Major Attack*.

Pre-attack preparation

When assigned to an ADAT, there are tasks you need to accomplish before an attack occurs. The first thing is to check all your equipment and ensure that it is functional and undamaged. Make certain that you have the basic equipment to perform damage assessment, such as a vehicle, a way to communicate (usually a radio), and a way to record the damage (a map, and/or a pen and paper). Preparing before an attack will save time during damage assessment. The faster ADATs deliver the information, the faster the installation commander can get aircraft back in the air. Figure 2–2 lists recommended ADAT equipment.

Item	Quantity
1. Safety ropes (for rescuing team members from a collapsed camouflet)	2
2. Crash grid map, 1:50,000 (MGRS)	1
3. Airfield pavement map, 1” = 400’ (with PRMS grid)	1
4. Damage assessment forms	25
5. Clip boards	3
6. Writing instruments	6
7. Radios (with spare batteries)	2
8. Binoculars	2
9. Night vision devices	2
10. Flashlights, explosion-proof plastic-cased	3
11. Measuring tape, nonmetallic	2
12. Marking tap, roll	5
13. Marking flags	50
14. UXO Markers	100
15. Backpacks (for dismounted assessments)	3

Figure 2–2. Basic ADAT engineering items.

Pavement reference marking system

The PRMS is your next pre-attack preparation priority. The PRMS is a series of stakes, and/or paint markings offset from the runway shoulder pavement every 50 to 100 feet indicating the distance from the threshold. If a PRMS does not exist on the runway, consider establishing one (fig. 2–3). One of the best ways to mark a PRMS is using a raised marker (fig. 2–4).

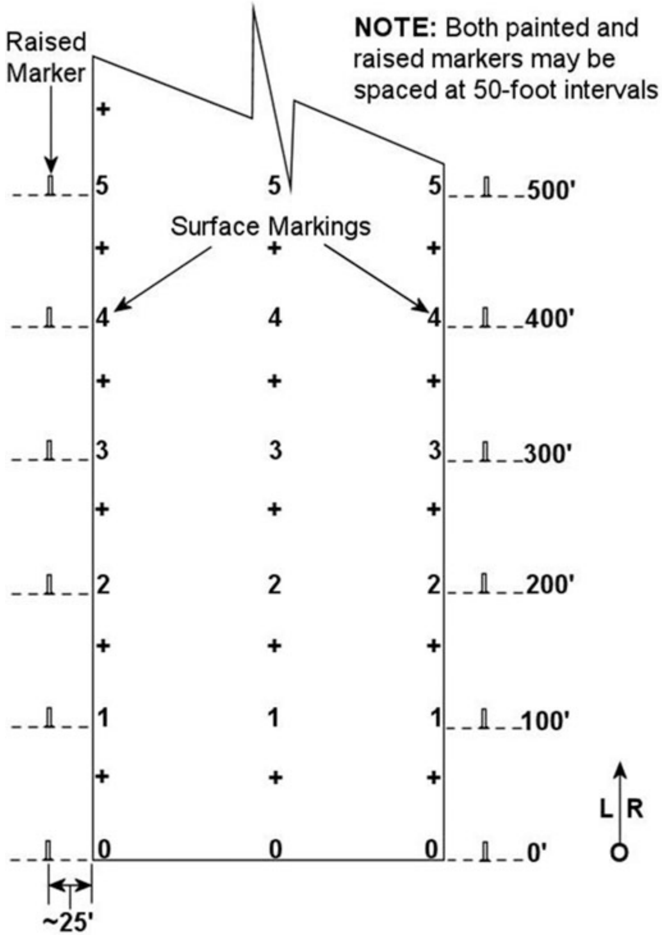


Figure 2–3. **PRMS layout plan.**

Figure 2–4. PRMS raised marker.

When establishing a PRMS, apply the following rules:

- Zero Point Rule: The zero point is fixed. Established at the runway threshold and will not change. This rule ensures clarity of communication and conformity of information between the ADATs and the MAOS selection team.
- Centerline Rule: All distance measurements are along the centerline. The centerline is generally straighter and more accurate than the shoulders.
- Left/Right Rule: Left and right of the centerline are determined as the ADAT faces down the centerline of the pavement away from the zero point.

If a PRMS is unavailable, and establishing one is not practical, then you may need to get creative. Use the distance between runway lighting, concrete slab dimensions, or runway striping lengths to give you an estimate for the distance from the threshold. Find a way to figure out how far from the threshold and how far left or right of the centerline is the damage. A military grid reference system (MGRS) map is a good backup to an absent PRMS. An MGRS map is necessary for recording damage outside the runway, such as taxiways, aprons, and access roads.

Air damage assessment team routes

The last pre-attack action you will need to accomplish is the preparation of the paths ADATs will follow to assess the airfield in its entirety. There may be more than one ADAT running during post-attack recovery. Coordination and planning between all ADATs will speed up the damage assessment process. Plan the route starting and ending points, checkpoints, and estimated times of completion. For example, there could be a travel route for the main runway, one for each taxiway and one for airfield lighting and equipment. Each team should be familiar with these routes to prevent delays. During damage assessment, the ADAT team normally travels along the runway or taxiway centerline, making it easy to assess both sides of the runway at once. Damage and unexploded ordnances (UXO) along the centerline may require the team to deviate from this path.

> **CAUTION:** Always make sure you confirm left or right of the centerline before calling in your coordinates.

Damage assessment phases

Two phases of damage assessment occur immediately after an attack. The first is the initial reconnaissance or recon phase. During the recon phase, the tower and any observation posts around the airfield provide an initial condition report of the airfield. This is useful to help the ADATs focus on certain areas of the airfield that need detailed assessment and/or prevent the ADATs from venturing into dangerous areas. The second phase is the damage assessment phase. In this phase, the ADAT performs a thorough assessment of the runways, taxiways, and parking aprons.

Damage assessment priorities

The airfield is the top priority for damage assessment because without it there is no mission. Not all assets and airfield pavements are of equal importance. The ADATs survey the airfield using the following list, which is prioritized by importance:

1. Takeoff and landing surfaces, including runways, alternate launch and recovery (LOR) surfaces, and taxiway segments long enough to permit aircraft LOR.
2. Access pavements to LOR surfaces.
3. Aircraft shelters and parking areas.
4. NAVAID (aircraft navigational devices).
5. Aircraft arresting barriers.
6. Aircraft maintenance, rearming, and refueling areas.

Other EOC specified locations.

Reporting procedures

Report items found during damage assessment to the EOC using standardized reporting codes called *damage coordinates.* Record craters, UXOs, spalls, and bomblets types by the designating letters C, X, S, and B, respectively. The type is followed by letters and numbers describing the size and position of the item as seen in the table below (fig. 2–5). Depending on the item, there is either a single set of coordinates defining its center or a double set of coordinates describing both ends of a field. Craters and UXOs use single sets of coordinates; spall fields and bomblet fields use double sets of coordinates. You should be thoroughly familiar with damage coordinates so you can report and interpret damage quickly and accurately.

X	550	L	20	Description of the UXO									
C	340	R	35	D	30								
S	860	R	45	W	70	F	1120	L	15	W	120	N	100
B	1350	L	10	W	60	F	1615	R	30	W	40	N	250
TYPE OF DAMAGE OR ORDNANCE	DISTANCE DOWN PAVEMENT	DIRECTION LEFT OR RIGHT OF CENTERLINE	DISTANCE LEFT OR RIGHT OF CENTERLINE	DIAMETER OR WIDTH	SIZE OF WIDTH OR DIAMETER	FIELD IDENTIFIER	DISTANCE DOWN PAVEMENT	DIRECTION LEFT OR RIGHT OF CENTERLINE	DISTANCE LEFT OR RIGHT OF CENTERLINE	WIDTH	SIZE OF WIDTH	NUMBER	NUMBER OF SPALLS OR BOMBLETS
				Shaded area represents mandatory coordinate items.									

Figure 2–5. Plotting airfield damage.

As the ADATs encounter damage and UXOs, they report their coordinates to the EOC. Make reports as soon as possible because MAOS selection teams use this information to select an MOS for repair. Use radios to report the damage. If radios are not available, use a telephone or runner. The ADAT and the EOC both keep a written log of each item reported.

The log in the table below contains examples of the item numbers, coordinates, and descriptions. This log is important when cross-referencing ADAT and MAOS selection team coordinates. The team can refer to these logs if they suspect a mistake, or if they need more information about a particular item.

Example Damage Assessment Report Log		
Item #	**Coordinates**	**Description**
1	X550L20	UXO. GREEN, FINS, 18 FEET LONG, YELLOW BAND AT FRONT.
2	C340R35D30	30 FEET CRATER, LOT OF DEBRIS, UPHEAVED PAVEMENT, NO VISIBLE UXO.
3	S860R45W70F1120L15W120N100	APPROX 100 SPALLS, MAX DEPTH APPROX 4 INCHES.
4	B1350L10W60F1615R30W40N250	APPROX 250 BOMBLETS, GREEN, SPHERES.

Crater coordinates

Craters are airfield damage that penetrates the full depth of pavement. Upheaval is pavement pushed up and away from the crater's center. The ADAT will give the apparent diameter of craters. The full repair size is the apparent crater diameter plus the upheaval. The EOC doubles the apparent size to estimate the repair size. The ADAT always delivers the *apparent* size of damage.

Since a crater is a hole with a central location, report them as a single coordinate. The coordinate will tell the damage plotters the distance from the runway threshold, the distance right or left of the centerline, and the crater's *apparent* diameter. Figure 2–6 shows that the apparent diameter is the void created by the blast.

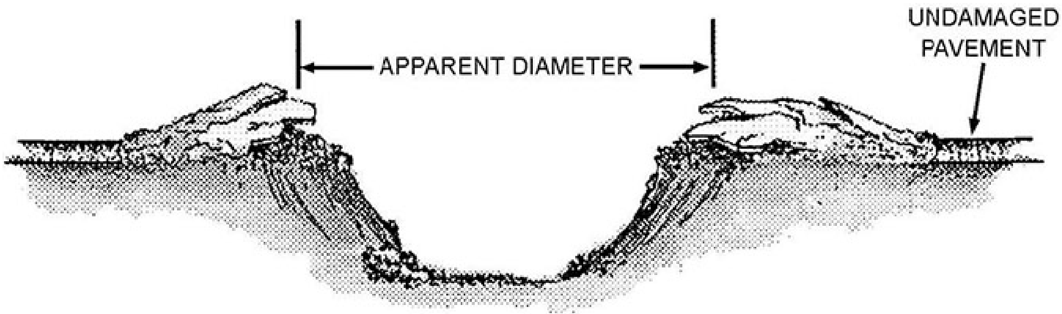
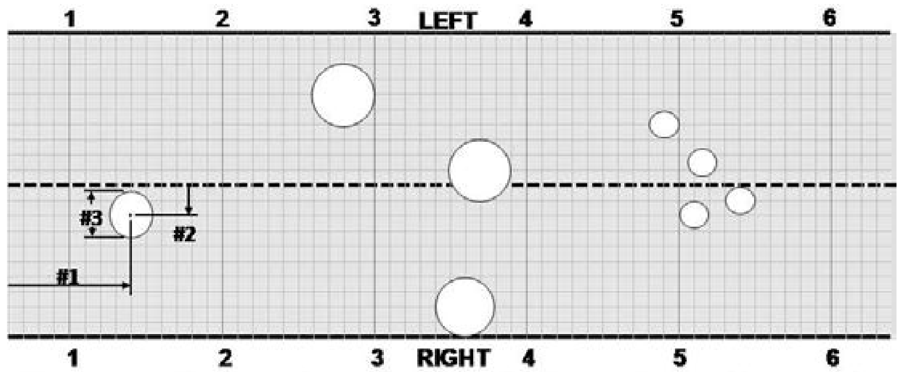


Figure 2–6. Typical crater.

The bottom-left of figure 2–7 lists crater coordinates. These correlate with the craters plotted on the runway map. The steps in the figure describe how to find the coordinates. One hundred foot increments separate the markers on the edge of the runway. On the airfield pavement map, created during pre-attack preparation, each square represents 10 feet. When collecting damage information, you need to estimate to the best of your ability using the most expedient method possible.

Consider this example: Crater C280L60D40 is the first one plotted on the left of figure 2–7. The designator is *C* for Crater, and it is 280 feet from the threshold, or zero point. Next, the designator *L* shows it is **left** of the centerline 60 feet. Designator *D* shows that the *apparent* **diameter** is 40 feet. When filling in the report log, describe the crater in a sentence, and include pertinent information like UXO presence, or water or fluids in the crater. When called over the radio, this coordinate is spoken, "Charlie two-eight-zero, Lima six-zero, Delta four-zero."



Step 1. Determine the distance of crater from beginning of pavement. (140 feet)

Step 2. Determine distance left or right of runway centerline. (20 feet, right)

Step 3. Determine the apparent diameter of the crater. (30 feet in diameter)

Step 4. Enter data in your log, and report damage to the SRC. Example coordinates: C140R20D30

Other coordinates:
C280L60D40
C360R80D40
C370L10D40
C490L40D20
C510R20D20
C515L15D20
C540R10D20

Figure 2–7. Crater location reporting.

Unexploded ordnance coordinates

A UXO is a munition (i.e., mortar, artillery, bomb, etc.) that launched but, for unknown reasons, did not detonate. This makes UXOs potential craters or spalls. Defer to the assigned EOD technician for UXO safety proximity. When traveling by vehicle, pass large UXOs from the opposite edge of the pavement or leave the pavement altogether. Before you leave the pavement, make sure you will not encounter other UXOs or get the vehicle stuck.

Report UXOs using the same process as craters. The assessment team members only need to give a coordinate with the distance from threshold, and the distance left or right of the centerline, as you can see in figure 2–8. In logs, record a description of the UXO. The EOD representative in the EOC will estimate the blast radius based on the description and help plot it accordingly. The first of the coordinates in figure 2–8 is reported over the radio as, “X-ray three-seven-zero, Lima five-zero,” followed by a general description.

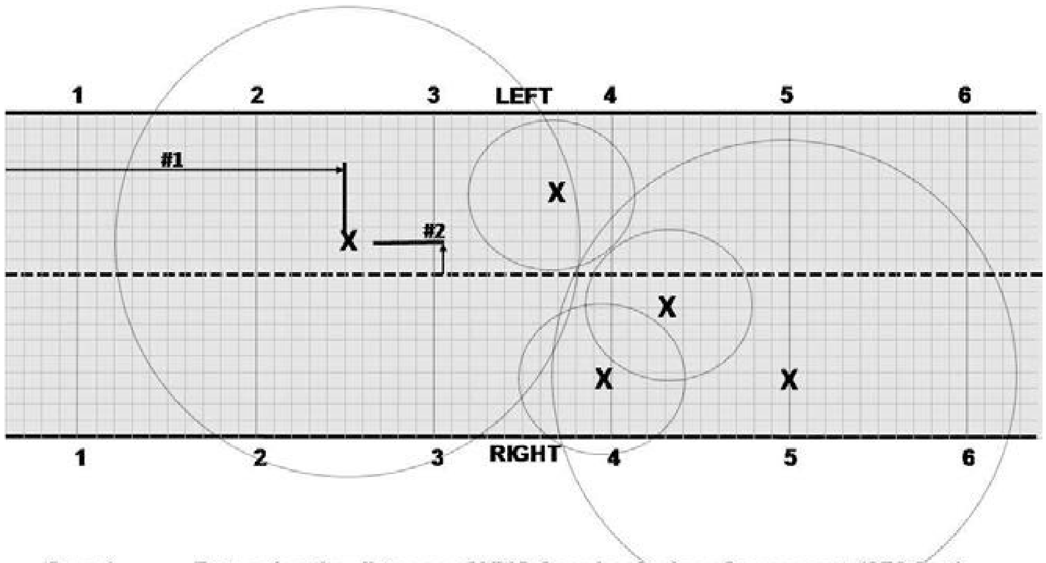
Bomblet and spall field coordinates

Spall and bomblet fields differ from craters and UXOs in that they have a double coordinate system. There are fourteen parts to this type of coordinate as opposed to the six parts of a crater coordinate. First, just like craters, measure the distance down the runway and distance right or left of the centerline for the beginning of the spall field. The example in figure 2–9 shows *S* for Spall field, 355 feet from the runway threshold. Next, the *center* of the spall field begins 50 feet right of centerline, or *R*50. At its beginning, the field is 50 feet wide, or *W*50. Repeat the same steps for the far end of the spall field, beginning with an *F*, for field. In the example, the field finishes at 475 feet, or *F*475. Repeating the initial steps, you report the end of the field at 40 feet left of the centerline, *L40*, and 75 feet wide, *W*75. Last, the *estimated* number of spalls is 45, or *N*45. The entire field coordinate is S355R50W50F475L40W75N45. This coordinate is read over the radio as, "Sierra three-five-five, Romeo five-zero, Whiskey five-zero, Foxtrot four-seven-five, Lima four-zero, Whiskey seven-five, November four-five."

The steps presented in the spall example are the same for reporting a bomblet field. The only difference is that you will need to add a description and estimated number of the bomblets in the field.

Camouflets

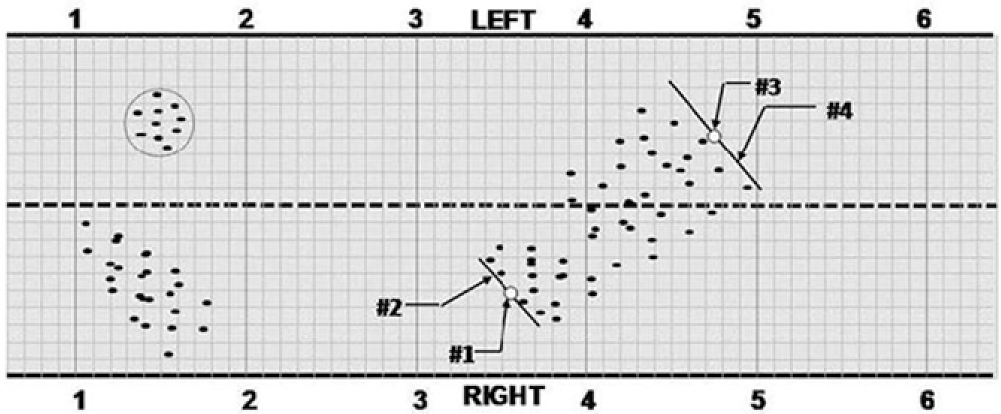
Camouflets occur when a munition penetrates the surface of the pavement and detonates underground, causing a void underneath the pavement. If you get too close, the ground could collapse under you. The gases produced by the exploding munitions also release and may be toxic or flammable. If you must approach a camouflet, be sure you are wearing a safety rope. When plotting, treat camouflets like craters. Record and communicate the opening of the camouflet and estimate the cavity sizes, send as two separate damage coordinates—one for the cavity and the other for the potential crater size.



Step 1. Determine the distance of UXO from beginning of pavement. (250 feet)
Step 2. Determine distance left or right of runway centerline. (20 feet, left)
Step 3. Plot this location on your map with a "X".
Step 4. Plot the "area of effect" of the UXO. This data will be given to you by the EOD representative in the SRC.
Example coordinates: X250L20 (Description)

Other plotted coordinates:
X370L50 (With radius of effect)
X395R65 (With radius of effect)
X430R20 (With radius of effect)
X425R65 (With radius of effect)

Figure 2–8. UXO location reporting.



Step 1. Locate the distance of the beginning entry point of the spall field from the beginning of the pavement. (355 feet approximately.)
Step 2. Determine the distance left or right of the runway centerline of the center of beginning of the spall field. (50 feet, right.)
Step 3. Determine the approximate width of the beginning of the spall field. (50 feet.)
Step 4. Locate the distance of the ending center point of the spall field from the beginning of the pavement. (475 feet, approximately.)
Step 5. Determine the distance left or right of the runway centerline of the center of the end of the spall field. (40 feet, left.)
Step 6. Determine the approximate width of the end of the spall field. (75 feet.)
Step 7. Determine the approximate number of spalls in the field. (45 spalls.)
Step 8. Enter data into your log, and report damage to the SRC. Example coordinates: S355R50W50F475L40W75N45

Other coordinates:
S150L50D40N10 (You can call them in as diameters, it saves time.)
S100R10W20F170R80W40N25

Figure 2–9. Spall/bomblet field location reporting.

Military grid reference system coordinates

The MGRS is the best way to communicate damage outside of the runway's PRMS. A military map has vertical lines (top to bottom) and horizontal lines (left to right). These lines form small squares 1,000 meters on each side called grid squares. The lines that form grid squares number along the outside edge of the map picture. No two grid squares have the same number. There is only one rule to remember when reading or reporting MGRS grid coordinates: always read to the RIGHT and then UP. The first half of the reported set of coordinate digits represents the left-to-right (easting) grid label, and the second half represents the label as read from the bottom to top (northing). The grid coordinates may represent the location to the nearest 10-, 100-, or 1,000-meter increment. The number of digits in the coordinates shows the precision of a point location; the more digits, the more precise the location such as:

- 1996 – 1,000-meter grid square.
- 192961 – to the nearest 100 meters.
- 19269614 – to the nearest 10 meters.

Your address is grid square 1181 on figure 2–10. To determine this, start from the left and read right until you come to 11, the first half of your address. Then read up to 81, for the other half. Your address is somewhere in grid square 1181.

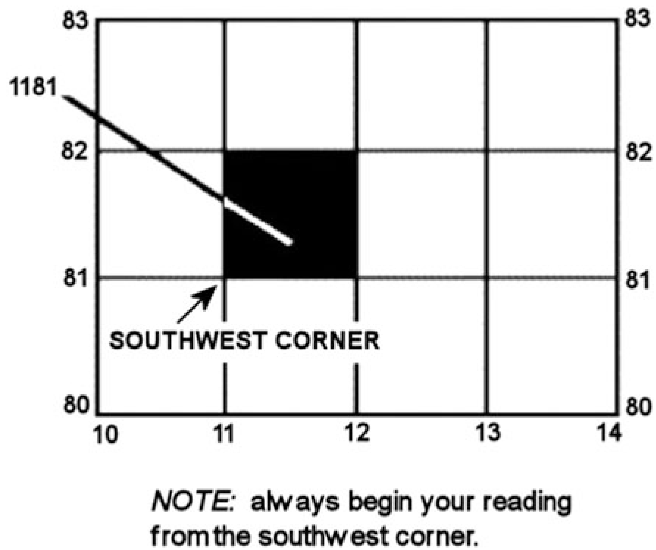


Figure 2–10. Determining a six-digit grid coordinate.

Grid square 1181 gives your general neighborhood, but there is a lot of ground inside that grid square. To make your address more accurate, just add another number to the first half and another number to the second half by dividing the grid square into ten more boxes. Your address now has six numbers instead of four, which brings the coordinate accuracy within 100 meters instead of 1,000 meters.

When plotting damage coordinates, using MGRS replace the PRMS coordinates with MGRS coordinates. A spall field damage coordinate such as S1000R10W20F1500L15W10N40, translates to MGRS as an 8-digit MGRS coordinate as S19269614W20F19299619W10N40. It is important to inform the EOC about the damage coordinates you are sending in MGRS.

613. Performing minimum airfield-operating surface selection team

The MAOS selection team, in the EOC, receives damage coordinates from ADATs as they complete their routes. The MAOS team plots the damage coordinates on a map in the EOC. This map is for EOC situational awareness as well as the MAOS selection team. The MAOS team then prepares MOS options for the installation commander. After the commander selects a single MOS, the MAOS selection team will calculate the allowable "sag" or "bump" in crater repairs. The "sag" or "bump" is the difference in surface height between the repair and the existing/undamaged pavement, measured in terms of RQC. RQC is covered in greater detail in a later lesson. When the minimum needed repairs are complete, aircraft will use the MOS as a launch and recovery surface to continue the mission.

Minimum airfield-operating surface plotting kit

If the installation performs damage assessment and tracking using automated mapping tools, such as a geographic information system (GIS), the kit may include that software, but sufficient backup capability must be available. The MAOS team should train regularly, on both software and legacy methods, to ensure wartime-unique skills are ready and equipment is sufficient. Though not all-inclusive, the following list should be the minimum items available to the MAOS selection team:

1. Transparent material for making MOS templates (e.g., clear acetate or Plexiglas).
2. Plotting board.
3. Critical-resource charts found in AFTTP 3–32.12, *Minimum Airfield Operating Surface (MAOS) Selection and Repair Quality Criteria*.
4. Straight edge, engineer scale, and transparent circle templates with decimal units matching the airfield map scale.

5. AFTTP 3–32.12.
6. Markers, pens, and pencils.
7. Damage reporting/recording forms (RQC).
8. Base map – 1:4800 (1″ = 400′) scale with MGRS.

Airfield map – 1:1200 (1″ = 100′) scale with MGRS and the runway identifier and station marker posts indicated. Ideally, the runway portion of the airfield map should be lightly partitioned in 10 feet increments to ease and expedite plotting.

Pre-attack actions

When an attack is imminent, the EOC calls the MAOS selection team. The backup MAOS selection team will report to the CE-UCC and/or alternate EOC. It is the primary MAOS team's responsibility to contact the EOC director/manager for expected aircraft operations, gross weights of mission aircraft, and the capability for a unidirectional or bidirectional MOS. The MAOS team will contact base weather for the current and projected weather conditions, determine operational lengths for mission aircraft, and conduct communications checks with the CE-UCC, ADATs, and alternate EOC.

Plotting airfield damage

As the ADATs radio in damage coordinates, the MAOS selection team plots each item directly on a standard-sized airfield map (1:1200 scale). The runway on the map divides into one hundred-foot increments, and each increment further divided into ten-foot grids. The one hundred-foot increments represent the PRMS distance markers on the physical runway. This makes it much easier to plot damage left, right, and along the centerline by counting the squares. Engineering personnel on the MAOS selection team must be certain they plot damage in the same way the ADAT collected it.

Craters

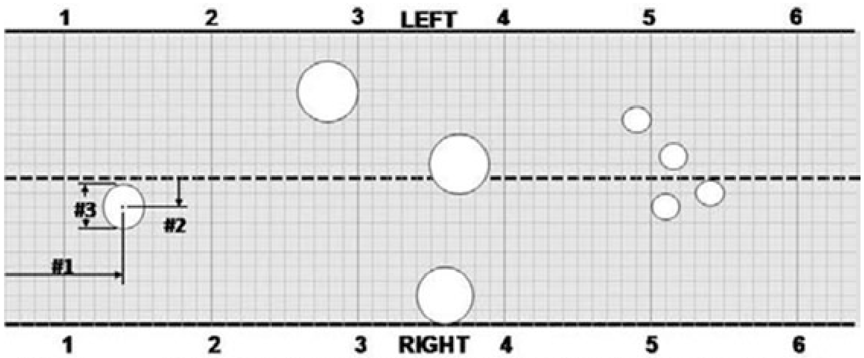
Draw craters as circles on the airfield map, with the apparent crater diameter noted inside the circle (fig. 2–11). Draw crater damage at twice the apparent diameter to include estimated upheaval. Actual repair diameter will depend on how much upheaval needs to be removed during repair. This is not known until the repair crews perform crater profile measurements (CPM). Ignore step four in figure 2–11 when plotting as it applies to ADATs only.

Unexploded ordnances

Symbolize UXOs as "Xs" on the map. Place the item number (from the ADAT report log) next to the "X" for reference. Also, plot the UXO's "radius of effect" (the area of effect if the UXO detonates). Symbolize the radius of effect as a large, dashed circle drawn around the UXO. EOD personnel in the EOC will provide the size of the radius of effect. Follow the steps in figure 2–12 to plot UXO damage coordinates.

Spall and bomblet fields

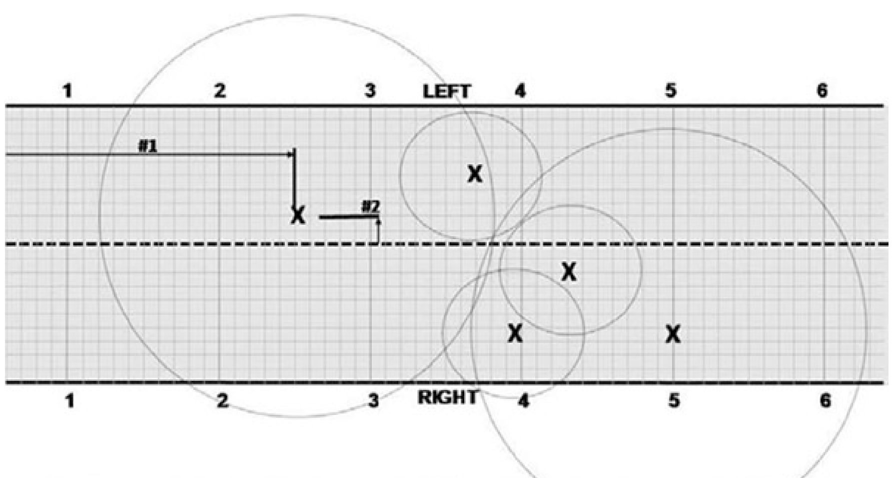
Plot spall and bomblet fields as polygons. The coordinates for these polygons split at the "F" identifier. The first half provides the position and width of the first side of the polygon. The second half provides the same for the opposite side. We draw a line between these two points, and *then* draw both sides perpendicular to this connecting line. Draw the widths, then connect their endpoints to complete the polygon. Finally, place the estimated number of spalls or bomblets within the polygon. See figure 2–13 for field plotting procedures.



Step 1. Determine the distance of crater from beginning of pavement. (140 feet)
Step 2. Determine distance left or right of runway centerline. (20 feet, right)
Step 3. Determine the apparent diameter of the crater. (30 feet in diameter)
Step 4. Enter data in your log, and report damage to the SRC. Example coordinates: C140R20D30

Other coordinates:
C280L60D40
C360R80D40
C370L10D40
C490L40D20
C510R20D20
C515L15D20
C540R10D20

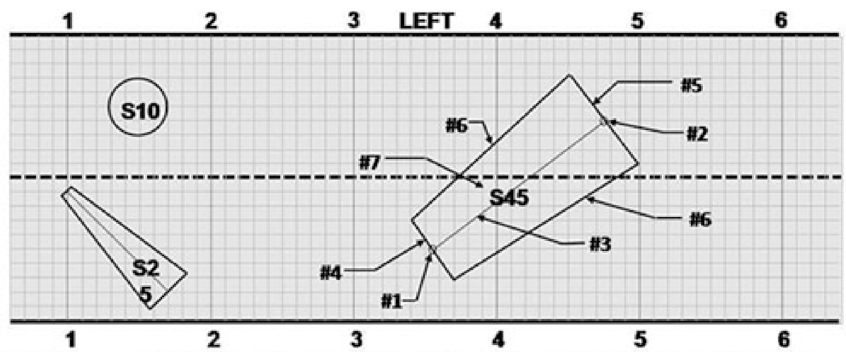
Figure 2–11. Crater plotting.



Step 1. Determine the distance of UXO from beginning of pavement. (250 feet)
Step 2. Determine distance left or right of runway centerline. (20 feet, left)
Step 3. Plot this location on your map with a "X".
Step 4. Plot the "area of effect" of the UXO. This data will be given to you by the EOD representative in the SRC.
Example coordinates: X250L20 (Description)

Other plotted coordinates:
X370L50 (With radius of effect)
X395R65 (With radius of effect)
X430R20 (With radius of effect)
X425R65 (With radius of effect)

Figure 2–12. UXOs plotting.



Step 1. Plot the beginning center point of the field from the beginning of the pavement, and the correct distance left or right of the runway centerline. (355 feet down, 50 feet right)

Step 2. Plot the ending center point of the field from the beginning of the pavement, and the correct distance left or right of the runway centerline. (475 feet down, 40 feet left)

Step 3. Connect the beginning and ending center points.

Step 4. Plot the beginning width perpendicular to the line drawn in step 3.

Step 5. Plot the ending width perpendicular to the line drawn in step 3.

Step 6. Plot the left and right edge lines connecting the end points of the width lines drawn in steps4 and 5.

Step 7. Label the field with either an "S" or a "B" designating the field as a spall field or bomblet field, and add the number of spalls or bomblets.

Example coordinates: S355R50W50F475L40W75N45

Other coordinates:
S150L50D40N10 (You can call them in as diameters, it saves time.)
S100R10W20F170R80W40N25

Figure 2–13. Spall and bomblet field plotting.

Other damage

Take note of the maps in the equipment list at the beginning of this lesson. Both maps call for MGRS. Use an MGRS grid when damage occurs outside of the runway. Only the runway has a PRMS, and that is only if established beforehand. In areas other than the runway or if the runway has no PRMS, you will use MGRS coordinates in the damage coordinates. Simply replace the distance from the threshold, and the distance left or right of the centerline with the appropriate MGRS coordinates. The overall format will remain the same.

614. Selecting minimum operating strip candidates

After plotting all the damage coordinates, the MAOS selection team members develop potential MOSs for recommendation to the installation commander. After MOS approval, the EOC director sends EOD to clear UXOs in the area. Once cleared, teams dispatch to repair craters and spalls, clear debris, repair airfield collateral damage, and mark the MOS location.

The goal of MOS candidate selection is to locate the best available MOS within 30 minutes. The best MOS is the MOS that can be prepared to launch and recover aircraft in the least amount of time. The MOS selection process is flexible enough to identify the best option under a wide variety of circumstances; the following is an overview of considerations.

Minimum operating strip dimensions

EOC personnel provide known requirements of expected aircraft, mission objectives, weather, and environmental conditions that drive MOS dimensions. Communication with ESF and airfield operations personnel is critical when determining MOS dimension requirements. However, the installation commander has the final say regarding MOS dimensioning.

Aircraft/operation requirements

Consult EOC personnel to collect information on what type(s) of aircraft will use the MOS and if each type will be landing only, taking off only, or both. When considering landing, determine whether the aircraft will use regular braking or an arresting system. An arresting system affects the length of the MOS by reducing the distance required to stop. Figure 2–14 illustrates the general rule when existing arresting systems are available. Certain takeoff circumstances require an evacuation strip. Evacuation is a minimum gross-weight takeoff, requiring the shortest amount of pavement for take off of the specified aircraft.

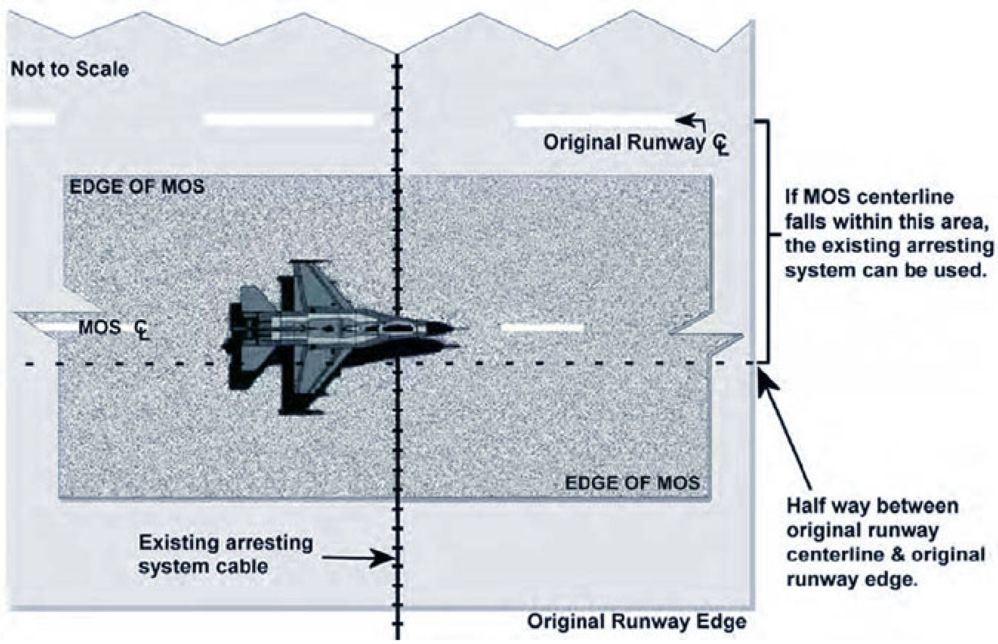


Figure 2–14. Requirements for use of existing AAS.

Unidirectional or bidirectional minimum operating strip

A MOS can be unidirectional (take off and land in one direction on the MOS or the other, not both) or bidirectional (take off and land in both directions). This decision affects repairs in landing zones, which require stricter RQC and, therefore, more time to repair. Wind conditions also affect the direction requirement, since it is desirable for aircraft to take off with a head wind to generate more lift. One of the major obstacles to using a bidirectional MOS is the NAVAID. A bidirectional MOS needs two sets of most major NAVAIDs, such as precision approach path indicators (PAPI).

Minimum operating strip location

A MOS may be located on the main runway, on a parallel taxiway, or even on an alternate launch and recovery surface on or off base (an empty stretch of interstate, or highway). The MOS location affects LOR status by limiting access and egress, air traffic control, the types of aircraft, or by restricting the flight approach of aircraft.

Sortie generation

Aircraft should be able to get to and from the MOS quickly. Accessibility (access/egress) is the efficiency of the routes aircraft take to reach the MOS for takeoff and leave the MOS upon landing. Sortie generation is the rate at which aircraft land, repair, refuel, load with munitions, and take off again.

Access/egress limitations

Inadequate access or egress forces aircraft to taxi on the MOS, slowing the rate of LOR (and, therefore, sortie generation). At least two access routes are desired, preferably one at each end of the MOS. There are three primary access/egress limitations listed in the table below.

Access/Egress Limitations	
Cul-de-sac	The term cul-de-sac refers to a taxiway-access route requiring an aircraft to taxi back on the MOS before takeoff or after landing.
Only one access route	A MOS with a single-access route requires aircraft to taxi the length of the MOS before takeoff or after landing.
Taxi distance	Selecting a MOS that is located off base or has a long taxiway route will reduce LOR capability and time to first launch. In addition, taxiing aircraft will spend more time in an exposed, vulnerable condition.

A MOS with only one access route has reduced launch and recovery capabilities. If damage is high, operations may begin with one access route; as repair teams become available, more routes become usable. Figure 2–15 shows a taxiway blocked by crater damage.

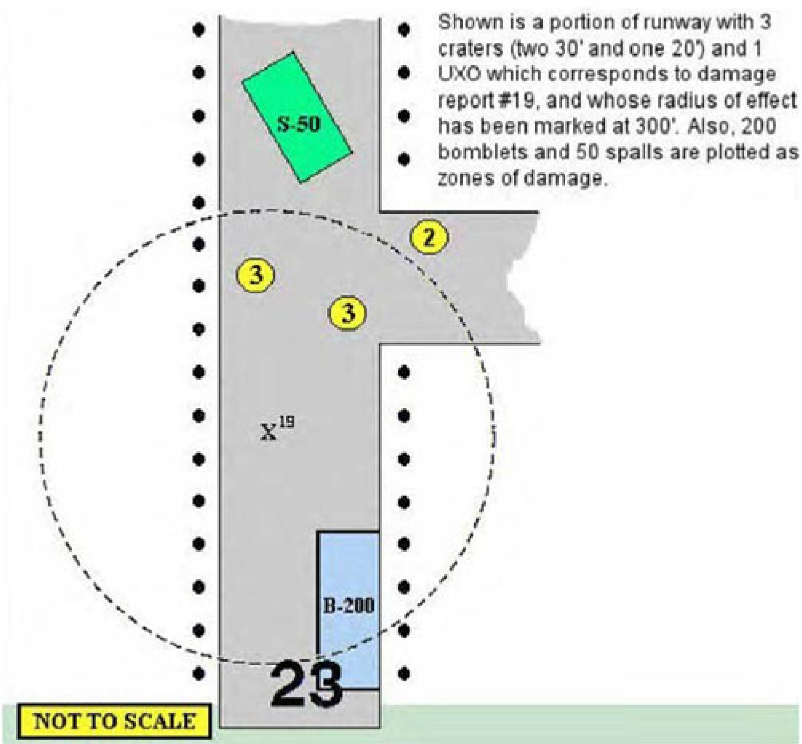


Figure 2–15. Example of damage plots.

Taxiway widths

Gather data on taxiway requirements early in the selection process. The taxiway widths and the sizes of aircraft they support are of primary concern. Figure 2–16 shows minimally accepted repaired taxiway widths for common aircraft. The EOC personnel are the best source for information regarding taxiway width requirements.

Aircraft	Repaired Width (Feet)
F-15/16/22, A-10/7	25
C-130 30	
C-17 50	
C-5, KC-10, B-747	60
KC-135 75	

Figure 2–16. Minimally accepted repaired taxiway width criteria.

Evaluating a candidate minimum operating strip

Using the above considerations, you should have several ideas for MOS candidates. Ranking these options and preparing your three best candidates to present to the installation commander is the next challenge. It is best to receive input from EOC members on selections, especially the CE personnel because of their experience. Keep in mind that you must have at least three MOS candidates to provide to the installation commander within 30 minutes of the final damage coordinates.

Engineering repair times

Repair times are a discussion you will have with the CE ESF and/or the UCC. Availability of vehicles, equipment, and material directly affect MOS repair times. Three equipment packages (R–1, R–2, and R–3) are available to manage crate repair requirements. Each package supports a defined crater repair requirement. For example, the R–1 set will only provide enough vehicles and equipment to repair three 50-foot (large) bomb craters within a 4-hour period; whereas, an R–3 set will provide enough assets to allow a properly manned team to repair a total of 12 large craters within the same 4-hour time limit. Figure 2–17 shows estimated crater repair times.

Apparent Diameter	Repair Time First Crater	Additional Time For 2nd Crater	Total Repair Time For Both Craters
5-20 feet	65 minutes	35 minutes	100 minutes
>20 feet	155 minutes	65 minutes	220 minutes
NOTE: Times reflected are for both AM-2 and folded fiberglass mat repairs conducted under ideal environmental conditions with a complete vehicle/equipment complement utilized by a highly trained and capable team. Estimates do not include travel times to repair locations.			

Figure 2–17. Estimated crater repair times for a dual crater repair.

Explosive ordnance disposal time estimates

The EOD representative in the EOC will estimate the UXO clearance times for candidate MOSs. In addition, they will prioritize EOD activities before airfield repair can begin. The input from the EOD representative is critical to MOS selection and evaluation. It is possible that disapproval of the MOS with the least crater repair work occur because of extensive UXO safing and clearing requirements.

Navigational aids

Consider the availability of NAVAID such as PAPI and airfield lighting. If NAVAID are inoperative, what will it take to put them back in service? Are mobile NAVAID units available? If NAVAID will be out of service for an extended period, how does that affect MOS preparation times? The more questions you ask, the better prepared you are to brief the installation commander.

Commencement of repairs

Once the commander selects a particular MOS to repair, the base civil engineer (BCE) informs the UCC. The UCC dispatches repair teams that begin work on the airfield. At the same time, the EOC directs the EOD technician to dispatch the UXO safing and bomb removal teams. The UXO and bomb removal teams clear the repair team's route to the MOS, and the MOS itself, of munitions.

The EOC staff provides details of the selected MOS to the UCC and alternate EOC. This information includes length, width, MOS location, aircraft turning radii, access/egress route width, sweeping width, and times for ancillary equipment installation (e.g. airfield lighting, etc.). The EOC and UCC staffs must effectively communicate to ensure recovery instructions and requirements are clear.

Minimum operating strip naming

Review the method of identifying the basic information pertaining to a selected MOS in figure 2–18. The process uses the same principles as recording, calling in and plotting airfield damage. When forwarding MOS information to the UCC, it is important to include data that indicates the direction of travel for a unidirectional MOS. The best method for doing so is to include the compass heading. For example, on a 06-24 runway, the indication would be either "compass heading 060" if aircraft travel is from the 06 end to the 24 end, or "compass heading 240" degrees if aircraft travel is from the 24 end to the 06 end.

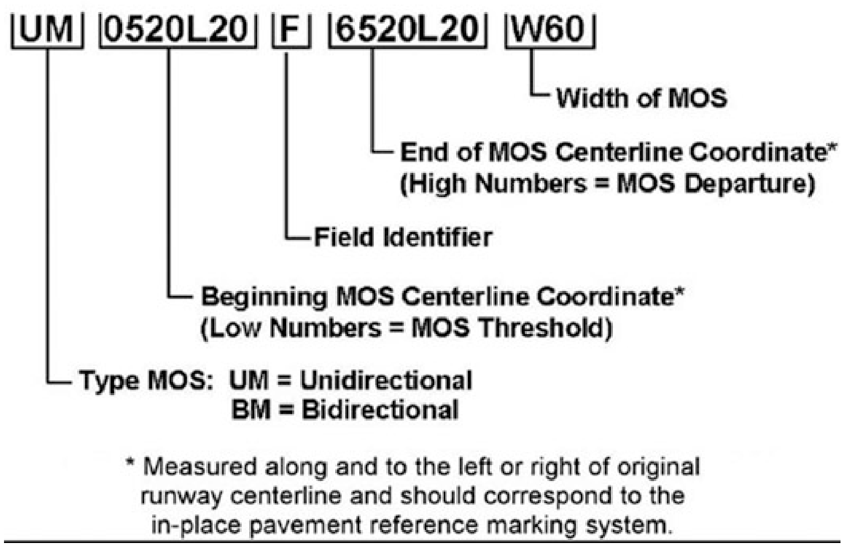


Figure 2–18. MOS identification coordinates.

As airfield recovery progresses, the MOS selection team calculates RQC for the crater repairs, monitors the repair processes, and updates the appropriate maps and charts to indicate the airfield repair's progress.

615. Calculating repair quality criteria

RQC are a value calculated to determine the minimum quality of repair for craters on the runway. RQC is a number representing the allowable "bump" or "sag" of a repair. Every aircraft type has different requirements for takeoff and landing. This means we calculate RQC value for each aircraft type and whether the aircraft are taking off or landing. The process of calculating the RQC is the responsibility of the MAOS selection team in the EOC. Find further guidance governing RQC calculation in AFTTP 3–32.12.

This part of the text covers the procedure for RQC calculation step-by-step. Attention to detail is important here because of the amount of information and the paperwork required for this task.

Step 1 – Environmental Data (Worksheet 1)

The first thing you, as a member of the MAOS team, should do upon arrival to the EOC is collect information. Worksheet 1 records all the environmental data we need to determine the RQC (fig. 2–19).

WORKSHEET 1 - REPAIR QUALITY CRITERIA (RQC) ENVIRONMENTAL DATA							
TEMPERATURE (°F)			MOS THRESHOLD *(Feet)*		RUNWAY SURFACE CONDITION (RSC)		
ALTITUDE (Feet)			DEPARTURE END *(Feet)*		Condition *(Choose One)*		DRY ☐ WR ☐ SLR/LSR/PSR/IR ☐
DENSITY RATIO			MOS LENGTH *(Feet)*		Condition Depth *(Estimated to Nearest Tenth)*		__.__ Inch
OPERATION NUMBER	AIRCRAFT MODEL	GROSS WEIGHT *(Lbs)*	OPERATION	SPECIAL LANDING PROCEDURES	DIRECTION *(Choose One)*	CHART	OPERATION LENGTH *(Feet)*
					☐ FROM MOS THRESHOLD ☐ FROM DEPARTURE END		
					☐ FROM MOS THRESHOLD ☐ FROM DEPARTURE END		
					☐ FROM MOS THRESHOLD ☐ FROM DEPARTURE END		
					☐ FROM MOS THRESHOLD ☐ FROM DEPARTURE END		
					☐ FROM MOS THRESHOLD ☐ FROM DEPARTURE END		
					☐ FROM MOS THRESHOLD ☐ FROM DEPARTURE END		
					☐ FROM MOS THRESHOLD ☐ FROM DEPARTURE END		
					☐ FROM MOS THRESHOLD ☐ FROM DEPARTURE END		
RSC: WR=WET RUNWAY	SLR=SLUSH ON RUNWAY		LSR=LOOSE SNOW ON RUNWAY		PSR=PACKED SNOW ON RUNWAY		IR=ICE ON RUNWAY

Figure 2–19. Worksheet 1.

Aircraft Model and Gross Weight columns

First, fill in the Aircraft Model and Gross Weight columns. Speak with airfield operations in the EOC to find aircraft model information. Record the gross weight found in the upper-right corner of the aircraft model's operation chart found in AFTTP 3–32.12, Attachment 3, *Aircraft MOS Requirement Charts.*

Operation column

At a minimum, each aircraft model will have two operations—takeoff and landing. Evacuation is a third operation but is rare.

Special Landing Procedures column

In the Special Landing Procedures column, you will record aero braking, wheel braking, arrestment with chute and without chute, or leave it blank for none. If there is a special landing procedure, it should be a separate landing operation. An example is an F–16 with three operations—takeoff, landing, and a landing with arrestment.

Direction column

Next, check the box in the Direction column corresponding to the direction of the operation. This is relative to the MOS threshold and departure. There are normally takeoff and landing operations for each direction. An F–16 for example has takeoff from both the threshold and departure ends of the MOS.

Chart column

Each aircraft operation has an RQC calculation chart at the back of AFTTP 3–32.12, Attachment 3. In the Chart column on Worksheet 1, record the chart number that corresponds with the aircraft model and operation.

Temperature, altitude, and density ratio

In the top left of the worksheet, you will see three items to fill in. The temperature box will be the *highest* expected temperature for that *day*. The altitude is the pressure altitude taken from airfield operations or base weather measured from sea level. Calculate the density ratio (DR) using the DR table (fig. 2–20). To figure out the DR, begin at the bottom of the table and move right until you find the *highest* temperature value for that day. From that temperature, draw a vertical line up to the approximate pressure altitude line. You may have to make an educated guess to place the end of the line in the right position. Then, draw a horizontal line from the top of the vertical line to the left. The DR is the value where the horizontal line ends.

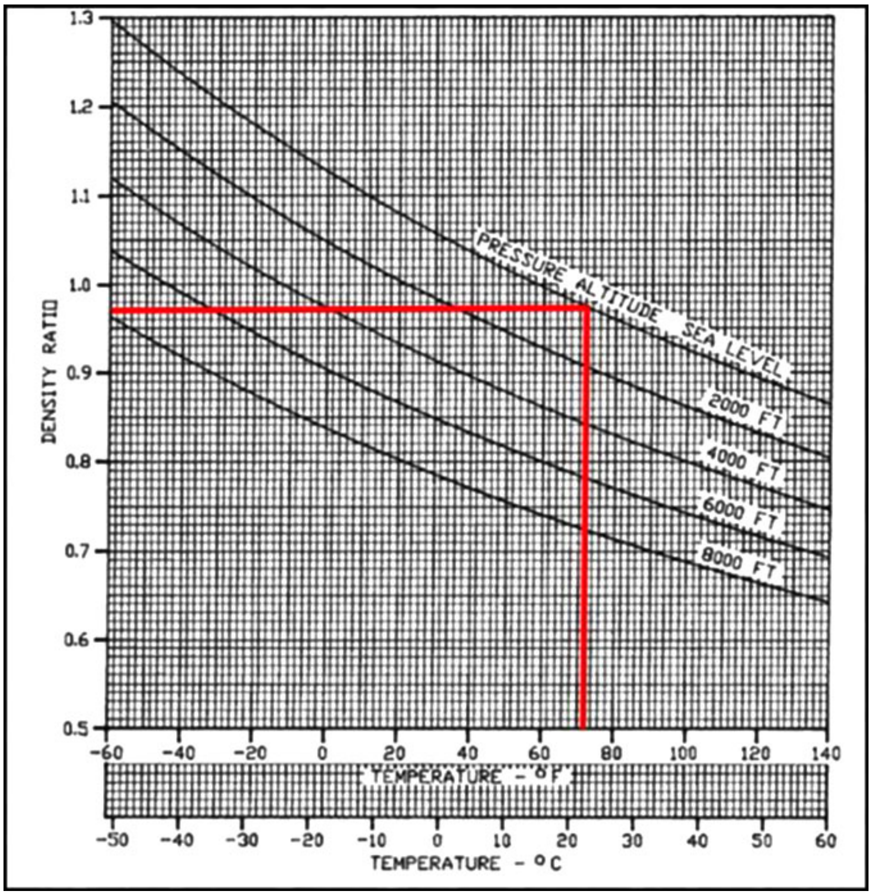


Figure 2–20. DR table use.

Runway surface condition

In the upper right of Worksheet 1, you will find the runway surface condition (RSC) items. Possible conditions include dry runway, wet runway (WR), slush on runway (SLR), loose snow on runway (LSR), packed snow on runway (PSR), and ice on runway (IR). The condition depth is the depth of the runway condition *estimated* to the nearest tenth of an inch.

Minimum operating strip threshold, departure, length

This will be where you place the position and total length of the final MOS selection by the installation commander. Since we are in step 1 and have only just arrived in the EOC, this is not important right now.

Step 2 – Operational Lengths (Worksheet 1)

The final column of Worksheet 1 is the operational lengths column. The operational length is the length of runway that a given operation needs, at a minimum, to be successful. Takeoff of an aircraft requires one length and landing requires a different length. We use the aircraft operation charts that we listed in the chart column to figure out what the operational lengths are. See figure 2–21 for the example explained below.

Procedure

1) Draw a horizontal line corresponding to the DR recorded on Worksheet 1 (our example is 0.97).
2) Draw another horizontal line in the RSC (condition) table corresponding to the condition type (the figure shows both wet, in blue, and dry, in red).
3) In the DR table, draw a vertical line from the intersection of the shaded region and your horizontal line, to the bottom of the RSC (condition) table.
4) If RSC (condition) is dry, draw a vertical line down from the intersection of the shaded region to the patch location chart and record the value on Worksheet 1 as the operational length.
5) If the RSC is not dry, follow the arcs from the bottom of the RSC table to the horizontal line corresponding to the RSC (condition) value.
6) From where the horizontal RSC line and the arc intersect, draw a vertical line down to the patch location chart and record the value on Worksheet 1 as the operational length.

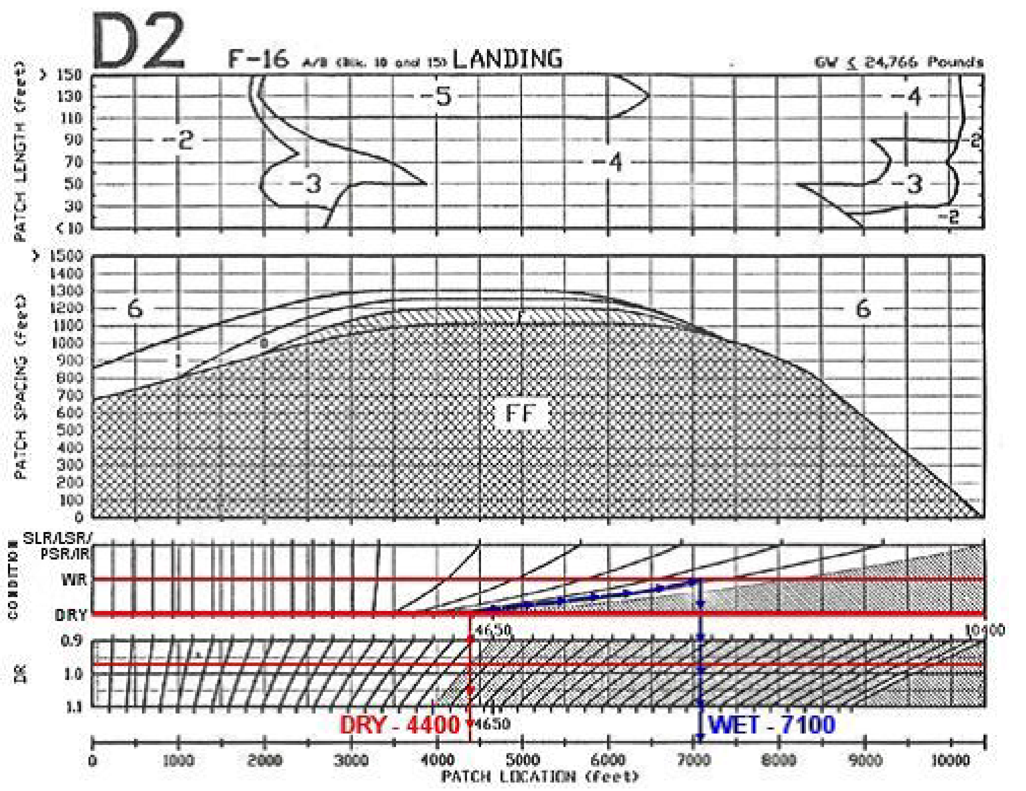


Figure 2–21. Determining operational lengths.

Step 3 – Define Repair Patches on the Takeoff and Landing Map

Now that Worksheet 1 looks like figure 2–22, we need to look at the take-off and landing (ToL) map. Let us fast-forward now to after an airfield attack and after MOS selection. After the ADAT team has delivered damage coordinates, the ToL map will have craters. We are going to draw repair patches and number them for cross reference.

WORKSHEET 1 – REPAIR QUALITY CRITERIA (RQC) ENVIRONMENTAL DATA							
TEMPERATURE (°F)		72	MDS THRESHOLD (Feet)		RUNWAY SURFACE CONDITION (RSC)		
ALTITUDE (Feet)		Sea Level	DEPARTURE END (Feet)		Condition (Choose One)		DRY ☒ WR ☐ SLR/LSR/PSR/IR ☐
DENSITY RATIO		.97	MDS LENGTH (Feet)		Condition Depth (Estimated to Nearest Tenth)		0.0 Inch
OPERATION NUMBER	AIRCRAFT MODEL	GROSS WEIGHT (Lbs)	OPERATION	SPECIAL LANDING PROCEDURES	DIRECTION (Choose One)	CHART	OPERATION LENGTH (Feet)
1	F-16B	33,000	Takeoff		☒ FROM MDS THRESHOLD ☐ FROM DEPARTURE END	D1	3,525
2	F-16B	22,800	Landing		☒ FROM MDS THRESHOLD ☐ FROM DEPARTURE END	D2	4,400
3	F-16B	22,800	Landing	Arrestment	☒ FROM MDS THRESHOLD ☐ FROM DEPARTURE END	D3	2,034
4	F-16B	33,000	Takeoff		☐ FROM MDS THRESHOLD ☒ FROM DEPARTURE END	D1	3,525
5	F-16B	22,800	Landing		☐ FROM MDS THRESHOLD ☒ FROM DEPARTURE END	D2	4,400
					☐ FROM MDS THRESHOLD ☐ FROM DEPARTURE END		
					☐ FROM MDS THRESHOLD ☐ FROM DEPARTURE END		
					☐ FROM MDS THRESHOLD ☐ FROM DEPARTURE END		
RSC: WR=WET RUNWAY	SLR=SLUSH ON RUNWAY	LSR=LOOSE SNOW ON RUNWAY	PSR=PACKED SNOW ON RUNWAY	IR=ICE ON RUNWAY			

Figure 2–22. Completed Worksheet 1.

Begin by drawing two lines, one at the beginning and one at end of the first crater from the operational threshold, perpendicular to the MOS centerline. This should make a dark shaded box-like in figure 2–23. Shade the areas between the lines. If the distance between two shaded areas is 25 feet or less, shade the area between them and consider them the same patch. Number each shaded-patch area starting from the MOS threshold.

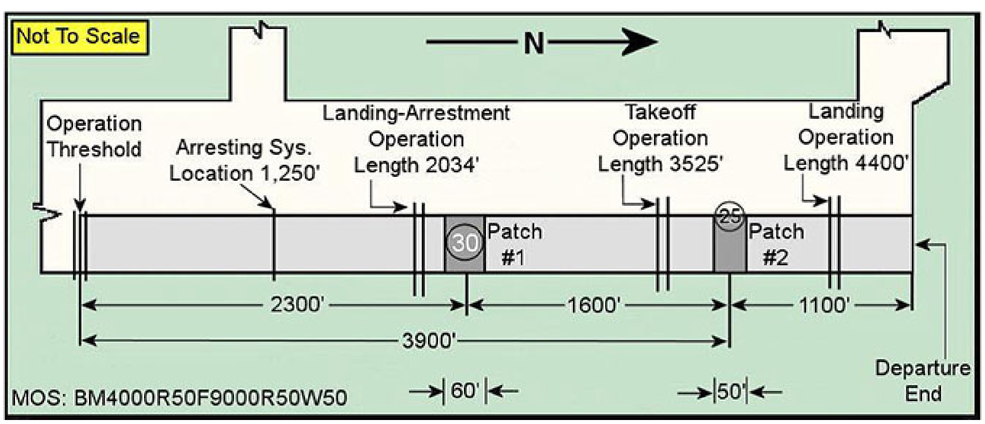


Figure 2–23. ToL map.

Second, mark the operational threshold and operation lengths. The operational threshold of the MOS is marked with two lines perpendicular to the MOS centerline. The operation lengths are marked the same way, as two lines, perpendicular to the MOS centerline. See figure 2–23 for an example.

Next, identify the patch locations. The patch location is the distance from the MOS threshold to the center of the shaded patch area. A good example is in figure 2–23, patch #1 is 2,300 feet from the threshold.

Finally, determine the patch spacing. The patch spacing value will be from one patch to another. The distance from the center of patch #1 to the center of patch #2 will be the first patch spacing. Continue recording the space between patches until you record the space between the last two shaded-patch areas.

Step 4 – Repair Quality Criteria Values (Worksheet 2)

After you have collected the patch locations, lengths, and spacing, you can fill in Worksheet 2. You use Worksheet 2 to record and calculate the RQC values. Like Worksheet 1, it is broken into columns and blocks (fig. 2–24).

MOS Threshold	3000	Operation #		1	2	3	4	5
Departure End	10000	Direction	Threshold	X	X	X	X	X
			Departure					
MOS Length (Ft.)	7000 x150	Operational Length (Ft.)		3300	6500	2051	2850	3625

Chart #	Op. # / Patch #	Patch Location	Patch Length	Patch Spacing	Uncorrected RQC	Correction Factor	RQC
D5	1/1						
	1/2						
D6	2/1						
	2/2						
	2/3						
	2/4						
D7	3/1						
	3/2						
G1	4/1						
	4/2						
G2	5/1						
	5/2						

Figure 2–24. Worksheet 2.

Chart Number

The Chart Number column holds the aircraft model operation chart. This is the same chart reference found on Worksheet 1. This column provides a quick reference to both Worksheet 1 and to the chart; we need to calculate the RQCs.

Operation Number / Patch Number

This column lists the operation number and its corresponding patches. The operation number is that length of MOS, from the threshold, needed to complete the operation referenced in the chart number column. The patch number is the reference number for the patch on the ToL map. An example would be, the landing operation of an F–16 is 4,400 feet long (operation number 1) and has two patches from the threshold (patches 1 and 2). Worksheet 2 lists these patches as 1/1 and 1/2.

Patch Location

The patch location is the distance the patch is from the MOS threshold. Input the values from step 3 into this column.

Patch Length

Patch length is the width of the shaded-patch area from edge of crater to edge of crater. Input the values from step 3 into this column.

Patch Spacing

The spacing is the distance from one shaded-patch area center to the next shaded-patch area center. Input the values from step 3 into this column.

MOS Block

In the upper right of the worksheet is the MOS block. The three rows are where to record the MOS dimensions and location. Input the location of the MOS threshold from the runway threshold in the “MOS threshold” box. Measure the location of the MOS departure end from the threshold of the runway. Finally place the dimensions, both length and width, of the MOS into the “MOS length” box.

Operation Block

In the upper left of the worksheet is the operation block. Record the operation numbers from Worksheet 1 into the “Operation #” box. Then, record the direction in which the operation occurs in the “Direction” box. Lastly, record the lengths of each operation in the “Operation Length” box.

Step 5 – Calculate Repair Quality Criteria (Worksheet 2)

In figure 2–24, there are three columns we have not addressed—Uncorrected RQC, Correction Factor, and RQC. In this step, we will address each column one after another.

Uncorrected repair quality criteria

First, take out the aircraft-model operation chart. At the bottom of this chart is the patch-location line. Mark the location of the patch (from Worksheet 2) on this line. Then, in the DR graph, draw a horizontal line from the DR value (from Worksheet 1). Now, draw a vertical line from the mark you made on the patch location line up to the horizontal line you made in the DR graph. Next, keeping the same distance along the curve, follow the nearest arc up to the top of the DR graph. Finally, draw a vertical line from the top of the DR graph to the top of the top most graph on the RQC chart.

NOTE: If your operation chart has an RSC graph, you will need to follow the closest arc from the bottom of the graph to the RSC value, continue your vertical line to the top of the top most graph on the RQC chart.

Your chart should now look similar to figure 2–25. After this prep work, we can finally determine the uncorrected RQC value. To do this, draw a horizontal line on the patch spacing graph starting at the patch spacing value for the repair (Worksheet 2). If there is only one patch, or repair, use the maximum value on the graph. The value of the area on the graph where the horizontal line and vertical lines intersect is the uncorrected RQC (fig. 2–25).

Correction factor

The process for calculating the correction factor and calculating the uncorrected RQC is the same. In the patch length graph, draw a horizontal line form the patch length value (Worksheet 2) across the graph. The point area upon which the horizontal and vertical lines intersect is the correction factor value. The correction factor will always be negative or zero.

Repair quality criteria column

The final step is to add the uncorrected RQC and the correction factor together. The sum of the two values is the final RQC for that repair patch. If the RQC value is negative, the repair must be flush or

"F." If the value in either the patch spacing or patch length graphs on the charts is "FF," then the repair patch and the repair patch immediately following are both flush repairs.

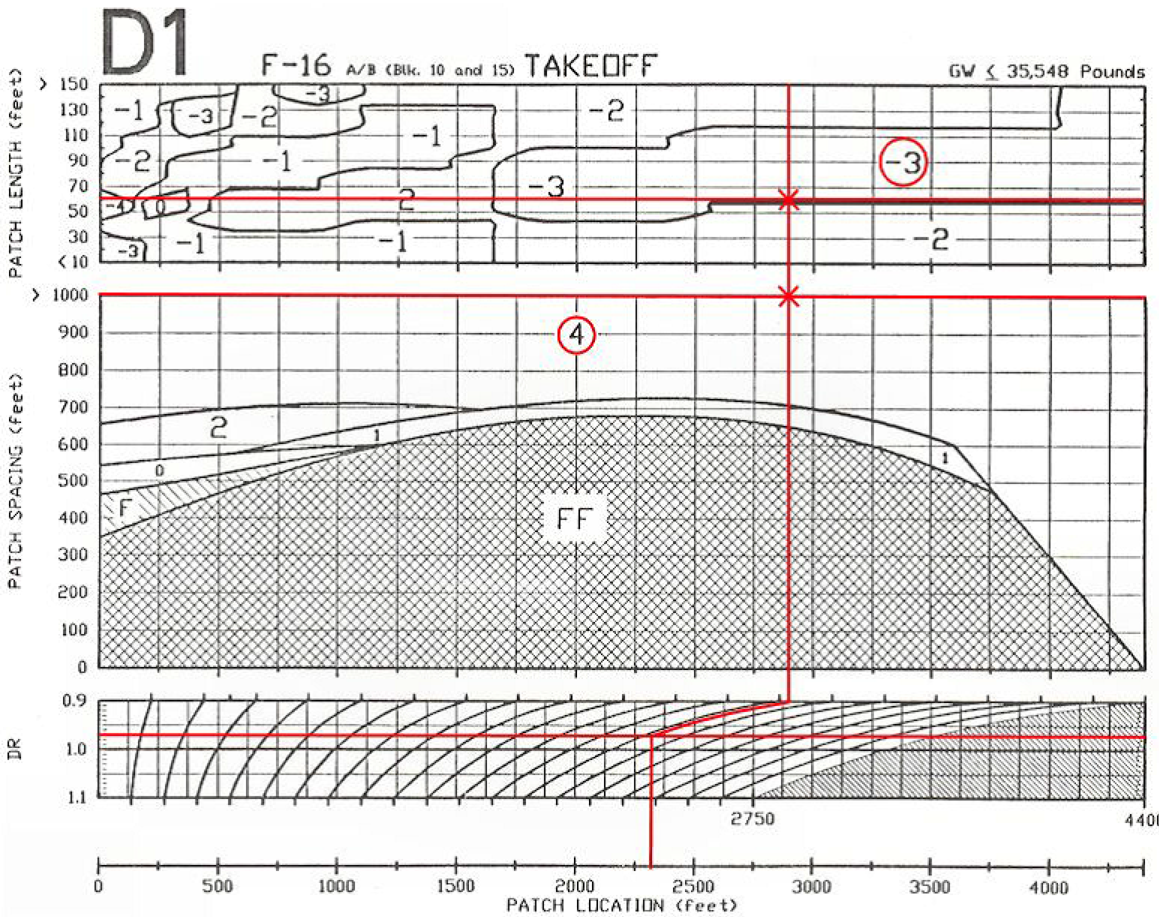


Figure 2–25. Example RQC procedure.

Crater profile measurement – repair quality criteria

When you calculate more than one RQC for the same repair, the most stringent value is the standard for the repair. Relay the value to the repair team and to the CPM team. The CPM team will then perform CPM procedures to verify the crater was repaired within allowable tolerance (adjusted RQC). Do this using the CPM stanchions, and the RQC rod. The RQC rod is on the opposite end of the CPM rod (fig. 2–26).

Figure 2–26. CPM team evaluating crater.

Adjust the rod

The first step is to adjust the rod to the RQC value. The bottom triangle of the rod is the "bump," which is the RQC. The top triangle is the "sag" and is 2 inches except when the repair sits flush (F) or flush follows (FF) (fig. 2–27). If the RQC is F or FF, then the "sag" and the "bump" will both be set to 3/4."

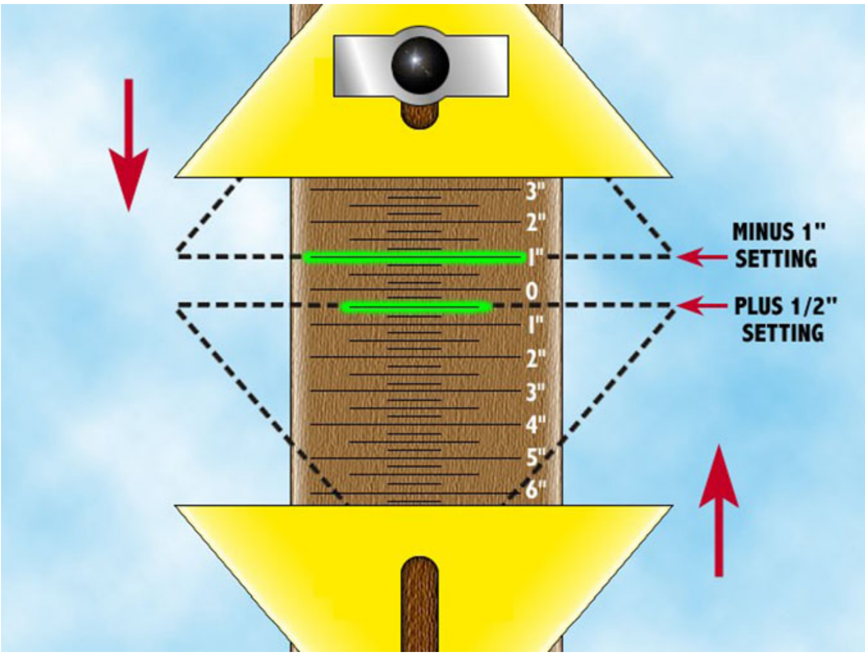


Figure 2–27. RQC rod adjustment.

Perform check

The next step is to divide the repair into lanes parallel with the centerline of the MOS (fig. 2–28). It is important that the lanes are parallel with the centerline because the repair has a slope that matches the surrounding pavement. This is especially important when evaluating F or FF repairs.

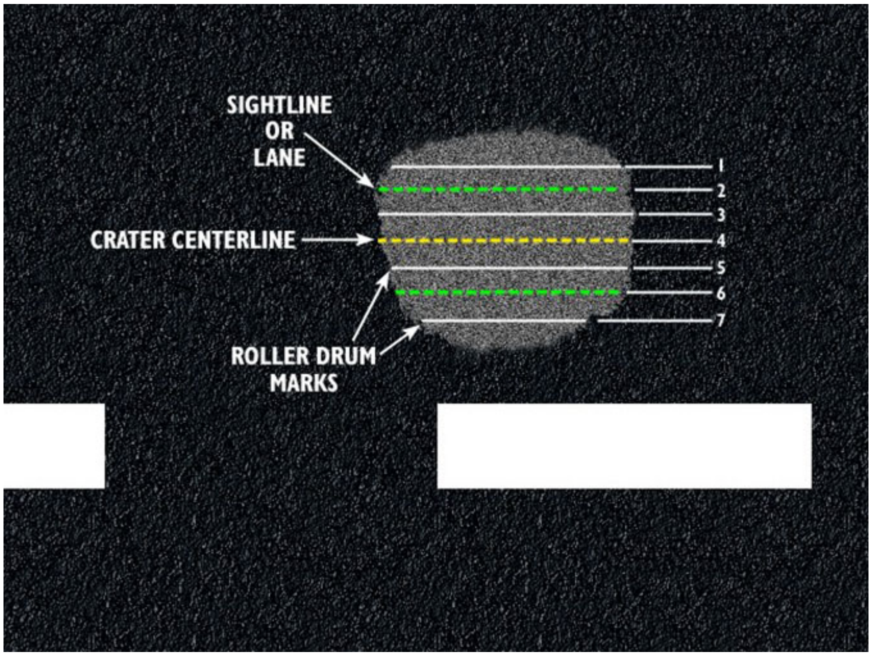


Figure 2–28. RQC evaluation lanes.

Checking the repair

Because we have adjusted our equipment, we can now perform the checks. The preparation we have done makes the checks quick and simple. Use the stanchions to read the rod. If the tops of the stanchions fall between the triangles, then the repair is good. If the stanchions fall in the yellow area, then the repair is not good (fig. 2–29).

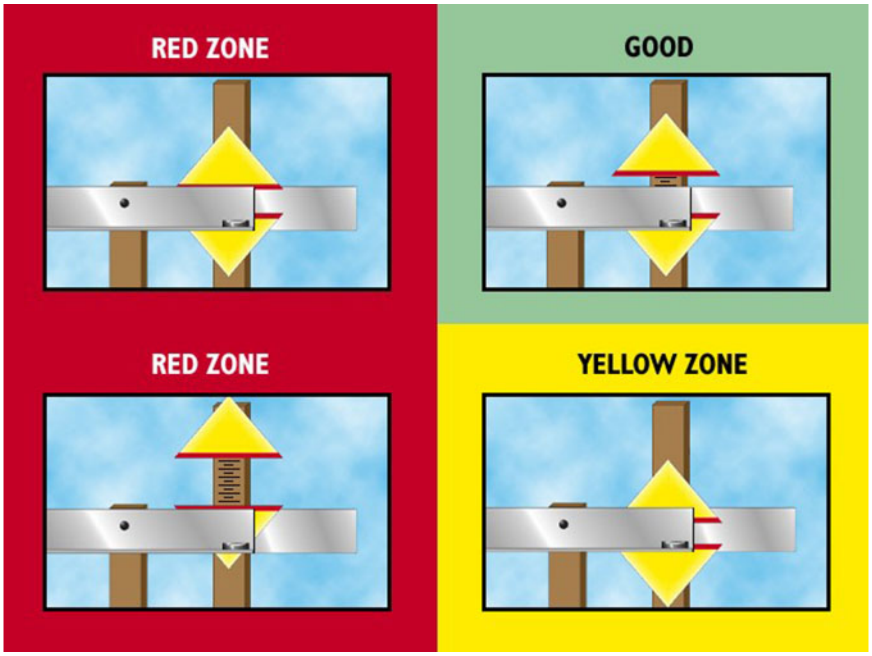


Figure 2–29. RQC rod measurement.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

612. Airfield damage assessment team

1. What are the three rules to remember when establishing a pavement reference marking system?

2. What is the difference between the *apparent* crater size and the “full repair size?”

3. List the six parts of a standard crater damage coordinate.

4. List the five parts of an UXO damage coordinate.

5. List the fourteen parts of a spall or bomblet field damage coordinate.

6. How is a camouflet damage coordinate written?

7. Using the MGRS coordinate 19269614, what is the 1,000-meter grid coordinate? The 100 meter? The 10 meter?

613. Performing minimum airfield-operating surface selection team

1. What are the pre-attack actions of the MAOS selection team?

2. What is noted inside a crater on the 1:1200 airfield map?

3. What is noted inside next to UXO on the airfield map?

614. Selecting minimum operating strip candidates

1. Which personnel is it critical to communicate with regarding MOS dimensions?

2. What are the two types of MOS?

3. In what way does the MOS location affect LOR status?

4. What are the three primary access/egress limitations?

615. Calculating repair quality criteria

1. What are the three checkboxes listed under runway surface condition (RSC) on worksheet 1?

2. What two pieces of information do you need to calculate the DR using the density ration table?

3. Operation lengths are calculated using the aircraft operation chart, the DR, and what else?

4. What is the difference between patch location and patch spacing?

5. In the RQC column, what is the last step in calculating the RQC?

6. What is the result of a RQC CPM check, when the stanchion falls into the yellow portion of the rod triangles?

2–3. Airfield Recovery Actions

After MOS selection, field operations begin. We first mark the MOS using the Minimum Airfield-Operating Surface Marking System (MAOSMS). While the MOS is marked, we evaluate the damage. The CPM team measures the upheaved pavement, while our dynamic cone penetrometer (DCP) tests will evaluate the strength of a crater repair. You will also use the DCP to evaluate the strength of the soil for the Mobile Aircraft Arresting System (MAAS) installation team. Our most critical action will be the installation of the PAPI, which guides the pilot into a safe landing. The airfield recovery team is depending upon us to be quick and accurate.

616. Using the Minimum Airfield-Operating Surface Marking System

After the MOS selection and while any damage on that MOS is being repaired, we mark out the takeoff and landing surface. The MOS is marked with orange markers. This gives pilots a visual as they take off and land. We mark the MOS by using the MAOSMS. The MAOSMS kit provides enough marking material for a 10,000-feet by 150-feet bidirectional MOS.

In this section, we will cover the MAOSMS team composition, components of the kit, the layout sequence, and layout configuration details.

Team composition

A standard-marking team consists of an Engineering Journeyman (3E551), a Structural Journeyman (3E351), and four personnel from any CE specialty. The engineering journeyman will brief and manage the four augmentees while laying out the kit. The structural journeyman and one augmentee will, after it is marked, operate the paint striper and mark the new MOS centerline.

It is important that if there is more than one team, an Engineering Craftsman (3E571) must be on hand. The craftsman can provide clear coordination and quality control for the marking system. The goal is to implement the marking system as quickly and accurately as possible so that aircraft launch and recovery can begin.

Minimum Airfield-Operating Surface Marking System components

The following is a list of components that constitute the MAOSMS. The kit takes up a lot of space and requires a large truck for transport.

As we proceed through the layout sequence, refer back to this list often to get an idea of the scope of the marking operation.

MAOSMS COMPONENTS	
Item	**Quantity**
Traffic cones	150
Edge marker bases	140
Edge marker tops	152
DTG signs (2 per number, 1–9)	18
Measuring tape (200 feet)	2
Paint striping set	1
D-handle shovel	2
Sand bags	100

Layout sequence

The layout sequence for an MOS is broken into two parts. The first part is the layout of the traffic cones. The traffic cones mark the centerline, threshold, taxiways, crater "T" clear zones, and approach lighting of the MOS. The centerline and taxiway cones will show the paint striping team where the centerline and taxiway lines are to be painted. The "T" clear zone cones mark the work area around the craters on the MOS.

The second part of the sequence uses the edge markers. The edge markers are large rubber mats with foam reflective triangles that attach to the top of the mats. These mark the edge of the MOS and the threshold. Included in the kit are stanchions with distance-to-go (DTG) signs and MAAS signs.

The layout configuration is the way in which we carry out each part of the layout sequence.

Layout Configuration – Traffic Cones

Place the cones in a specific order to allow other specialties to do their job. The order is threshold, approach lighting, MOS centerline, crater repair "T" clear zones, navigational aids (PAPI lights), MAAS location, taxiway intersections, and the departure end.

Threshold/departure

Though they are done at different times in the sequence, threshold first and departure last, they are done the same way. The corners of the MOS are marked first. Then, we place the threshold/departure centerline cone. Place the centerline cone on the centerline offset two feet to the left (fig. 2–30). The paint striping team uses the offset to line up the paint-striping machine.

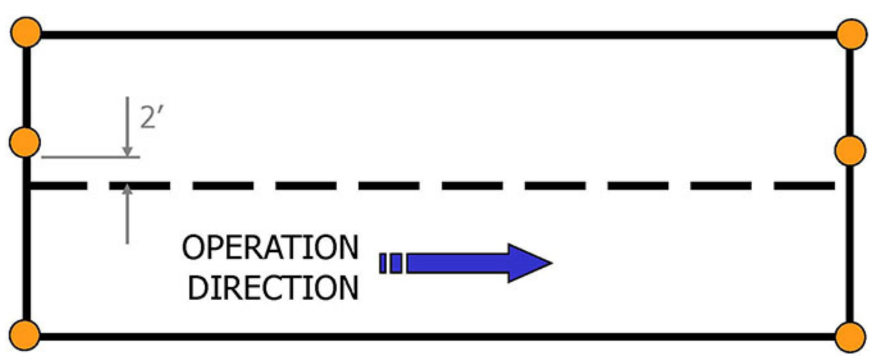


Figure 2–30. Threshold/departure and centerline cone layout.

Approach lighting

The approach-lighting markers will tell the EALS team where to place the approach lights. Place approach-lighting cones off the MOS leading up to the threshold (fig. 2–31). The approach markers will be a row of seven (7) cones. Each cone will be 200 feet apart for a total distance of 1,400 feet.

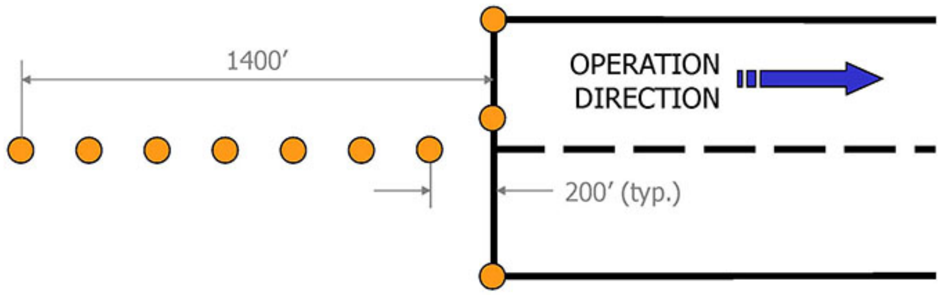


Figure 2–31. Approach-lighting configuration.

Minimum operating strip centerline

Place the centerline marking cones exactly the same way as the centerline marking cones for the threshold and departure. In fact, they will be in line with them. Place a cone every 200 feet along the MOS centerline. Offset the cones two feet to the left of the centerline (fig. 2–32). Again, this will ensure that the paint-striping machine can quickly paint a centerline for the MOS.

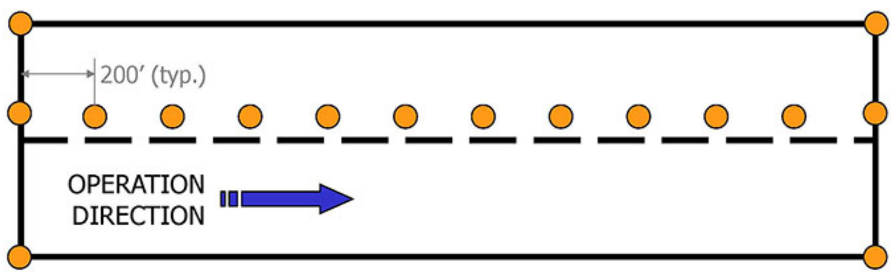


Figure 2–32. Centerline-cone configuration.

Crater repair "T" clear zones

There is a special rule for the centerline cones when they approach a crater repair area. During the layout process, the crater repair teams will already be working. In order to give them room to work and continue to lay out the marking system we create "T" clear zones. We call them "T" clear zones because of their shape, with the top of the "T" facing the crater. The rule for the clear zone is that there must be *at least* 100 feet before and after a crater on the MOS, but we place cones at the next 200 feet interval. This means that if the next station 100 feet after a crater is at 500 feet from the MOS threshold, then we place the cone at the 600 feet station (fig. 2–33).

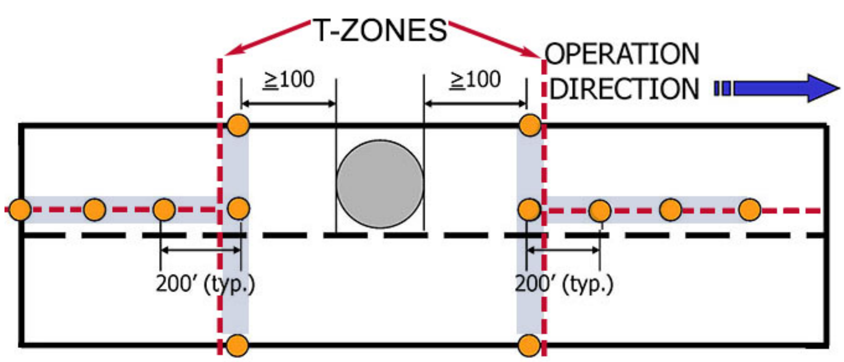


Figure 2–33. "T" clear zone.

Mobile Aircraft Arresting System location

Another example of how the cones assist other specialties is the MAAS marking. The configuration is two cones on either side of the MOS—one on the edge and the other three feet outside the MOS (fig. 2–34). This shows the MAAS installation team where to place it.

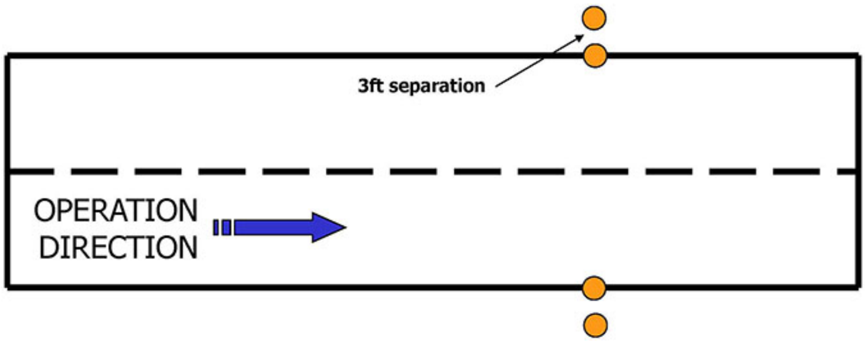


Figure 2–34. MAAS marking cone configuration.

Taxiway intersections

At areas that the MOS connects to its taxiways, we place a triangle of cones. We create an equilateral triangle by placing the cones three feet apart "pointing" toward the taxiway centerline. The base of the triangle rests on the edge of the MOS (fig. 2–35).

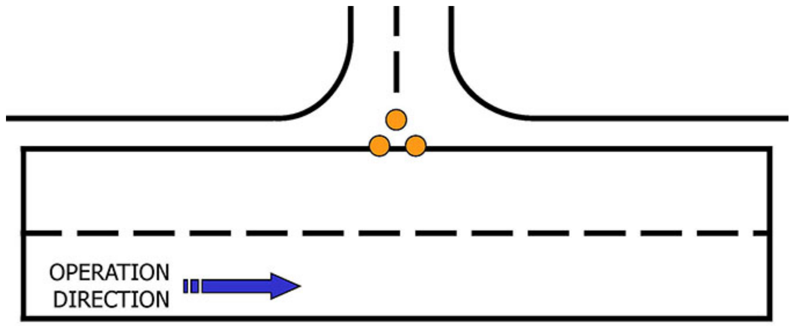


Figure 2–35. Taxiway intersection triangle.

Aircraft hold line

On taxiways, there is a hold position usually indicated by a line. Aircraft and vehicles stop on this line and call into the tower to request clearance for runway access. Doing this ensures the safety of aircraft on the runway and those attempting to access it. When laying out an MOS we place the hold lines 100 feet down the taxiway from the MOS edge. A stack of two cones each goes on either side of the taxiway (fig. 2–36). This indicates the place to paint the hold line and the point at which aircraft should wait for clearance.

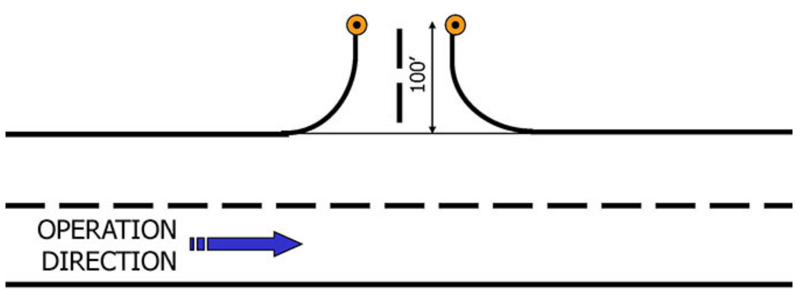


Figure 2–36. Taxiway hold-line markers.

Taxiway access turns

The last thing that the cones need to mark is the taxiway lines. These will include both the curves around obstacles, such as craters, and the curves from the MOS centerline into the taxiway centerline. These cones will guide the painters on where to put the taxi lines that aircraft will follow to get onto and off the runway. Place cones 25 feet apart. There must be at least five cones per change in direction. If there are three curves, then there needs to be at least fifteen cones. See figure 2–37 for an example.

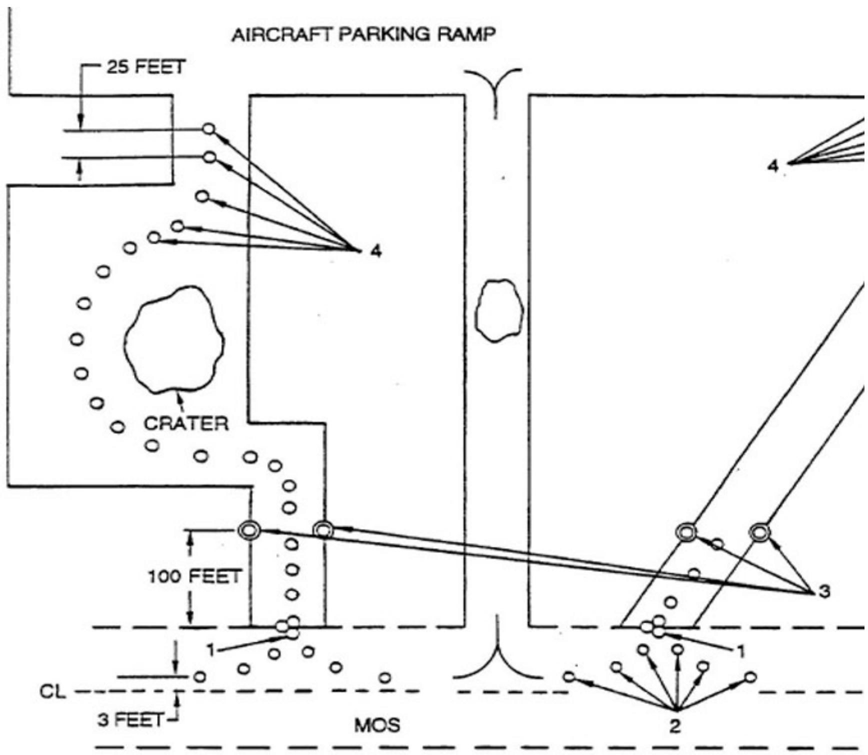


Figure 2–37. Taxiway access-turn marking.

Layout configuration – edge markers

The edge markers come in two pieces–a large rubber mat and a foam triangle with a reflective surface (fig. 2–38). The triangle attaches to the mat using hook and pile fasteners. Place edge markers at the threshold/departure ends and on the outside edge of the MOS. Along with these edge markers are the DTG signs and the MAAS sign.

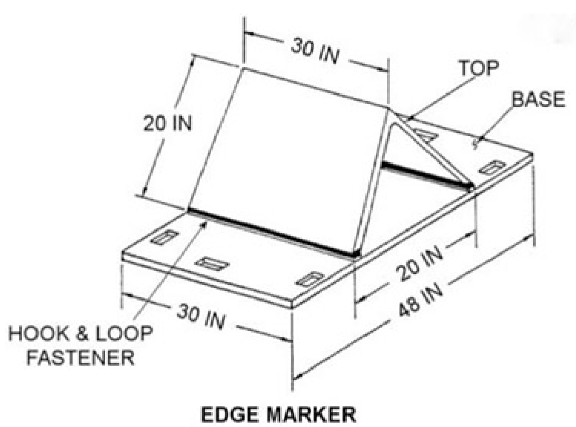


Figure 2–38. Typical MOS edge marker.

Threshold/departure

The threshold and departure markers show the pilot the beginning and end of the MOS. These markers are a warning, along with the DTG signs, telling the pilot when the MOS starts and ends. The threshold and departure are marked with ten edge markers on either side of the MOS, placed in a row, four to six inches apart. Offset the row four to ten feet from the edge of the MOS (fig. 2–39). Whichever offset distance is used it remains consistent throughout the rows.

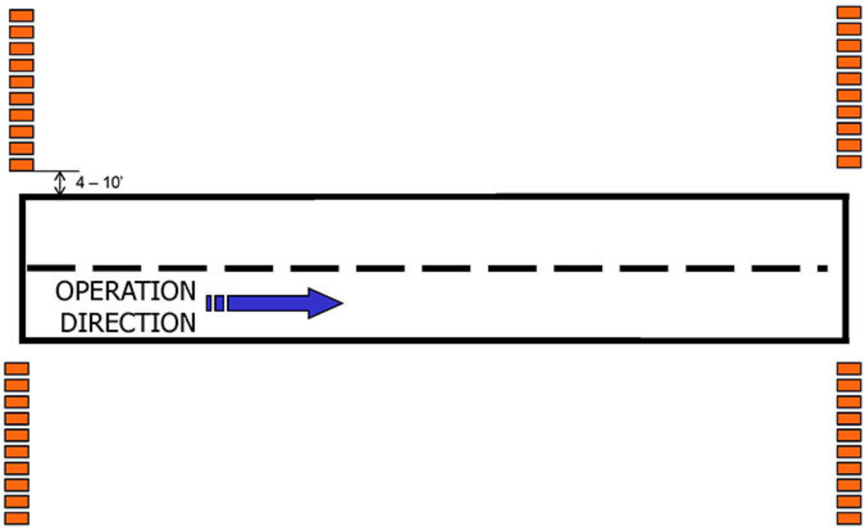


Figure 2–39. Threshold/departure edge markers.

Minimum operating strip edge marking

Place these markers on the edges of the MOS to inform the pilots of the left and right limits of the MOS. They are the same type of edge markers used in threshold/departure marking but in a different configuration. They are offset from the edge of the MOS, the same distance the threshold/departure markers are offset (4–10 feet). Place them parallel to the MOS at 200 feet intervals beginning 200 feet after the threshold/departure rows (fig. 2–40).

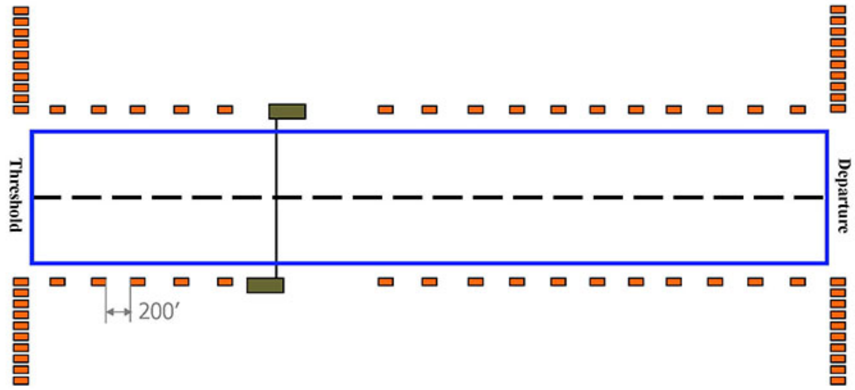


Fig. 2–40. Threshold/departure edge markers.

NOTE: Some edge markers after the MAAS are omitted because of the cable sweep area. See the table in figure 2–41 for rules on the distance the tape sweep will cover. Compare the edge marker offset you chose with the edge light offset in the table and round up to the next 200 feet station. An example would be 450 feet offset rounds up to 500 feet, but the next interval is 600 feet and that would be the next edge marker.

MOS WIDTH (Feet)	PENDANT LENGTH (Feet)	EDGE LIGHT OFFSET		
		0-FEET	5-FEET	10-FEET
50	90	550 *	450 *	350 *
50	153	700	650	600
90	90	150	50	0
90	153	450	400	350
150	153**	50	0	0

* Distance from AAS to far edge of tape sweep area (in feet). Round up to nearest 50-ft; interpolate this data for other conditions.

** No numbers are provided for a 90-ft pendant on a 150-ft wide runway; the 90-ft pendant effectively reduces the runway width to 90 ft.

Figure 2–41. Table showing distance after MAAS empty of edge markers.

Signs

There are two types of signs you will have to place—the DTG and the MAAS signs (fig. 2–42). We place DTG signs on the pilot's right. The DTG signs will begin with the highest number near the threshold and the lowest number near the departure end (fig. 2–43). They count down the distance remaining, in thousands of feet, until the MOS ends. Place DTG signs approximately 25 feet off the edge of the MOS, at 1,000 feet stations, adjacent to the nearest edge marker. Place MAAS signs 25 feet or 35 feet off the edge of the MOS in line with the MAAS cable. Figure 2–43 shows the completed configuration of the MAOSMS.

Figure 2–42. Typical DTG signs.

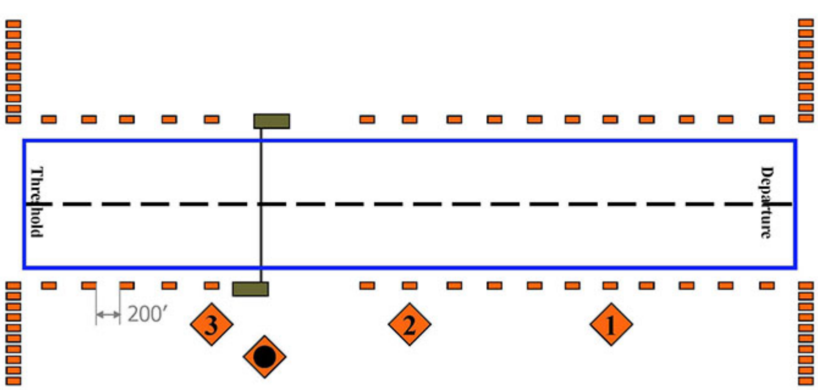


Figure 2–43. Complete MAOSMS MOS layout.

617. Using crater profile measurement

Before we can repair a crater, we have to figure out how much of the pavement to replace. The way that we do that is CPM. This is an expedient method of measuring the amount of upheaval around a crater. Upheaval is the disturbed pavement around a crater (fig. 2–44). When ADAT sends the damage coordinates to the MAOS selection team in the EOC, they use the apparent diameter. Apparent diameter is the width of the void area disregarding upheaval. The MAOS selection team will plot the crater damage on the map double the ADAT damage coordinate size. The doubled-sized estimates size of repair to include upheaval. The CPM is then used to measure the actual amount of pavement that we have to repair.

Figure 2–44. Crater upheaval.

Equipment

The only equipment required for CPM are the two CPM stanchions and the target rod. The three pieces of equipment are set at the same static height. The stanchions are metal rectangles, of any color, while the target rod is an inverted equilateral triangle colored differently than the stanchions.

Use

The idea behind this equipment is to place the stanchions parallel to the centerline of the runway. Because they are parallel to the centerline, both stanchions are at the same relative elevation. Use the rod to measure, by line-of-sight, the difference in elevation (figs. 2–45 & 2–46). This is a two-person task. One person will be moving the rod toward or away from the stanchions. The second person will be looking over the nearest stanchion, lining up the stanchion tops, and viewing the difference to the target rod.

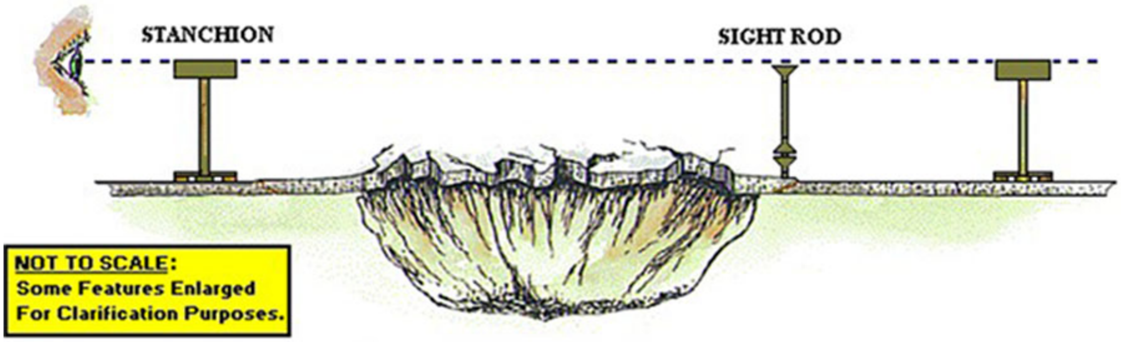


Figure 2–45. CPM equipment use example.

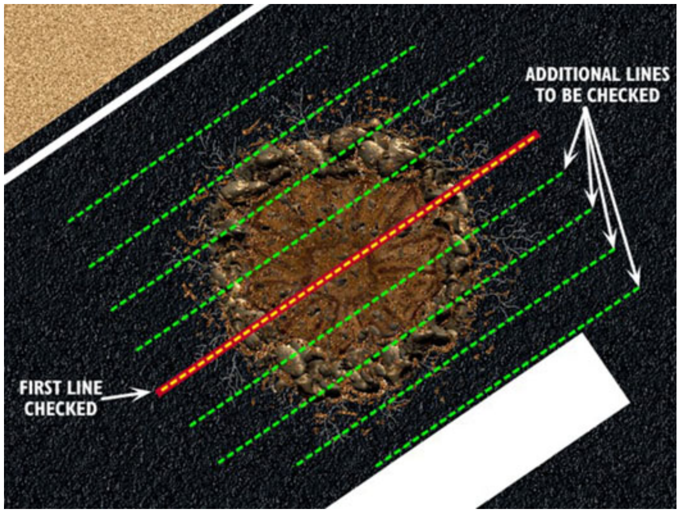


Figure 2–46. CPM lanes parallel to runway centerline.

Procedure

Now that you have a basic understanding of the purpose, function, and use of the equipment, we can cover the procedure for measuring crater upheaval. The table below describes the general procedure for evaluating craters. When evaluating a crater greater than 20 feet in diameter, use Technical Order (TO) 35E2–5–1, *Crushed Stone Crater Repair and Line-of-Sight Profile Measurement for Rapid Runway Repair*, and when less than 20 feet, use procedures in AFTTP 3–32.17, *Rapid Airfield Crater and Spall Repair*.

Procedure for Measuring Crater Upheaval	
Step	**Action**
1	Start with the lane that runs through the center of the crater (red lane in fig. 2–47). Place the stanchions approximately 10 paces from the crater edge.
2	The person with the target rod will begin on the edge of the obvious upheaval and the stanchion person will make a line of sight reading.  Figure 2–47. CPM measurement.

<table>
<tr><th colspan="2">Procedure for Measuring Crater Upheaval</th></tr>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>3</td><td>If the target triangle is visible, the person holding the rod will take one pace toward the stanchion. The stanchion person will take another reading. Repeat until the target triangle is no longer visible.</td></tr>
<tr><td>4</td><td>Once the triangle is no longer visible to the stanchion person, the rod person will take one additional step toward the stanchion and draw a large “X” on the pavement.</td></tr>
<tr><td>5</td><td>The team will repeat steps 1 through 4 for the opposite side of the crater in the same lane.</td></tr>
<tr><td>6</td><td>The team will repeat steps 1 through 5 for each lane of the crater.

The product of this effort will be a large circle of “Xs” around the crater (fig. 2–48). The “Xs” become the outer edge of the crater repair area. The damage repair team will cut the pavement at those markings.

Figure 2–48. Connecting the CPM markings.</td></tr>
</table>

618. Evaluating soil strength

When we talk about soil strength, we are referring to its load-bearing capacity. The California Bearing Ratio (CBR) measures load-bearing capacity. The tool we use to measure CBR is the DCP.

California Bearing Ratio

California limestone is the basis for CBR values, which has a CBR of 100. To give this value perspective, tilled farmland has a CBR of three, moist clay has a CBR of 4.75, moist sand has a CBR of 10, and crushed rock has a CBR around 80. While 100 is the baseline, it is not the limit. There are soils, usually engineered, that will have CBR values over 100.

Dynamic cone penetrometer

The DCP evaluates a soil’s CBR value using mechanical effort. The average number of blows it takes to drive a metal rod a given distance measures the mechanical effort. Figure 2–49 shows the basic components and assembly of the DCP. The DCP has three main parts—the upper assembly, lower assembly, and the vertical scale assembly.

Upper assembly

The upper assembly is the handle, hammer, and anvil. Use the handle to keep the DCP plumb, or perpendicular to the ground. The hammer weighs 17.6 pounds (8 kilogram) and drops down 575 millimeter onto the anvil. The hammer falls free, which ensures that each blow to the anvil has the same force. The upper assembly joins to the lower using a steel retaining pin secured by a cotter pin.

Lower assembly

The lower assembly consists of the drive rod, extension rod, and cone tip. The drive rod and extension rod are stainless steel and together measure 36 or 50 inches depending on the rod used. The cone tips are either hardened and reusable, or disposable and are both the same size and shape. When the hammer strikes the anvil, the cone and rod are driven into the soil. The hammer, anvil, rod, and cone are all of consistent shapes and sizes. This means that only one variable remains the load-bearing capacity of the soil.

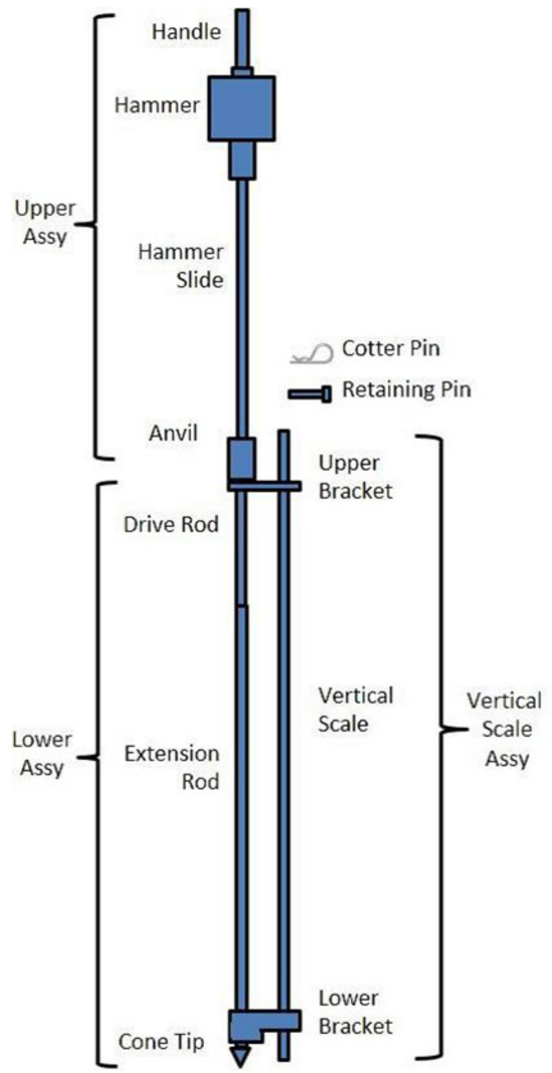


Figure 2–49. DCP.

Vertical scale assembly

A vertical-standing graduated scale rests between the upper and lower brackets. Take an initial reading from the bottom of the upper bracket. A recording person will observe the graduated scale and count the number of hammer blows. Every 25 millimeters of depth, the recorder will record the number of blows.

Procedure

Two people will operate the DCP, both counting the number of hammer blows. One person will hold the rod plumb and operate the DCP hammer; the other person will observe the scale and record measurements. The procedure is as follows:

1. Place the DCP onto the test area and hold perpendicular to the ground.
2. Record the initial reading of the graduated scale, measuring to the nearest millimeter (.04 inches).
3. Gently raise the hammer until it rests against the bottom of the handle.
4. Let the hammer drop freely, DO NOT exert downward force.
5. Repeat steps 3 and 4, counting hammer blows, until the depth reaches 25 millimeters.
6. Once the rod reaches a depth of 25 millimeters, record the number of blows and current depth.
7. Repeat steps 3–6, recording number of blows every 25 millimeters until the rod reaches its full depth, usually 35 inches.

Some things to be aware of when operating the device:

- Restart the test if the rod deviates 3 inches or more vertically and/or 6 inches laterally.
- If the number of blows exceeds 20 before a depth of 25 millimeters, stop. Damage to the rod may occur if you continue. Instead, remove the rod, drill an inch, and retry the test. If it happens again, change test location.

Recording

Organized notes are important. The purpose of collecting this information is to communicate it to someone else. At a minimum, the record sheet should have the following (fig. 2–50):

1. Name or purpose of the test.
2. Name of the recorder.
3. Test number (if more than one test for area or purpose listed in item 1).
4. Brief location description.
5. Diagram or sketch of the area.
6. Number of blows per measurement.
7. Cumulative blows per measurement.
8. Cumulative depth per measurement.

Determining California Bearing Ratio

Soil is broken into layers. Each layer can be a different soil type, like a clay, sand, or gravel. This means that each layer can have a different CBR value. It also means that each layer requires a different number of blows to penetrate it. To define and calculate the CBR of each layer, we graph the data. We place the cumulative blows on the x-axis of the graph, and the cumulative depth on the y-axis (fig. 2–51).

Describe soil layers

On the graph, a constant rate of penetration represented by a relatively straight line represents a soil layer. Figure 2–51 has three major layers from 1–5 blows, 6–10 blows, and 13–19 blows. Use sound personal judgement and experience to define the layers of soil.

Practice and experience are the best ways to develop better judgement. CBR graphing is no exception. The best example is the interpretation of the gap at 10–13 blows. Gaps between the more obvious layers are up to interpretation. We can dismiss them as a minor anomaly, or a group of thin layers, or even a void. While it may be easy to distinguish layers defined by a clear line of points, it will be up to you to define or dismiss variations such as the 10–13 blow layer.

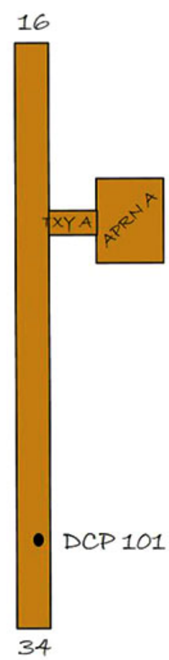
Calculate California Bearing Ratios

Each layer of soil will have its own CBR value. Each DCP will have a manual that has a chart and formula used to calculate CBR. The chart translates the DCP index into CBR value. The DCP index is the ratio of number of blows versus depth of penetration for a layer. Using figure 2–51, the layer between 1–5 blows has a depth range from 150 to approximately 325. Therefore, over five blows the rod penetrated 175 millimeters. The ratio is 5:175 or 1:35, or 35 millimeters per blow. Using the chart in the manual (fig. 2–52), we can translate a DCP index of 35 into a CBR of five. The remaining two layers, by the same process, have CBRs of 4.2 and 4.0.

Airfield Name General Helgy Field
DCP # 101
Name of Recorder 2lt Tucker
DCP Description Rt side of 34 TD zone

Blows	Total Blows	Depth	Blows	Total Blows	Depth
0	0	90	8	107	545
3	3	110	8	115	565
3	6	130	7	122	585
5	11	150	7	129	605
5	16	170	7	136	625
4	24	190	4	140	645
4	28	210	4	144	665
4	32	230	4	148	685
4	36	255	5	153	705
4	40	275	5	158	725
5	45	295	5	163	745
5	50	315	5	168	765
5	55	335	5	173	790
3	58	355	5	178	810
3	61	380	5	183	820
3	64	400	5	188	840
3	67	420	4	192	865
3	70	440	4	196	885
6	76	460	3	199	905
7	83	480	3	202	925
8	91	500	3	205	945
8	99	520	3	208	960

Diagram



8 DCP

Figure 2–50. DCP data sheet.

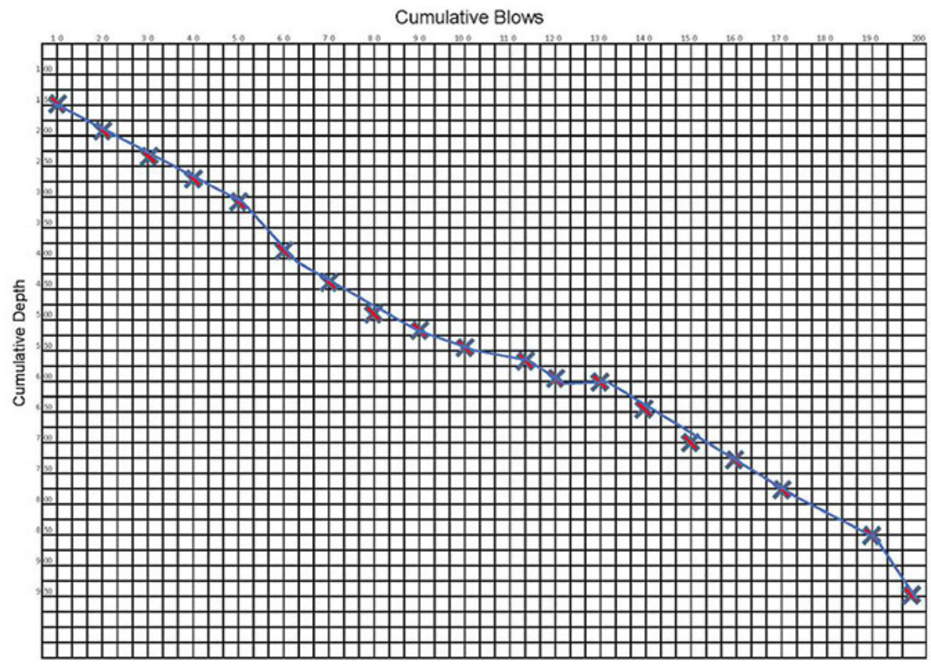


Figure 2–51. Cumulative blow graph.

DCP Index mm/blow	CBR %	DCP Index mm/blow	CBR %	DCP Index mm/blow	CBR %
<3	100	39	4.8	69-71	2.5
3	80	40	4.7	72-74	2.4
4	60	41	4.6	75-77	2.3
5	50	42	4.4	78-80	2.2
6	40	43	4.3	81-83	2.1
7	35	44	4.2	84-87	2.0
8	30	45	4.1	88-91	1.9
9	25	46	4.0	92-96	1.8
10-11	20	47	3.9	97-101	1.7
12	18	48	3.8	102-107	1.6
13	16	49-50	3.7	108-114	1.5
14	15	51	3.6	115-121	1.4
15	14	52	3.5	122-130	1.3
16	13	53-54	3.4	131-140	1.2
17	12	55	3.3	141-152	1.1
18-19	11	56-57	3.2	153-166	1.0
20-21	10	58	3.1	166-183	0.9
22-23	9	59-60	3.0	184-205	0.8
24-26	8	61-62	2.9	206-233	0.7
27-29	7	63-64	2.8	234-271	0.6
30-34	6	65-66	2.7	272-324	0.5
35-38	5	67-68	2.6	>324	>0.5

Figure 2–52. DCP index to CBR chart.

Crater repair and arresting system installation

DCP testing is key in evaluating crater repairs and MAAS installation sites. Generally, a CBR value of *at least* 25 per layer is required for airfield crater repair and *at least* seven per layer for MAAS installation. For crater repair, this is not a difficult requirement to meet. The repair is backfilled and compacted with the intent of making the material dense and, therefore, making for a high CBR. Arresting systems are different. Some arresting systems have to anchor in the natural, or in-situ, soil. This means that the CBR value will vary more. This may affect the type of anchoring used for the MAAS, covered later in this unit.

619. Placing precision approach path indicators

During aircraft landing, the pilot approaches the airfield at a certain angle. This angle is referred to as the "glide slope," which ensures the aircraft contacts the runway (or MOS) in such a way as to soften the impact of landing. A softer impact upon touchdown prevents damage to the aircraft landing system and improves pilot safety. If the glide slope is too steep, aircraft damage will occur and, if too shallow, there is a danger of the aircraft hitting obstructions, such as trees. The PAPI guides the pilot along the glide slope (fig. 2–53).

The lights inside the PAPI units are two colors, usually red and white. If the pilot is on the correct glide slope, then he or she will see both colors, one from each unit. If the units are displaying both white colors, the pilot is too high, or both red, the pilot is too low (fig. 2–54).

During MAOSMS layout, you will place a pair of PAPIs. This is a three-phase process; calculate PAPI location, lay out the PAPIs, and finally align the inboard and outboard units.

Figure 2–53. Precision approach path indicator.

Figure 2–54. Glide slope indicators.

Phase I – Calculate PAPI Location

Engineering is responsible for calculating the PAPI location. To begin our calculations, we need two pieces of information—the threshold crossing height (TCH) and the glide slope. Both the glide slope and the TCH are dependent upon the aircraft. Obtain them from the senior airfield authority (SAA) either on the airfield or in the EOC. Let's look at figure 2-55, which displays fighter jets along with their TCH at 40 feet.

Height Group	Approximate Cockpit-to-Wheel Height	Threshold Crossing Height (TCH)
#1 T-37, T-38, C-21, T-1, C-12, C-20, & fighter jets	10 ft (3m) or less	40 ft (10 m)
#2 F-28, CV-340/440/580, B-737, DC-9, DC-8, C-9, T-43, C-130, B-2	15 ft (4.5 m)	45 ft (12 m)
#3 B-727/707/720/757, KC-135, C-141, C-17, B-52	20 ft (6 m)	50 ft (15 m)
#4 B-747/767, L-1011, DC-10, A300, KC-10, C-5, VC-25	Over 25 ft (7.5 m)	75 ft (22 m)

Figure 2–55. Visual TCH groups.

The next piece of information we will ask the SAA for is the glide slope. The glide slope can range from 2.5 to 4 degrees. If a SAA is unable to provide the number or is unavailable, we use 3 degrees. Now that we have a glide slope of 3 degrees and a TCH of 40 feet, we can begin to calculate the PAPI's distance from the MOS or runway threshold. We can achieve this in two steps; first by calculating the uncorrected distance, then calculating and adding (or subtracting) the correction distance.

Step 1 – Uncorrected PAPI Distance

Take a close look at figure 2–56. Notice the right triangle made by the PAPI location, the TCH, and the glide slope. In order to complete this step, we are going to calculate the value for *d* using the function for tangent. The trigonometry function is:

$$\text{Tan } \theta = O / A$$

In our example, θ (theta, or the angle) equals the glide slope, 3, *O* (the opposite side) equals the TCH, 40. The function now looks like this:

$$\text{Tan } 3 = 40 / A$$

The remaining variable is the length of the adjacent side. The adjacent side of the triangle in our example is the distance from the threshold to the uncorrected PAPI location. Therefore, we need to use some algebra and solve the equation for A. After it should look like this:

$$A = 40 / \text{Tan } 3$$

After we do the math, the value of A is approximately 763.25 feet. We can round down to the nearest foot giving us an uncorrected distance from threshold of 763 feet.

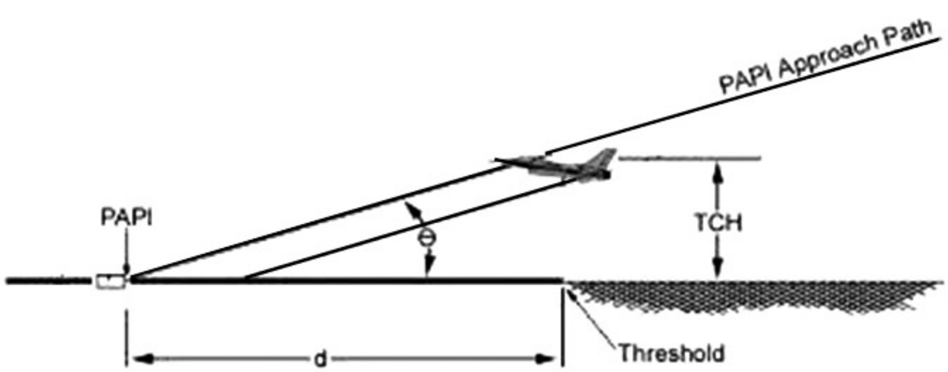


Figure 2–56. Approach Path Diagram.

Step 2 – Correction Distance

The uncorrected PAPI distance assumes that the airfield is level. Actual airfields are not level. An airfield threshold that is higher than the uncorrected PAPI location means the PAPI lights need to move farther away. Conversely, an airfield threshold that is lower than the uncorrected PAPI location means the PAPI lights need to be moved closer to the threshold.

In order to find our correction distance, we start by measuring the difference in elevation between the MOS threshold and the uncorrected PAPI location. After we have the elevation difference, we make a new triangle with the same glide slope as the first, and we set the opposite side as the measured height difference. In our example, we surveyed the elevation difference between the threshold and the uncorrected PAPI distance and got five feet. This means that the height of the threshold is higher than the uncorrected PAPI location. Figure 2–57 shows an illustration of our triangles.

Using the equation for Tangent, we calculate side “a” to be 95 feet, after rounding. Remember we said that if the threshold is higher than the uncorrected location, we move the location further away. Therefore, we will add the uncorrected distance of 763 feet to the correction distance of 95 feet for a total of 858 feet. We then round this to the nearest ten feet, for a value of 860 feet. This is where the PAPI is located.

If the threshold were lower than the uncorrected PAPI location, then the math would be the same except we would subtract the corrected and uncorrected distances. Meaning that if the threshold where lower than 95 subtracted from 763 would give us 668 feet that we could round to 670 feet.

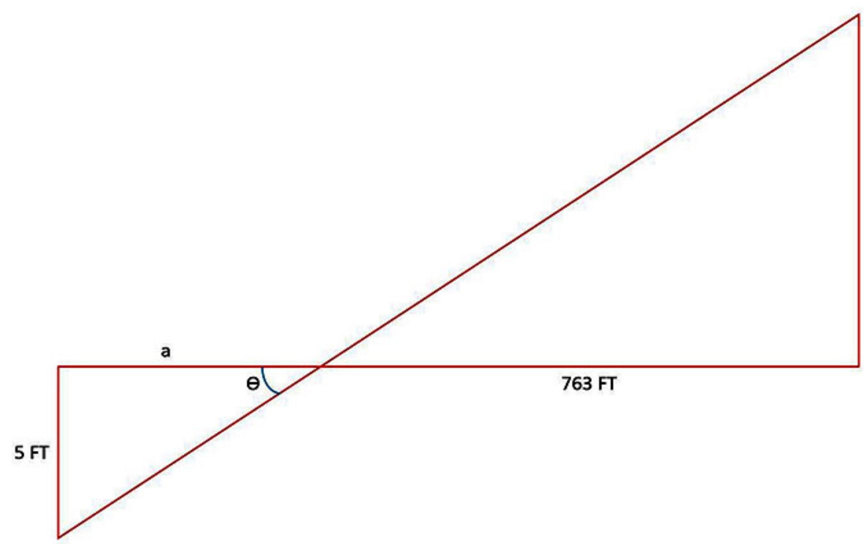


Figure 2–57. PAPI calculation diagram.

Phase II – Lay out the PAPI

Place the PAPI unit pairs on the left side of the runway when viewed from the approach end. Place the centerline of the *inboard unit* (the one closest to the runway/MOS edge) 50 to 60 feet from the edge of the runway/MOS. The *outboard unit* (furthest from the runway/MOS edge) is 20 to 30 feet from the *inboard unit*. They should be no closer than 50 feet to a runway, taxiway, or apron.

The elevation of the PAPI units is just as important as their position. In order to achieve both as quickly as possible, we will build a “box.” The box will consist of six stakes, one for the inboard precision approach path indicator (ip), one for the outboard precision approach path indicator (op), and four guide stakes for string line. We will mark the stakes and place the string line to build mounds to place the PAPI units at the correct elevation. The following procedure will guide you through this process.

Step 1 – Instrument placement

Setup the survey instrument over the PAPI location (point "p") and back sight to the threshold centerline (point "t") as shown in figure 2–58. Point "p" is the final PAPI location distance we calculated. Point "t" is any point on the runway/MOS centerline.

Step 2 – Siting inboard/outboard stakes

Turn the instrument 90 degrees right and place a stake (ip) 50 feet from the left edge of the runway. This will be the location of the front and center of the inboard PAPI light. Place another stake (op) 30 feet from the inboard PAPI stake (ip). This will be the location of the front and center of the outboard PAPI light.

Step 3 – Siting guide stakes

Set the instrument up over the "ip" stake and back sight to point "p." Turn 90 degrees right and place a 36- to 48-inch long guide stake 10 feet away. Plunge the scope and place another guide stake 10 feet away. Repeat steps for placement of outboard PAPI light guide stakes (fig. 2–59).

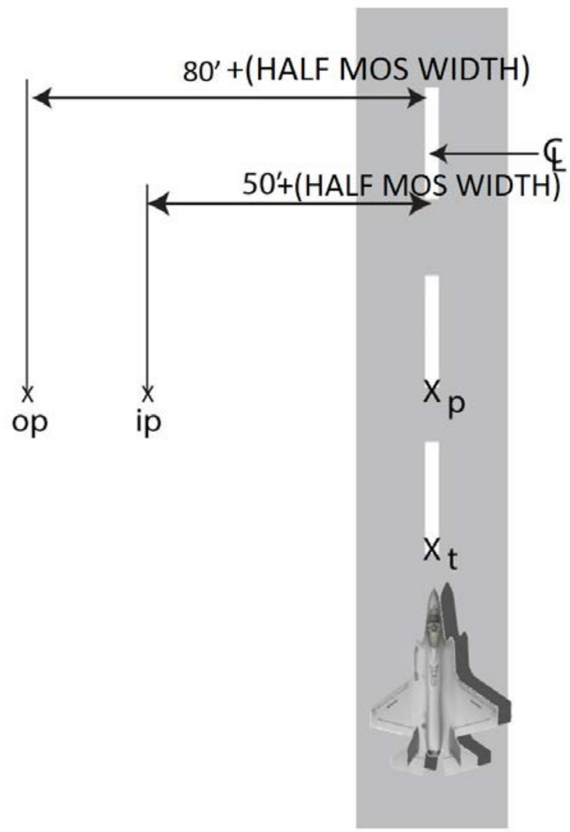


Figure 2–58. Initial runway alignment.

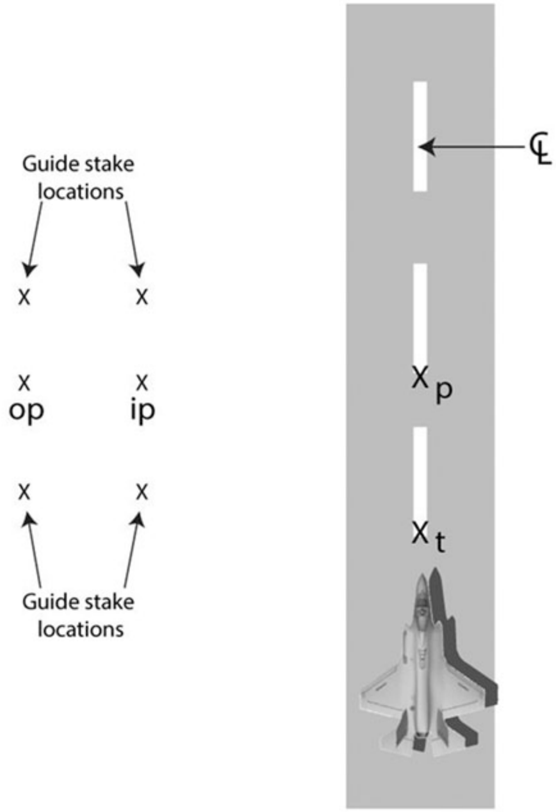


Figure 2–59. Guide stake locations.

Step 4 – Adjust guide stake elevations

The lenses of the PAPI lights have to be within one inch of the PAPI location elevation. To do this, we transfer the PAPI location elevation minus nine inches to the guide stakes. This nine-inch difference represents the distance between the PAPI base and the center of the light lenses.

Step 5 – Establish PAPI unit installation elevation

Once the adjusted elevations have been marked on the guide stakes, stretch a string between the "ip" grade stakes. Then, build a platform or backfill with earth to reach the elevation of the string (fig. 2–60). Obtain backfill by coordinating with pavements and equipment's supervision. Perform for both ip and op units.

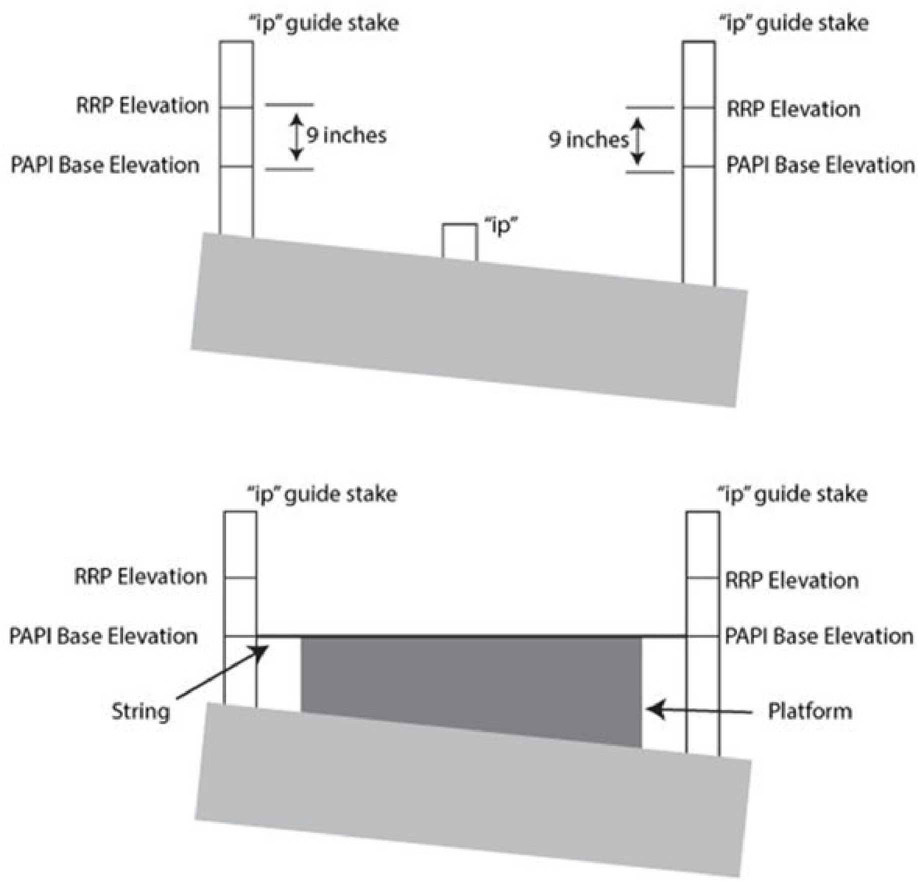


Figure 2–60. PAPI installation elevation.

Step 6 – PAPI unit placement

You are now ready to place the PAPI units. Setup the instrument over point "p," back sight to point "t," and then turn 90 degrees right. Adjust the PAPI left or right until the center rivet is on the vertical crosshair, and finally anchor the bases (fig. 2–61). Accomplish for both ip and op units. Installation is now complete.

While a team installs the PAPI lights, two engineering personnel will assist the MAAS installation team. First, engineering personnel perform DCP tests to determine the soil quality at the installation site and then align the guide stakes for the MAAS installation team.

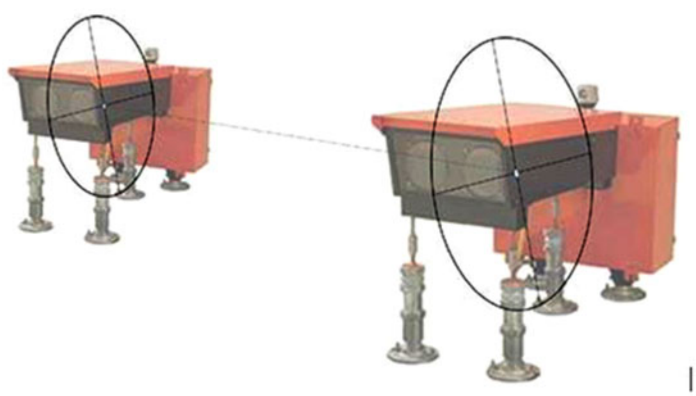


Figure 2–61. PAPI alignment.

620. Laying out and aligning the Mobile Aircraft Arresting System

The MAAS is a rapidly installed aircraft recovery system. The idea is that the aircraft hook catches the cable, and the system slows the aircraft, thereby, reducing the length of runway needed to stop it. This is vitally important to MOS selection for base recovery after an attack and when opening a damaged bare base. MAAS unit installation takes less than two hours and, with the correct hardware, operates for bidirectional runways. MAAS units install on concrete, soil, and asphalt (fig. 2–62).

Figure 2–62. Concrete MAAS install (top) and soil install (bottom).

Wide-body fighter aircraft are too large to use the MAAS in its standard configuration because the wings may collide with the MAAS units. Therefore, place the MAAS further away from the runway in order to accept larger fighters. The problem with this is that the “sweep” area of the cable becomes shorter and the system less effective. To compensate for this, we use a low-profile beam to guide the cable from the runway shoulders. There are two primary types we use—the lightweight fairlead beam (LWFB) (fig. 2–63) and the standard fairlead beam (SFB) (fig. 2–64).

Figure 2–63. LWFB and MAAS unit.

Figure 2–64. Standard beam and MAAS unit.

Lay out and Align MAAS with lightweight fairlead beams

The LWFB is used to “setback” or place the MAAS unit up to 200 feet away from the edge of the runway or MOS. It comes on a trailer as a mobile kit. The kit comes with hardware for both concrete and soil installation. Engineering assists in the installation of the MAAS units and LWFB in two ways. First, we perform the DCP test to evaluate whether the soil is strong enough for the unit. The standard MAAS and LWFB configurations require the soil CBR to evaluate to seven (7) or greater. Engineering also lays out and aligns the units and beams on both sides of the runway or MOS.

The MAAS layout and alignment procedure (below) is a simple stakeout. The idea is to place three stakes in a row on each side of the runway or MOS at distances defined by the MAAS installation chief. Temporary benchmark (TBM) #1 is the runway/MOS centerline instrument setup point. The first stake marks the front of the LWFB, and the second marks the back of the LWFB. The final stake, set 200 feet from the MOS/runway edge, is the point the cable exits the MAAS unit (fig. 2–65). Do not over complicate this procedure.

Layout/alignment stake procedure

1. If not already marked, determine the location of the barrier and mark the runway/MOS centerline as TBM #1.
2. Set up instrument over TBM #1 and establish runway centerline as baseline.
3. Turn 90 degrees and set TBM #2 on MOS/Runway edge.
4. Place the LWFB front stake, at the distance determined by the MAAS installation chief, in line with TBM #2.

   NOTE: It is mandatory that the edge sheave stake is level with or above the runway edge elevation.
5. Place another stake in line with TBMs #1 and #2 setback 12 feet from the LWFB front stake.
6. Place a final stake in line with TBMs #1, #2, and the LWFB front stake setback 200 feet from runway edge. This is the MAAS exit sheave location.
7. Turn instrument 180 degrees.
8. Repeat steps 3 through 6 for beam and unit on opposite side of runway/MOS.

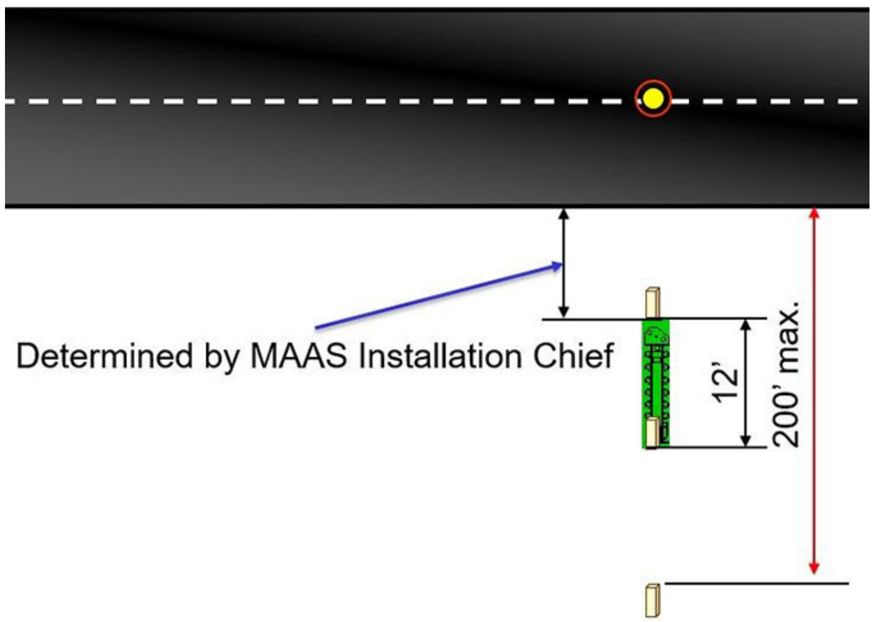


Figure 2–65. LWFB alignment stakes.

Lay out and align MAAS with standard fairlead beams and dead-man anchoring system

The LWFB is not used when the DCP test shows a CBR of less than seven (7). Install the dead-man anchoring system and the SFB instead (fig. 2–66). The dead-man anchoring system uses chains attached to metal plates buried underground on both sides of the standard beam (fig. 2–67).

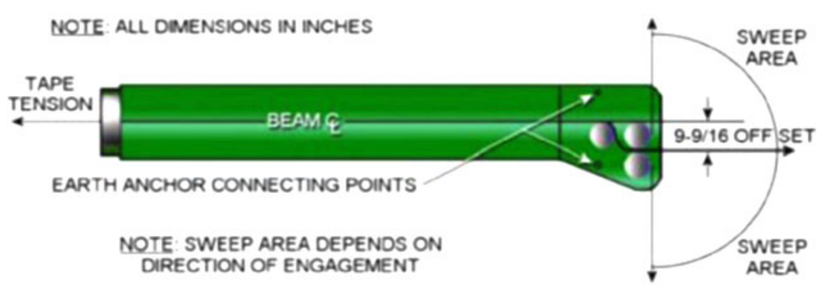


Figure 2–66. SFB.

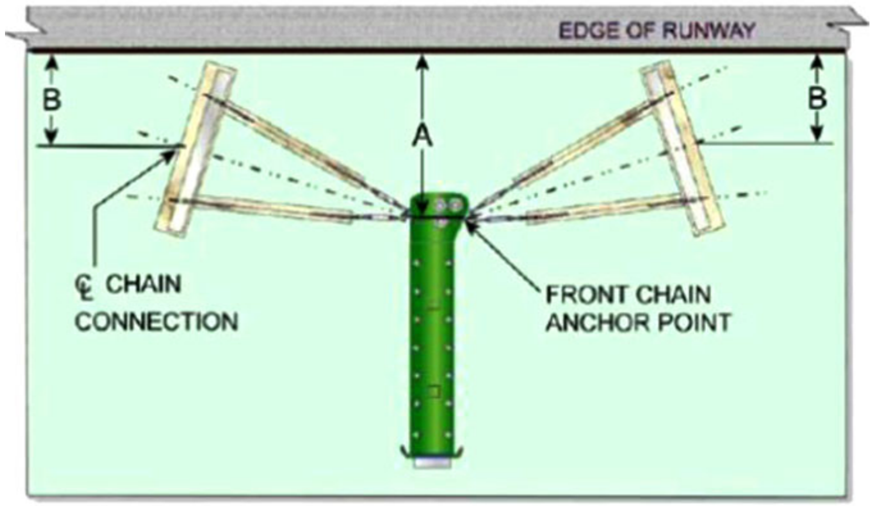


Figure 2–67. Dead-man anchoring.

The procedure for layout and alignment mirrors the LWFB but has a few additional steps. After setting the alignment stakes for the SFB, place stakes to align the metal plates and chains. The setup will be on the SFB's front stake and backsighted to TBM #1 for a zero baseline. Turn two angles from the baseline, one at 80 degrees and the other at 280 degrees. These stakes will mark the center of the metal plate. Place four more stakes to mark the points that the chains connect to the metal plates. There are two chain connection points, one on each side, on each metal plate centerline stakes. The chain connection stakes will be 6.5 feet perpendicular to the line from the beam to the metal plate centerline stake.

Layout/alignment stake procedure

1. Determine the location of the barrier and set up the instrument over that point (TBM #1), then zero the instrument using the runway/MOS centerline as the baseline.
2. Collect stake distance information from the MAAS installation chief.
3. Place stake A (fig. 2–68) the "setback" distance from the runway/MOS edge designated by the MAAS chief.
4. Set up the instrument over stake A and backsight to TBM #1, then zero the instrument.
5. Turn the instrument 80 degrees right and place stake B1 15 feet away from stake A.
6. Turn 80 degrees left and place stake B2 15 feet from stake A.
7. Place two stakes on both sides of stake B1 at 6.5 feet perpendicular to the line A to B1.
8. Repeat step 7 for stake B2.
9. Repeat steps three thru eight on the opposite side of the runway/MOS.

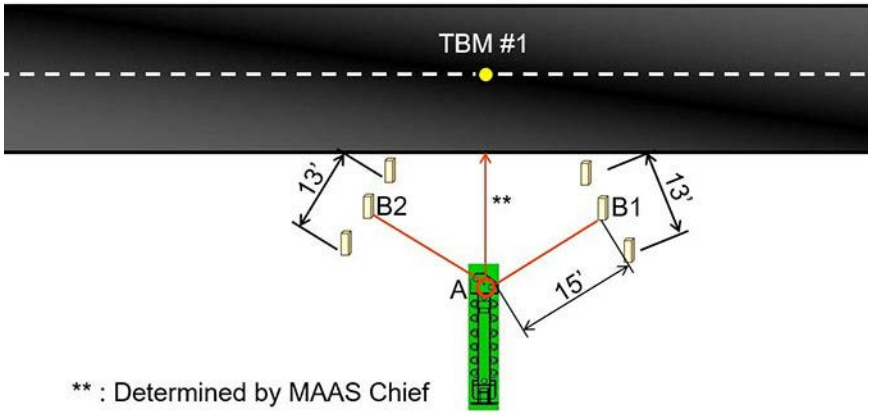


Figure 2–68. Dead-man stake layout.

Unit 2 Summary

Before, during, or after an attack or natural disaster, the installation commander will order the stand-up of the EOC. The EOC will, then, contact each ESF representative, and UCCs across the installation. Once the threat has passed, the EOC will order the ADATs to begin inspection of the airfield. The ADATs will relay all damage to the MAOS selection team in the form of damage coordinates. Within 30 minutes of receiving the final damage coordinate from the ADAT, the MAOS selection team will develop *at least* three MOS candidates for the installation commander's approval. After MOS selection, the airfield damage repair (ADR) teams move to the airfield. Among the ADR teams are the CPM team, the MAOSMS layout team, and the MAAS team. The MAOSMS layout team will setup the markers and PAPIs for the MOS, while also providing DCP measurements at the MAAS location and on all crater repairs. The CPM team will measure the upheaval before crater repair, then the RQC, calculated by the MAOS selection team, after crater repair. Finally, aircraft will launch to provide natural disaster support or to counterattack!

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

616. Using the Minimum Airfield-Operating Surface Marking System

1. What is the composition of the MAOSMS team?

2. List the two parts of the MAOSMS layout sequence.

3. MAOSMS traffic cone layout occurs in what order?

4. Describe how taxiway intersection cones are placed.

5. MOS edge markers indicate what two areas of an MOS?

617. Using crater profile measurement

1. CPM is an expedient method used to measure what around a crater?

2. CPM use requires two personnel, each doing what?

618. Evaluating soil strength

1. List the CBR values of tilled farmland, moist sand, crushed rock, and California limestone.

2. List the three parts of the DCP.

3. What is the weight of the DCP hammer? How far is it dropped?

4. What is the required CBR value for airfield crater repair and MAAS installation?

619. Placing precision approach path indicators

1. List the three phases for PAPI installation.

2. To calculate PAPI location we need two pieces of information. What are they? Where can we find them?

3. The correction distance is calculated using the elevation difference between what two points?

4. Where are the guide stakes placed relative to the inboard and outboard PAPI stakes?

620. Laying out and aligning the Mobile Aircraft Arresting System

1. What are the two types of low-profile beam used to allow the MAAS to be placed further away from the runway (offset)?

2. What is the minimum CBR required for the LWFB?

3. The standard fairlead beam with dead-man anchoring system will be used if the CBR is less than what number?

Answers to Self-Test Questions

610

1. Unity of efforts, coordinate ESFs together, to recover from disasters, enemy attacks, or dangerous incidents.
2. Each ESFs log of activity and reports on status, to include personnel and supplies.

611

1. Operations management (3E6X1).
2. Tracks personnel accountability, task completion, priorities, and supplies.

612

1. (1) Zero point rule.
   (2) Centerline rule.
   (3) Left/right rule.
2. Apparent size is from edge to edge of crater interior, while full repair size includes upheaval.
3. (1) The type designator C.
   (2) Distance from threshold.
   (3) Left/right designator.
   (4) Distance from centerline.
   (5) Diameter designator.
   (6) Apparent diameter size.
4. (1) Type designator X.
   (2) Distance from threshold.
   (3) Left/right designator.
   (4) Distance from centerline.
   (5) Description.
5. (1) Type designator S or B.
   (2) Closest side's center distance from threshold.
   (3) Left/right designator.
   (4) Distance from centerline.
   (5) Width designator.
   (6) Width distance.
   (7) Field identifier.
   (8) Opposite side's center distance from threshold.
   (9) Left/right designator.
   (10) Distance from centerline.
   (11) Width designator.
   (12) Width distance.
   (13) Number designator.
   (14) Number of spalls or bomblets within the field.
6. Same as a crater, but twice, once as the opening for the camouflet, and again as the estimated full-sized crater with the potential crater size.
7. 1000: 1996, 100: 192961, 10: 19269614.

613

1. Contact EOC director/manager for aircraft operations, gross weights, capability for unidirectional or bidirectional MOS. Contact weather, determine operational lengths, and conduct communications checks with UCC, ADATs, and alternate EOC.
2. The apparent diameter.
3. The item number from the ADAT report log.

614

1. ESF and airfield operations personnel.
2. Unidirectional and bidirectional
3. Limiting access/egress, air traffic control, the types of aircraft, or by restricting flight approach of aircraft.
4. (1) Cul-de-sac.
   (2) Only one access route.
   (3) Taxi distance.

615

1. (1) Dry.
   (2) WR.
   (3) SLR/LSR/PSR/IR.
2. Temperature and pressure altitude.
3. RSC.
4. Patch location is the distance from the MOS threshold to the center of the patch area. Patch spacing is the distance from the center of one patch to the center of the next patch.
5. Add the uncorrected RQC and the correction factor together.
6. The repair is out of tolerance or the repair is not good.

616

1. Engineering Journeyman (3E551), Structural Journeyman (3E351), and four personnel from any CE specialty.
2. Layout of the traffic cones and the edge markers.
3. Threshold, approach lighting, MOS centerline, crater repair “T” clear zones, navigational aids (PAPI), MAAS location, taxiway intersections, and the departure end.
4. Three cones arranged in an equilateral triangle three feet apart, pointing toward the taxiway centerline.
5. Threshold/departure ends and MOS outside edge.

617

1. Upheaval.
2. One person will be moving the rod toward or away from the stanchions. The second person will be looking over the nearest stanchion, lining them up, and viewing the difference to the target rod.

618

1. 3, 10, and 80.
2. (1) Upper assembly.
   (2) Lower assembly.
   (3) Vertical scale assembly.
3. It is 17.6 lbs. and is dropped 574 mm.
4. 25 for crater repair and at least 7 for MAAS installation.

619

1. (1) Calculate PAPI location.
   (2) Lay out the PAPIs.
   (3) Align the inboard and outboard units.
2. The threshold crossing height, and the glide slope, both received from the SAA.

3. The uncorrected PAPI location and the MOS threshold.
4. Ten feet on either side of each.

620

1. LWFB and SFB with dead-man anchoring system.
2. 7.
3. 7.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field-Scoring Answer Sheet.

Do not return your answer sheet to the Air Force Career Development Academy (AFCDA).

31. (610) What person fills the emergency operations center (EOC) director position?
    a. Installation commander.
    b. Contracting commander.
    c. Civil engineering commander.
    d. Mission support group commander.

32. (610) Who is the "administrative arm" of the emergency operations center (EOC)?
    a. EOC director.
    b. EOC manager.
    c. Incident commander.
    d. Civil engineer commander.

33. (610) Which is NOT considered a first responder?
    a. Firefighters.
    b. Law enforcement.
    c. Mortuary affairs personnel.
    d. Emergency medical personnel.

34. (611) Who is in command of the unit control center (UCC)?
    a. Programs element.
    b. Chief of operations.
    c. Chief of engineering.
    d. Civil engineer commander.

35. (611) Who monitors task completion and reports it to unit control center (UCC) leadership?
    a. Chief of operations.
    b. Chief of engineering.
    c. Air Force specialty code (AFSC) supervision.
    d. Noncommissioned office in charge (NCOIC), plans and programs.

36. (612) Which of these is NOT a part of the basic equipment an air damage assessment team (ADAT) needs?
    a. Vehicle.
    b. Lensatic compass.
    c. Way to record damage.
    d. Way to communicate with emergency operations center (EOC).

37. (612) At what interval, in feet, are pavement reference marking system (PRMS) markers placed?
    a. 25 to 50.
    b. 50 to 100.
    c. 100 to 200.
    d. 200 to 400.

38. (612) When establishing a pavement reference marking system (PRMS), which rule establishes left and right of the centerline when facing away from the runway zero point?
    a. Letter.
    b. Left/right.
    c. Centerline.
    d. Zero point.

39. (612) The air damage assessment team (ADAT) will record which type of crater diameter?
    a. Actual.
    b. Repair.
    c. Apparent.
    d. Upheaval.

40. (612) How is a crater 280 feet from the threshold, 60 feet left of the centerline, with a diameter of 40 feet written?
    a. C260L60D40.
    b. C280R50D40.
    c. C280R60D40.
    d. C280L60D40.

41. (612) What does the “F” in spall field damage coordinate designate?
    a. Front of the field.
    b. Corner of the field.
    c. Start of the coordinate for the far end of the field.
    d. Start of the coordinate for the closest side of the field.

42. (612) When a munition penetrates the surface of the pavement and detonates underground, leaving a void, what is it called?
    a. Spall.
    b. Crater.
    c. Bomblet.
    d. Camouflet.

43. (612) When replacing pavement reference marking system (PRMS) damage coordinates with military grid reference system (MGRS) coordinates, to what accuracy are they calculated?
    a. 4-digit, 1,000 meter.
    b. 6 digit, 100 meter.
    c. 8-digit, 10 meter.
    d. 10-digit, 1 meter.

44. (613) What scale is the standard-sized *airfield* map used by the minimum airfield-operating surface team?
    a. 1:1000.
    b. 1:1200.
    c. 1:2400.
    d. 1:4800.

45. (613) When plotting spalls as polygons, the last action to add to the polygon is
    a. marking the estimated number of spalls.
    b. connecting the beginning and ending centerpoints.
    c. connecting the end points to complete the polygon.
    d. plotting the ending width perpendicular to the first line.

46. (614) How many minutes does the minimum airfield operating surface (MAOS) team have to come up with minimum operating strip (MOS) candidates?
    a. 15.
    b. 30.
    c. 45.
    d. 60.

47. (614) Who has the final say regarding the dimensions of a minimum operating strip (MOS)?
    a. Unit control center.
    b. Installation command.
    c. Emergency operations center.
    d. Minimum airfield operating surface team.

48. (614) What factor is a major obstacle to utilizing a bi-directional minimum operating surface?
    a. Wind direction.
    b. Need for two sets of major navigational aids (NAVAID).
    c. Aircraft have to maneuver toward their target after takeoff.
    d. Elevation between the runway threshold and departure ends.

49. (614) Which of these is NOT a primary access/egress limitation?
    a. Back-taxi.
    b. Cul-de-sac.
    c. Taxi distance.
    d. Only one access route.

50. (614) Regarding minimum operating strip (MOS) naming, what does “UM” mean?
    a. Unilateral.
    b. Uniform mike.
    c. Unidirectional.
    d. Under minimum.

51. (615) In which column of repair quality criteria (RQC) Worksheet 1 would you note the need for arrestment during a landing operation?
    a. Direction.
    b. Operation.
    c. Special landing procedures.
    d. Aircraft model.

52. (615) How would the presence of ice on the runway be written in the runway surface condition (RSC) box on Worksheet 1?
    a. Runway ice (RI).
    b. Ice on runway (IR).
    c. Aircraft skid hazard (ASH).
    d. Packed snow on runway (PSR).

53. (615) What two sections on the aircraft operation chart are used to determine the operational lengths?
    a. Density ratio (DR) and condition.
    b. DR and patch spacing.
    c. Condition and patch spacing.
    d. Patch spacing and patch length.

54. (615) What characteristic is defined as the distance from one patch area's center to the next patch area's center?
    a. Patch length.
    b. Patch spacing.
    c. Patch location.
    d. Operation block.

55. (615) When a repair patch, and the one immediately after need to be repaired flush, how is that noted?
    a. F.
    b. FL.
    c. FF.
    d. F-FF.

56. (615) Which team is responsible for comparing the crater repair with the repair quality criteria (RQC) value?
    a. Crater profile measurement (CPM) team.
    b. Damage assessment repair team (DART).
    c. Airfield damage assessment team (ADAT).
    d. Minimum airfield operating surface (MAOS) team.

57. (615) Because the repair slope matches the runway slope, how are the crater profile measurement (CPM) test lanes related to the runway centerline?
    a. Parallel.
    b. 45 degrees.
    c. Perpendicular.
    d. Measured from the shoulder.

58. (616) How many, and at what interval, are approach lighting marker cones placed off the minimum operating strip (MOS)?
    a. 7 at 100 feet.
    b. 7 at 200 feet.
    c. 9 at 100 feet.
    d. 9 at 200 feet.

59. (616) To assist the paint striping team, centerline cones are offset how far to the left when placing them along the minimum operating strip (MOS)?
    a. 2 feet.
    b. 2.5 feet.
    c. 3 feet.
    d. 3.5 feet.

60. (616) Taxiway intersections with the minimum operating strip (MOS) are marked by three cones, spaced three feet apart, in what type of formation?
    a. Line.
    b. Rectangle.
    c. Right triangle.
    d. Equilateral triangle.

61. (616) How many edge markers are placed on either side of the threshold and departure ends of the minimum operating strip (MOS)?
    a. 6.
    b. 8.
    c. 10.
    d. 12.

62. (616) With the exception of immediately after the arresting system, edge markers should be placed at what interval?
    a. 25 feet.
    b. 50 feet.
    c. 100 feet.
    d. 200 feet.

63. (616) How far off the edge of the minimum operating strip (MOS) are distance-to-go (DTG) markers placed?
    a. 10 feet.
    b. 15 feet.
    c. 25 feet.
    d. 35 feet.

64. (617) When performing crater profile measurement (CPM) to measure upheaval, the person holding the rod continues to take one pace toward the stanchion until the
    a. stanchion IS visible.
    b. stanchion IS NOT visible.
    c. target triangle on the rod IS visible.
    d. target triangle on the rod IS NOT visible.

65. (617) Before marking the pavement, the person holding the rod will do what last step during crater profile measurement (CPM)?
    a. Sidestep to the left of the rod.
    b. Sidestep to the right of the rod.
    c. Take one additional step toward the stanchion.
    d. Take one additional step away from the stanchion.

66. (618) To ensure that each blow to the dynamic cone penetrometer (DCP) anvil has the same force, what action must take place with regards to the hammer?
    a. Ease it onto the anvil.
    b. Throw it down on the anvil.
    c. Allow the hammer to freefall.
    d. Push the hammer into the anvil.

67. (618) During soil strength evaluation, the dynamic cone penetrometer (DCP) recorder notes the number of blows every
    a. 25 millimeters.
    b. 20 millimeters.
    c. 50 millimeters.
    d. 100 millimeters.

68. (618) After how many blows without penetrating deeper, should you remove the drive rod, change locations, and restart the dynamic cone penetrometer (DCP) test?
    a. 15.
    b. 20.
    c. 25.
    d. 30.

69. (618) What do we call the relationship between the number of dynamic cone penetrometer (DCP) blows and its depth of penetration?
    a. California Bearing Ratio (CBR) Index.
    b. Strength Ratio.
    c. CBR Value.
    d. DCP Index.

70. (619) Other than the handbook, where can you get the threshold crossing height (TCH) and/or glide slope for mission aircraft?
    a. Special Aircraft Agency (SAA).
    b. Senior Airfield Authority (SAA).
    c. Federal Airfield Authority (FAA).
    d. Federal Aviation Administration (FAA).

71. (619) Which trigonometry function is used to calculate the uncorrected precision approach path indicator (PAPI) distance?
    a. Sine.
    b. Cosine.
    c. Tangent.
    d. Cotangent.

72. (619) If the elevation at the threshold is lower than the elevation at the uncorrected precision approach path indicator (PAPI) location, how do we need to move the PAPIs?
    a. Left of the centerline.
    b. Right of the centerline.
    c. Closer to the threshold.
    d. Farther from the threshold.

73. (619) If the uncorrected precision approach path indicator (PAPI) distance is 765 feet, the correction is 90 feet, and the elevation at the threshold is HIGHER than the PAPI location, what is the corrected PAPI distance in feet?
    a. 675.
    b. 774.
    c. 756.
    d. 855.

74. (619) The inboard precision approach path indicator (ip) stake is placed how many feet from the left edge of the runway?
    a. 25.
    b. 35.
    c. 50.
    d. 80.

75. (619) The outboard precision approach path indicator (op) stake is placed how many feet from the left edge of the runway?
    a. 25.
    b. 35.
    c. 50.
    d. 80.

76. (619) When adjusting the guide stake elevations, what is the distance, in inches, from the precision approach path indicator (PAPI) base to the center of the light lenses?
    a. 6.
    b. 9.
    c. 12.
    d. 15.

77. (620) According the figure 2–65, what distance is the maximum, in feet, from the minimum operating strip (MOS)/runway edge that the Mobile Aircraft Arresting System (MAAS) exit sheave can be placed?
    a. 12.
    b. 100.
    c. 200.
    d. 300.

78. (620) When placing the center deadman anchor stakes, at what angle, in degrees, are they placed from the standard fairlead beam?
    a. 80.
    b. 10.
    c. 12.
    d. 15.

Student Notes

Glossary

Abbreviations and Acronyms

°	degree
θ	theta
ADAT	airfield damage assessment team
ADR	airfield damage repair
AEF	Air and Space Expeditionary Force
AETF	Air and Space Expeditionary Task Force
AFH	Air Force handbook
AFI	Air Force instruction
AFMAN	Air Force manual
AFPAM	Air Force pamphlet
AFSC	Air Force specialty code
AFTTP	Air Force tactics, techniques, and procedures
AM-2	aluminum-plank matting–2
BCE	base civil engineer
BEAR	basic expeditionary airfield resources
BOB	basic expeditionary airfield resources order of battle
C2	command and control
CAD	computer-aided drafting
CBR	California Bearing Ratio
CBRNE	chemical, biological, radiological, nuclear, and explosives
CCDR	combatant commander
CE	civil engineering
CIP	common installation picture
CPM	crater profile measurement
DCP	dynamic cone penetrometer
DoD	Department of Defense
DR	density ratio
DRF	disaster response force
DTG	distance-to-go
EALS	Expeditionary Airfield Lighting System
ECU	environmental control unit
EOC	emergency operations center

EOD	explosive ordnance disposal
ESF	emergency support function
F	flush; Fahrenheit
FEMA	Federal Emergency Management Agency
FF	flush follows
GeoExPT	Geospatial Expeditionary Planning Tool
GIS	geographic information system
GPS	global positioning system
HAZMAT	hazardous material
HVAC	heating, ventilation, and air conditioning
IC	incident commander
IDF	indirect fire
IED	improvised explosive device
IOC	initial operating capability
ip	inboard precision approach path indicator
IR	ice on runway
kW	kilowatt
LOR	launch and recovery
LOX	liquid oxygen
LSR	loose snow on runway
LWFB	lightweight fairlead beam
MAAS	Mobile Aircraft Arresting System
MAOS	minimum airfield-operating surface
MAOSMS	Minimum Airfield-Operating Surface Marking System
MEP	mobile electric power
MGRS	military grid reference system
MOPP	mission-oriented protective posture
MOS	minimum operating strip
MSG	mission support group
NAVAID	navigational aid
op	outboard precision approach path indicator
PAPI	precision approach path indicator
POL	petroleum, oil, and lubricants
PRMS	pavement reference marking system
PSR	packed snow on runway

QD	quantity-distance
RALS	Remote Area Lighting System
ROWPU	Reverse Osmosis Water Purification Unit
RQC	repair quality criteria
RSC	runway surface condition
SA	situational awareness
SAA	senior airfield authority
SDF	spatial data file
SF	security forces
SFB	standard fairlead beam
SLR	slush on runway
SME	subject-matter expert
SSS	Small Shelter System
Tan	tangent
TBM	temporary benchmark
TCH	threshold crossing height
TO	technical order
ToC	table of contents
ToL	takeoff and landing
UCC	unit control center
UFC	Unified Facilities Criteria
UTC	unit type code
UXO	unexploded ordnance
VBIED	vehicle-borne improvised explosive device
WR	wet runway

Student Notes

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