AIR FORCE TACTICS, TECHNIQUES, AND PROCEDURES 3-32.10

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INTRODUCTION TO RAPID AIRFIELD DAMAGE RECOVERY (RADR)

DEPARTMENT OF THE AIR FORCE

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BY ORDER OF THE SECRETARY OF THE AIR FORCE

AIR FORCE TACTICS, TECHNIQUES, AND PROCEDURES 3-32.10

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Tactical Doctrine

INTRODUCTION TO RAPID AIRFIELD DAMAGE RECOVERY (RADR)

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This publication supports Air Force Instruction (AFI) 10-210, *Prime Base Engineer Emergency Force (BEEF) Program*, and AFI 10-209, *RED HORSE Program.* This publication applies to the Regular Air Force, the Air Force Reserve, and the Air National Guard. This publication does not apply to the United States Space Force. This publication introduces Rapid Airfield Damage Recovery (RADR) and reference RADR tactical doctrinal publications. Ensure all records generated as a result of processes prescribed in this publication adhere to AFI 33-322, *Records Management and Information Governance Program*, and are disposed in accordance with the Air Force Records Disposition Schedule, which is located in the Air Force Records Information Management System. Refer recommended changes and questions about this publication to the office of primary responsibility using the Department of the Air Force (DAF) Form 847, *Recommendation for Change of Publication;* route DAF Forms 847 from the field through the appropriate functional chain of command.

SUMMARY OF CHANGES This publication has been substantially revised and must be completely reviewed. It includes additional guidance not available during the last revision and new guidance on Explosive Ordnance Disposal mitigation during contingency operations and returning to normal operations.

APPLICATION: This publication applies to individuals who perform and/or manage RADR operations, including the Air Force Reserve and Air National Guard, unless noted otherwise. This document is authoritative but not directive and does not replace mandatory compliance requirements in applicable Air Force Instructions (AFI) or other directive publications. If the TTPs found in this publication conflict with other nondirective publications, contact the Air Force Civil Engineer Center (AFCEC) Reachback Center or CE Dash (with contact info) for resolution. Contact the Reachback Center at Commercial 850-283-6995, Toll Free at 888-232-3721, and Defense Switched Network 523-6995, or Email at AFCEC.RBC@us.af.mil.

SCOPE: This publication introduces RADR operations for airfield recovery after attack. It describes the RADR phases, posturing assets, command and control, manning requirements, recovery progress and personnel status reporting, setting up temporary refueling stations to refuel vehicles while performing RADR operations, maintenance actions required for assets in War Reserve Materiel storage, and actions necessary to prepare for airfield recovery.

Chapter 1

INTRODUCTION

1.1. Overview. The ability to conduct uncontested aerial warfare and airlift operations within proximity to the theater of operations has been, until recently, an assumed ability—this assumption is no longer valid in all potential joint mission scenarios. This assumed ability becomes increasingly invalid as potential adversaries continue to increase their long range offensive capabilities. Joint forces will conduct operations in the face of significant anti-access area denial weapons, and the United States Air Force will be required to support combat sortie generation within this environment. Accordingly, the ability to repair aircraft operating surfaces after an anti-access area denial attack is crucial.

1.1.1. Rapid Airfield Damage Recovery (RADR) is an essential element of enabling air base resiliency and continuation of airfield operations to ensure the rapid projection and application of United States military power around the globe. RADR encompasses all actions required to rapidly repair aircraft operating surfaces and localized infrastructure to recover operations at an airfield after attack, whether the airfield is offered for use by a host nation or established as a United States operating location.

1.1.2. Preplanning should consider the scalability of the RADR capability to support the Combatant Commander's (CCDR) critical needs at various airfield locations as RADR operations may differ by airfield and aircraft configurations.

1.1.3. RADR may be conducted under multiple conditions such as non-permissive environments, all weather conditions, chemical, biological, radiological and in a degraded environment.

1.1.4. RADR forces, equipment, and operational concepts should be identified in the appropriate annex and attachments to the Installation Emergency Management Plan 10-2 and in other installation response plans for post-attack activities. See

Department of the Air Force Instruction (DAFI) 10-2501 for more information on the Installation Emergency Management Plan 10-2.

1.1.5. RADR is only one phase of recovery after an attack, which is only one function within Airfield Damage Repair (ADR). In addition to RADR, which rapidly establishes a minimum airfield operating surface (MAOS), other recovery phases include: MAOS sustainment, MAOS expansion, and reconstitution of the airfield. This AFTTP focuses only on RADR operations.

1.2. Integration of Overlapping Phases. After an attack on the airfield, hundreds of craters, camouflets, spalls, and various quantities of unexploded explosive ordnance (UXO) could be expected. RADR capability requires multiple critical tasks be accomplished with seamless integration. These are often accomplished within overlapping and simultaneous timeframes; otherwise, there is risk of failing to meet time compression goals while keeping attrition of recovery personnel, equipment, and vehicles within the CCDR's acceptable levels. These tasks include rapid airfield damage assessment, rapid mitigation of explosive hazards, and rapid repair of damaged surfaces and critical infrastructure. Effective damage assessment enables engineers to identify, assess, and analyze airfield damage and hazards. Explosive Ordnance Disposal (EOD) personnel must then mitigate the identified explosive hazards on the access routes, equipment and material staging areas, and the selected MAOS. Finally, once explosive hazards within repair areas are mitigated, teams begin repairing the MAOS and associated critical infrastructure.

1.3. Scalability. Due to various installations, threats, and missions, RADR capabilities are adaptive and scalable; a one-size, one-solution RADR capability will not support this broad spectrum. RADR capabilities can support thousands of combat sorties for all airframes, provide temporary to semi-permanent repair options in all pavement conditions, and support employ-in-place and expeditionary capabilities.

1.4. Capability. RADR equipment, material, personnel, and vehicles necessary to recover an airfield following an attack are similar to those required for airfield

opening and operation. However, airfield recovery likely requires far more assets in order to reestablish flying operations during day or night within acceptable timeframes. These capabilities are tailored to address specific installation or threat requirements. Commanders must be cognizant that RADR capabilities are directly impacted by attrition, environmental conditions, the chemical, biological, radiological and nuclear environment, and threat environment.

1.4.1. The RADR capability establishes a MAOS, including a Minimum Operating Strip (MOS) up to 150 ft. x 10,000 ft., and associated taxiways, ramps, access routes, and critical infrastructure. The resulting durable repairs provide an acceptable number of passes for any combination of US aircraft types before requiring sustainment maintenance.

1.4.2. As previously stated, RADR consists of three overlapping and interdependent phases:

1.4.2.1. Rapid Damage Assessment to identify and characterize the damage and hazards.

1.4.2.2. Rapid Explosive Hazard Mitigation (REHM) to neutralize UXO within and in close proximity to repair zones.

1.4.2.3. Rapid Damage Repair (RDR) to repair selected pavement damage and establish the MAOS. Each phase is critical to the RADR capability with the coordinated REHM and RDR phases conducted concurrently to maximize time compression.

1.5. Rapid Damage Assessment. This phase focuses on collecting and analyzing data to determine the presence of hazards and overall airfield condition to include the number, location and type of craters, UXO, and other damage characteristics such as camouflets (cavities formed from a deep underground burst with minimal surface rupture) and spalls (surface damage which does not penetrate the pavement base course). Assessment is accomplished using a combination of manual and automated data collection systems. Automated systems reduce the

UXO threat to Airmen and the assessment timeline. Data collected during this phase is used to select the most appropriate MAOS to repair (see AFTTP 3-32.12, *Minimum Airfield Operating Surface (MAOS) Selection and Repair Quality Criteria (RQC)*, for MAOS selection procedures). Airfield damage assessment procedures are described in AFTTP 3-32.11, *Airfield Damage Assessment after Attack*.

1.6. Rapid Explosive Hazards Mitigation (REHM). Expedient recovery of airfields requires an Explosive Ordnance Disposal (EOD) capability that can effectively remove hazards associated with UXO prior to the start of repairing aircraft operating surfaces and repairing damaged infrastructure. EOD technicians support RADR by removing, rendering safe, or detonating UXO impacting the recovery process. A family of UXO assessment and mitigation tools, platforms, and systems provides EOD technicians the capability to safely and rapidly mitigate the UXO threat. These platforms and systems, operated (or supervised) by EOD personnel, allow surface and subsurface UXO positive identification, neutralization, collection, removal, and ultimate disposal on and off the airfield operating surfaces, access routes, and equipment and material staging areas. See AFTTP 3-32.5V10, *Explosive Ordnance Disposal (EOD) Rapid Airfield Damage Recovery (RADR) And Explosive Hazards Mitigation (EHM)*, for general guidance on planning, training, equipping, and developing policy for RADR and recovery of airbases denied by ordnance (RADBO) directed energy operations.

1.6.1. Process. UXO mitigation within the RADR program is allotted sixty minutes from reception of the MAOS candidate to the recovery crews starting restoration activities. This includes team and material staging areas, convoy routes, and repair zones. Mitigation activities continue to clear the remaining threats to the MAOS throughout the entire recovery process.

1.6.2. REHM Capabilities. REHM is a family of systems and techniques used to locate, identify, and mitigate UXO threats. Each capability is packaged as a Unit Type Code (UTC).

1.6.2.1. Manned Operations:

1.6.2.1.1. Commonly known as blow-and-gos or in-and-outs. Blow and go involves walking a sweep line while setting charges to clear the maximum amount of ground rapidly. In and outs involves deliberately setting charges in sweep line and then initiating those charges while exiting the area. The primary consideration when choosing between the two is the safe area location in relation to the starting point. This process uses other munitions to detonate the extremely small UXO. This process creates a spall per mitigated munition.

1.6.2.1.2. Multiple techniques for removing ordnance from the runway exist. The most common of these is using rope or chain as a drag line to move the ordnance while maintaining a safe standoff during the move. These techniques require much more time than the explosive or heavy equipment methods, but still have a role.

1.6.2.2. 4F9RD EOD Recovery of Airbases Denied by Ordnance (RADBO) Vehicle: Large tactical vehicle with a laser. Intent is to eliminate small UXO by forcing a low-order detonation.

1.6.2.3. Mass Mechanical Clearance (MMC):

1.6.2.3.1. EOD personnel will be the primary operators of the MMC vehicles. Other licensed operators can be used to augment the driver pool. However, a qualified EOD person should manage the MMC team due to their knowledge of the UXO hazards. Driver augmentees should be provided additional UXO familiarization by EOD personnel upon selection.

1.6.2.3.2. 4F9XL EOD REHM Loader and Large Clearance Blade Assembly. A front-end loader with a specialized blade attached to the front of the vehicle. The blade is designed to protect the operator from blast and fragmentation hazards when pushing bomblet sized munitions to the side of the MAOS without causing detonations or additional damage to the runway. Munitions are to be mitigated at a later date or when time permits. This UTC is currently being fielded.

1.6.2.4. Munitions Reval Team (MRT). MRT can be formed to augment the EOD team. Once EOD has rendered safe a UXO for transport, the bomb removal team lifts, secures, and transports the UXO to a predetermined safe holding area. A MRT should be considered if the local threat includes larger ordnance items such as aircraft bombs or missiles.

1.6.2.4.1. Equipment commonly used for the MRT task are dump trucks and Front End Loaders (FEL). Both vehicles and heavy equipment should be reinforced with sandbags or sand to help cushion the UXO and provide protection in case of an inadvertent detonation.

1.6.2.4.2. Operators do not have to be engineers since Civil Engineer (CE) will more than likely be stretched to the limit. To the greatest extent possible, personnel should be volunteers from the installation augmentation pool. See AFTTP 3-32.5V10 for instructions on properly marking ordnance for the MRT.

1.6.2.4.3. The MRT will be trained by EOD personnel in accordance with AFTTP 3-32.5V10 during pre-attack actions.

1.6.3. Stockpiling/Marking. All munitions left adjacent to the MAOS must be dealt with as both debris and as an explosive hazard.

1.6.3.1. Small and medium munitions must be pushed at least 30-ft from the edge of the MAOS, and piled no higher than 36-in. However, due to the risk of explosion; the munitions are not to be pushed off the paved surfaces. Note: This may affect the MAOS selection process in that the pavement may be reserved for stockpiled munitions.

1.6.3.2. EOD personnel will dictate the number of munitions allowed to be in a single stockpile and the separation of the stockpiles. These calculations are based on the combined net explosive weight of the piled munitions. The UXO should be collected either on one side of the paved surface or on designated taxiways. This decision should be made in conjunction with the MAOS selection team.

1.6.3.3. Each UXO stockpile will be marked with survey tape to highlight the piles containing UXO and not just debris. Marking materials are being added to the 4FWCR, Crater Repair Vehicle UTC. The marking kit will be stored in the tool trailer and consist of plastic buckets, a marking rod, and survey tape. Until fielded, the survey tape can be attached to something within or near the stockpile. Note: For more guidance on REHM procedures see AFTTP 3-32.5V10.

1.7. Rapid Damage Repair Phase. Once the explosive hazard threat has been sufficiently mitigated in a repair zone, RDR teams begin repairing craters, camouflets, spalls, and other damage impeding flying operations on the MAOS. In some scenarios, hundreds of craters could require repair within acceptable time frames to meet the commander's Air Tasking Order. This requires multiple teams, each using an assembly line process to achieve repair objectives. Where logistics supply/resupply cannot support the repair in a timely manner, repair capabilities are prepositioned.

1.7.1. Optimized techniques and advanced, rapid-setting materials are used to minimize the Mean Time to Repair for both asphalt-concrete and Portland Cement Concrete (PCC) surfaces. Materials and procedures provide pavement repair supporting the range and intensity of joint aircraft traffic required to meet airpower objectives. Rapid crater repair processes are listed below. See AFTTP 3-32.17, *Rapid Airfield Crater and Spall Repair*, for detailed descriptions of the damage repair processes that follow.

1.7.1.1. Debris Removal**.** This process clears debris at least 15 feet from around each crater to allow subsequent processes to proceed. After debris is removed from around each crater, it is then pushed at least 30 feet from the edge of the MAOS.

1.7.1.2. Upheaval Determination and Marking. The explosion from munitions hitting the runway creates upheaved pavement around the crater. Upheaved pavement is not always visible to the eye; therefore, upheaval determination is accomplished through crater profile measurements to ensure all damaged pavement is identified and removed. Unremoved upheaval will most likely fail

under traffic and create foreign object debris (FOD) hazards. Conversely, removing more pavement than necessary increases repair times and uses more repair material than necessary, possibly depleting repair material before all repairs are complete. Identify extent of upheaval as described in Technical Order (T.O.) 35E2-5-1, *Crushed-Stone Crater Repair and Line-of-Sight Profile Measurement for Rapid Runway Repair* for craters with an apparent size of 20 feet in diameter or larger (**Note:** Marks should form square or rectangle pavement cut marks). Use procedures in AFTTP 3-32.17 when apparent crater size is less than 20 feet in diameter.

1.7.1.3. Pavement Cutting. In regard to time, pavement cutting is the most critical step in the repair process. Two compact track loaders (CTL) with wheel saw attachments cut pavement around craters by following the marks created during the upheaval marking process. The conventional walk behind concrete saw may be required in conjunction with the wheel saws when dowels or rebar are in the saw path.

1.7.1.4. Pavement Breaking and Excavation. This process includes breaking the damaged pavement within the cut lines with an excavator and hammer attachment and removing the disturbed subsurface material from the repair using a separate excavator with a bucket attachment. The Debris Removal Crew assists with removing the excavated debris from the MAOS.

1.7.1.5. Backfilling Repair. This process utilizes a medium strength, high viscosity, excavatable, rapid-setting, cementitious backfill material, known as flowable fill, in place of traditional crushed stone. Prior to capping the repair with PCC, the repair is backfilled with flowable fill using the dry placement technique commonly known as “slash and splash.” This is accomplished by suspending a 3,000 pound super sack of flowable fill over the excavated area, “slashing” the bottom of the sack to release the material into the repair, and then “splashing” the backfill with 50 gallons of water until reaching the prescribed depth. The process for backfilling beneath an asphalt cap is accomplished with the same flowable fill material but mixed with a volumetric mixer and using a wet placement technique.

Note: Crushed stone may be used in lieu of flowable fill; however, additional time, equipment, and personnel may be required to haul, place, and compact the stone.

1.7.1.6. Capping Repair. Capping material should match the existing material, but when material is short or when a team is repairing craters in both existing PCC and Asphalt-Concrete, mix-matching capping material and existing material is allowable; however, life expectancy of the repairs may be diminished. A concrete cap is placed using the volumetric mixer and a rapid-setting concrete mix provided in 3,000 pound super sacks. The asphalt cap is placed with asphalt produced by the asphalt recyclers and compacted with rollers.

Note: Airfield Matting (AM-2) may be used as a cap on aprons and taxiways, with the exception of high-speed taxiways and intersections. Fiber-reinforced Polymer (FRP) mat panels may be used as a cap depending on the aircraft type, operations, and location on the airfield. Use of these materials as caps may require additional monitoring and maintenance and will also require additional backfill materials. Furthermore, they will not be as durable as asphalt or Concrete caps.

1.7.1.7. Spall Repair. Spalls are defined as pavement damage that does not penetrate the full pavement thickness to the underlying base course, is not larger than five feet in diameter, and does not cause upheaval in surrounding pavements. Thousands of spalls will be expected after an attack with possibly hundreds requiring repairs. Spalls are expediently repaired by first removing debris and loose material from in and around them. Then, place rapid setting repair material in the spalls ensuring the final repair is level with the surrounding pavement.

1.7.2. Foreign object debris is removed from the MAOS by scraping, sweeping, and vacuuming all surfaces until accepted by Airfield Operations. As needed, airfield marking, aircraft arresting systems, and airfield lighting teams work simultaneously to restore required capability.

Chapter 2

POSTURING RAPID AIRFIELD DAMAGE RECOVERY (RADR) CAPABILITIES

2.1. Overview. RADR capabilities are scalable and modular and postured as primary and enabler UTCs. The baseline RADR capability (4FWCR) provides the tools, equipment, and vehicles to repair 18 small craters (8.5 ft x 8.5 ft x 2 ft), or two large craters (30 ft x 30 ft x 2 ft), within 6.5 hours utilizing flowable fill and rapid-setting concrete, or flowable fill and asphalt materials, depending upon the parent surface. Capabilities are typically considered "employ-in-place" UTCs and postured primarily as Medium (4FWCR x 3), Large (4FWCR x 5), or Very Large (4FWCR x 7) capabilities depending upon the local threat. In addition to the 4FWCR UTC, supporting UTCs (i.e. 4FWFD-FOD Removal, 4FWWH-Warehouse Operations, 4FWAE-Asphalt Batch Plant, and 4FWSR-Spall Repair) are required to provide the full RADR capability.

2.1.1. While the smallest capability is known as the "Small Capability," the name is somewhat a misnomer. The Small Capability has a fairly large footprint requiring approximately 93 personnel, 47 vehicles, and associated equipment and tools to execute the full capability.

2.1.2. If an expeditionary airfield recovery capability is desired, the Small Capability may be tailored to meet requirements. Transportation requirements can be considerably reduced if repair materials (i.e. crushed stone, PCC, asphalt, rapid setting concrete, or flowable fill) are available at the deployed location.

Note: If flowable fill, rapid-setting concrete, and/or asphalt materials are depleted, legacy repair materials (i.e., crushed stone, FOD covers) are utilized to complete repairs.

2.2. Vehicle UTCs. Vehicles listed in **Table 2.1** will normally be postured at installations with a required RADR capability (some major commands/combatant commanders [CCDRs] may centrally store assets). In accordance with AFI 24-

302, *Vehicle Management*, vehicles within RADR UTCs are considered War Reserve Materiel (WRM) assets; however, with coordination with the 441 Vehicle Support Chain Operations Squadron (VSCOS) some may be assigned to the CE unit as joint-use assets for normal day-to-day shop use.

2.3. Crater Repair Equipment. The equipment listed in **Table 2.2** will be postured at applicable installations with a particular RADR capability. Equipment is considered WRM assets, but some may be assigned to the CE unit as joint-use assets for normal day-to-day shop use.

Table 2.1. RADR Vehicle UTCs.

	Capability			
Vehicle	**Small**	**Medium**	**Large**	**Very Large**
4FWCR – Crater Repair				
Compact Track Loader	5	15	25	35
Front End Loader	2	6	10	14
Wheeled Excavator	2	6	10	14
Telehandler Forklift, 10K, 55ft Reach	2	6	10	14
Water Truck (Distributor), 1.5K Gal	2	6	10	14
Water Distributor Tank, 2K Gal	4	12	20	28
Volumetric Mixer	2	6	10	14
Dump Truck, 10-T (w/Water Skid)	1	3	5	7
Vibratory Roller, Dual Steel Wheel	1	3	5	7
Roller, Pneumatic	1	3	5	7
Trailer, 20T, 38’ Flatbed, Tool Attachments	2	6	10	14

	Capability			
Vehicle	**Small**	**Medium**	**Large**	**Very Large**
4FWFD – FOD Removal				
Grader	2	2	2	2
Dozer	1	1	1	1
Semi-Tractor Truck	1	1	1	1
Trailer, Lowboy, 50-60 Ton	1	1	1	1
Front End Loader	1	1	1	1
Ind. Tractor w/Kick-broom	2	2	2	2
Vacuum Sweeper	3	3	3	3
4FWWH – Warehouse				
Semi-Tractor Truck	1	3	5	7
*Warehouse Forklift, 6K	1	3	5	7
Telehandler Forklift, 10K, 55ft Reach	2	6	10	14
Trailer, 20-T, 38’ Flatbed	3	9	15	21
Dump Truck, 10-T	3	9	15	21
4FWAE – Asphalt Batch Plant Operations				
Asphalt Recycler Set (2 per set)	1	2	3	4
Front End Loader	1	2	3	4
TOTAL	**47**	**117**	**187**	**257**

*For use on improved surfaces only.
Note: During attack preparation actions marry prime movers with designated item to be towed to ensure no coupling or clearance issues. Also, ensure light and brake connections are compatible. Implement corrective actions as necessary.

Note: Spall Repair Crew(s) requires a truck(s) to haul personnel, repair material and tools, but is not included in the RADR vehicle UTCs. A dedicated vehicle(s) from the installation vehicle fleet should be identified for the spall crew(s) prior to commencement of hostilities (this situation holds true for the aircraft arresting system, airfield lighting, airfield marking, and water and fuel system repair teams).

Note: At the time of this writing, some volumetric mixers have experienced seized water pumps while stored in WRM. Recommend full operational test of all units before accepting from WRM. If pump is seized, WRM maintenance personnel should perform corrective action by disassembling pump, replacing the shear pin, and lubricating all lubrication points.

Table 2.2. RADR Crater Repair Equipment (4FWCR).

	Capability			
Equipment	**Small**	**Medium**	**Large**	**Very Large**
Compact Track Loader (CTL) Attachment Package				
Hammer, H65D	2	6	10	14
Chisel	2	6	10	14
Moil	2	6	10	14
Broom, Hyd, Angle	3	9	15	21
Broom, Poly Kit	3	9	15	21
Saw, Wheel, SW45	4	12	20	28
Saw, Wheel, SW60	5	15	25	35
Saw Teeth, Box (50 per box)	20	60	100	140
Compactor, Vibratory	1	3	5	7
Bucket-MP, BOCE 78”	1	3	5	7
Forks, 48” Pallet W/Carriage	2	6	10	14
Planer, Cold	1	3	5	7
Excavator Attachment Package				
Hammer, AR75B, W/Chisel PT	2	6	10	14
Bucket, 24”	2	6	10	14

	Capability			
Equipment	**Small**	**Medium**	**Large**	**Very Large**
Bucket, 48”	2	6	10	14
Compactor, Plate, 2300	2	6	10	14
Telehandler Forklift Attachment Package				
Forks, 72 inches long	4	12	20	28
Frontend Loader Attachment Package				
Bucket	3	9	15	21
Forks	3	9	15	21
Tool Trailer	1	3	5	7
Light Cart	6	18	30	42
Dump Truck Water Skid, 1K gal	2	6	10	14
Inclement Weather Kit	1	3	5	7

2.4. Crater Repair Materials. The materials listed in **Table 2.3** are postured at applicable installations with a particular RADR capability. Material will be considered WRM assets but may be stored in CE storage yards if WRM has insufficient storage space.

Table 2.3. RADR Crater Repair Material.

	Capability			
Material	**Small**	**Medium**	**Large**	**Very Large**
4FWCM – WRM RADR Concrete Crater Repair Material				
Flowable fill (3K-lb Super Sacks)	60	180	300	420
Rapid-Setting Concrete (3K-lb Super Sacks)	48	144	240	336
Citric Acid (50-lb bags)	2	6	10	14
4FWAE – WRM RADR Asphalt Crater Repair Material				
Flowable-Fill (3K-lb Super Sacks)	84	252	420	588
Asphalt (Tons)	40	120	200	280

ISO Containers to Store UTCs Above				
ISO Container	20	60	100	140
Note: Installations should stockpile appropriate quantities (depending on the RADR capability) of choke ballast, crushed stone, and sand.				

2.5. Spall Repair Kit (4FWSR). The Spall Repair Kit contains all necessary tools and material in three shipping containers (8-ft L x 6.5-ft W x 8-ft H) to expeditiously repair up to 200 spalls with an average size of 24-inches in diameter and 6-inches deep. Provide one 4FWSR per every 4FWCR tasked. A vehicle is required, but not provided in UTC (see AFTTP 3-32.18, *Rapid Airfield Damage Recovery Warehouse and Ground Transportation Operations*).

2.6. Ramp and Taxiway Expansion (4FWAM). Provides AM-2 matting, specialized components and assembly tools to cover damaged pavement and/or semi-improved airfield surfaces to expand/create a 216-ft x 198-ft aircraft parking apron or a 72-ft x 200-ft taxiway (taxiway is limited to this distance due to limited number of six foot panels). This capability consists of 98 bundles of 12-ft x 2-ft AM-2 mat, and six bundles of 6-ft x 2-ft mat, eight ramp assembly kits (a bundle contains nine ramp ends), one cruciform stake kit (56 stakes and edge clamps per kit), three Y-connector kits (36 Y-connectors per kit), one keylock kit (63 12-ft starter and typical keylocks per kit), one pavement anchor kit (400 concrete expansion bolts and tri-talon earth anchors, and 84 five-gallon buckets of rapid-set grout), one AM-2 tool component chest. This capability facilitates expansion of airfield operating surfaces.

2.7. AM-2 FOD Cover (4FWFC). Provides AM-2 matting, specialized components and tools to assemble and cover 31 each 10-ft craters, nine 15-ft craters, or three 30-ft craters. Package consists of nine bundles of 12-ft x 2-ft mat, 11 bundles of 6-ft x 2-ft mat, 14 ramp assembly kits (nine ramp ends per kit), one pavement anchor kit (400 expansion bolts and tri-talon earth anchors, and 84 five-gallon bucket of rapid-set grout), one AM-2 tool/component kit, and one AM-2 tow kit.

Note: Combining one 4FWFC with one 4FWAM will allow construction of a 72-ft x 612-ft taxiway and combining two 4FWFCs with one 4FWAM will allow construction of a 72-ft x 780-ft or 54-ft x 1008-ft taxiway.

2.8. Fiber Reinforced Polymer (FRP) Matting FOD Cover (4FWFR). Each kit provides matting and tools capable of providing a FOD cover for twenty 10-ft craters, three 30-ft craters, or one large crater up to 50-ft diameter. The kit includes 35 full-size panels, 30 half-size panels, 15 full-size anchor panels, 20 half-size anchor panels, 760 lower joining bushings, 875 upper joining bushings, and 625 anchor bushings.

Note: The use of FRP may not be compatible with some aircraft or operations.

2.9. Asphalt Batching. Asphalt batching requires space for storing asphalt products (i.e. asphalt cookie stockpiles or reclaimed asphalt pavement [RAP]), operational space for two recyclers, and space to load dump trucks. If batching occurs indoors (e.g., inside a hangar) during inclement weather, provide proper ventilation. See AFTTP 3-32.19, *Rapid Airfield Damage Recovery-Asphalt Batch Plant Operations*, for more information on batching asphalt.

2.10. Warehouse. In the context of RADR, the term warehouse (and warehouse operations) relates to the process, not a physical space. See AFTTP 3-32.18, *Rapid Airfield Damage Recovery Warehouse and Ground Transportation Operations*, for a complete description of warehouse operations.

2.10.1. Warehouse operations require semi-prepared areas, not actual facilities. Flowable fill and rapid-set super sacks are delivered to WRM in containers that may be double-stacked and centrally stored or dispersed. Stockpile(s) of traditional repair materials (i.e., crushed stone and choke ballast) should be located within seven minutes driving time to the runway.

2.10.2. When indications and warnings are observed, containers are unstacked (if applicable), dispersed within 7 minutes driving time to the airfield, and laid out to

support recovery operations. Once the containers are unloaded, they may be arranged to provide splinter protection for high priority assets.

2.10.3. Asphalt batching can be located near, or next to, warehouse operations to facilitate movement of hot mixed asphalt to the repair area via dump trucks.

2.11. Dispersal Areas. When RADR assets are released from WRM and placed in an operational configuration, several points should be considered:

Note: WRM long term storage locations should not be confused with RADR asset dispersal areas. As determined by the Installation WRM Manager, RADR assets residing within WRM during peacetime will most likely be stored in existing base supply consolidated storage locations, or CE storage areas if WRM space is an issue. In accordance with AFI 25-101, *War Reserve Materiel (WRM)*, the Logistics Readiness Squadron Commander, or equivalent, will assist in development and execution of plans to move WRM when threat of attack is heightened, or an attack is imminent, including movement to dispersed operational locations.

2.11.1. Dispersal and operating locations should be congruent with defense sectors, road barrier plans, chemical, biological, radiological and nuclear zones, etc.

2.11.2. Dispersal areas should be relatively level, but slightly sloped to provide adequate drainage. Storing loaded shipping containers on uneven surfaces may cause damage to contents or injury to personnel when opening and unloading containers.

2.11.3. The area should be at least semi-prepared to prevent standing water and muddy conditions.

2.11.4. Single capabilities should be stored in multiple locations for survivability purposes (i.e., FOD assets dispersed in multiple locations).

2.11.5. At locations with greater than a small capability, a single Crater Repair Team may be staged together since other teams replicate this capability.

2.11.6. Maximize materiel shipping containers as splinter protection for dispersed equipment, materials, and vehicles.

2.11.7. Staging areas are not more than seven minutes driving time from the airfield, with a primary and alternate route pre-identified.

2.11.8. Equipment and materials are preloaded/attached (i.e., water tanks filled, attachment and warehouse trailers loaded, 2 of 3 dump trucks per warehouse loaded with crushed stone). Fill volumetric mixer's water tanks, but do not load material until repair types (i.e., concrete or asphalt cap) are assigned following MAOS selection.

2.12. Water Storage. Flowable fill and rapid-setting concrete perform best when mixed with water between 70 and 80°F. Indoor storage or mechanical heating devices may be required to keep water at this temperature. During winter operations maintain the water temperature above 50°F to avoid the need for accelerants or longer cure times.

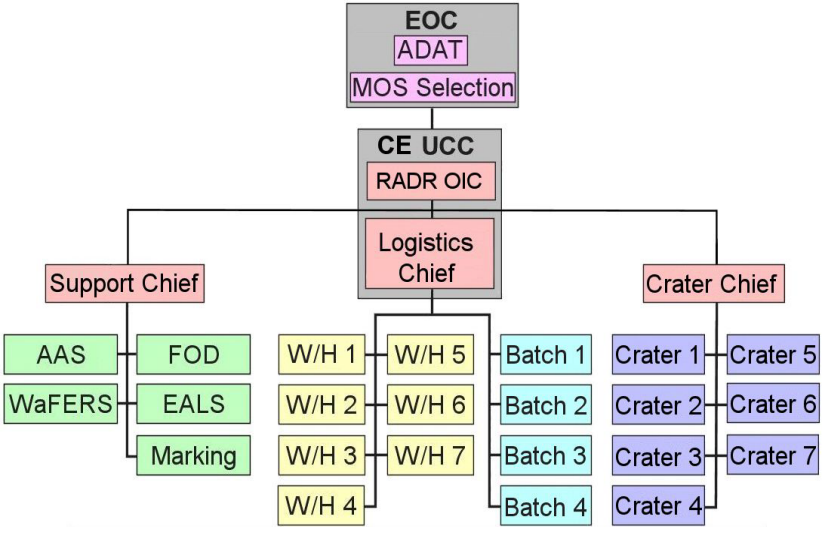
2.13. Water and Fuel Expedient Repair System (WaFERS) Overview. WaFERS is a modular and scalable set of capability-based UTCs configured to enable expedient repair or recovery of mission essential water and fuel distribution systems. Repair and recovery capability includes but is not limited to pipe repair and bypass; valves/manifold repair and bypass; hydrant capping; storage tank patching; fuel or water pumping; fuel filtering, and fuel storage. The UTCs may standalone or may be combined to provide sufficient repair capability and restore water or fuel system operations. The modularity and scalability of WaFERS also allows individualization or selection based on the installation's unique infrastructure and required specific contingency support planning. Input and output connection points for all modules are standardized to a pre- existing Department of Defense (DOD) configuration and allow for the use of quick-connect type fittings and couplers to the maximum extent possible.

Chapter 3

COMMAND AND CONTROL

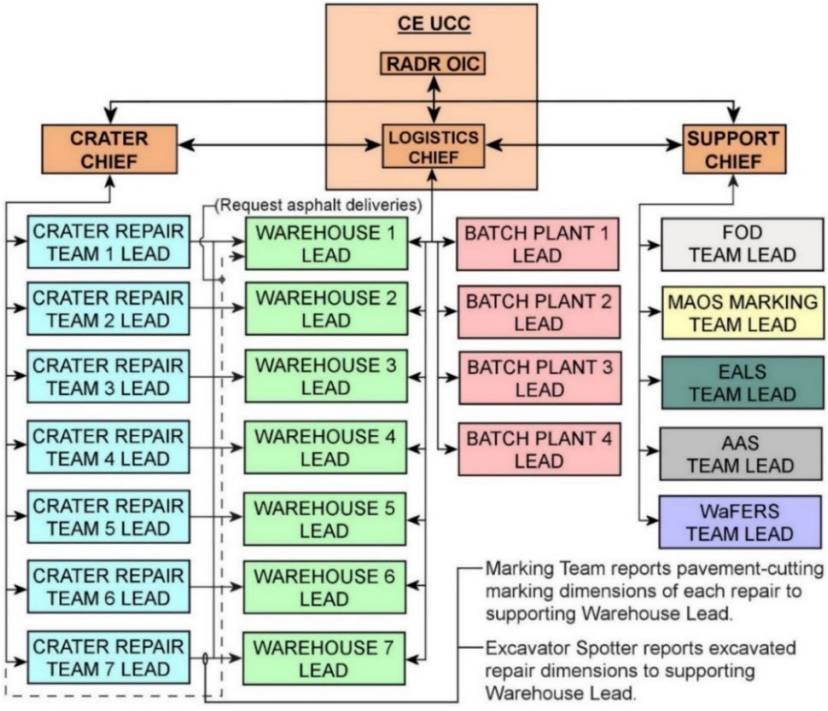
3.1. Overview. Effective Command and Control (C2) is critical to recover an airfield as effectively and rapidly as possible. RADR C2 occurs at four distinct, yet interrelated, echelons: 1) the Emergency Operations Center (EOC), 2) Civil Engineer Unit Control Center (CE-UCC), 3) repair material stockpiles/storage locations (warehouse) and asphalt production locations located near the airfield, and 4) repair teams on the airfield. The organizational structure shown in **Figure 3.1** is recommended to orchestrate the RADR process. **Note:** Each Crater Repair Team includes and controls one spall repair crew.

Figure 3.1. RADR Command and Control Overview.



3.2. Communications Flow. Although RADR is performed by many specialized teams (e.g., Crater Repair, FOD Removal, Marking, and Lighting), teams are very codependent; personnel and equipment are shared between teams and often teams contend for the same space on the MAOS; therefore, close coordination between all teams is critical. **Figure 3.2** illustrates the communications flow required to effectively manage RADR operations once repairs commence.

Figure 3.2. C2 Communications Flow.



3.3. Communications Equipment. The Engineer UTC 4F9ER supports communication requirements for RADR. **Table 3.1** identifies the recommended number and type of radios for RADR operations. **Figure 4.2** identifies recommended positions that should have radios during RADR operations.

Note: See AFPAM 10-219V3, *Civil Engineer Contingency Response and Recovery Procedures*, for using alternative communications when primary communications are inoperative.

Table 3.1. Land Mobile Radio Recommendations.

Team	Small	Medium	Large	Very Lg
OIC & Chiefs	4	4	4	4
Crater Repair	5	15	25	35
FOD Removal	8	8	8	8
Warehouse	4	12	20	28
Batch	1	2	3	4
MAOS Marking	2	2	2	2
EALS	2	2	2	2
AAS	2	2	2	2
WaFERS	1	1	1	1
Total per Capability	**29**	**47**	**67**	**86**
Note: Figure 4.2 identifies recommended positions with radios.				

3.4. Installation Recovery after Attack (IRAA) Tool. The purpose of the IRAA tool is to develop a database for Civil Engineer equipment, materials, personnel, and vehicles. It provides tools to manage these assets and timelines used during the recovery of an installation after attack. The tool is interoperable with other geospatial applications such as Geospatial Expeditionary Planning Tool (GeoExPT) and Joint Construction Management System. It allows input and data storage capabilities to include creating domain values, equipment, materials, personnel, and vehicle data. In addition, multi-user capabilities are provided so

users can synchronize changes to other IRAA application instances for data sharing purposes. IRAA will be extended to mobile devices to enable real-time field data to be entered and visualized at all command echelons.

3.5. Emergency Operations Center. The EOC is the C2 support element that coordinates information and resources to support the installation's enemy attack preparation, response, and recovery actions. The EOC provides C2 functions necessary to place multiple recovery plans into action and implement them as needed. The EOC communication capabilities must include exchanging data with First/Emergency Responders, the Incident Command Post, and installation UCCs. Through Emergency Support Function (ESF)-3 (Public Works [CE]), they also direct the Airfield Damage Assessment Team (ADAT), UXO mitigation teams, and the MAOS Selection Team.

3.6. Civil Engineer Unit Control Center (CE-UCC). UCCs provide a focal point within an organization to maintain unit C2, and to relay information to and from unit personnel and the EOC. They provide expertise to the EOC or Incident Commander, and leverage unit resources to respond to, and mitigate the attack. In regard to RADR, the CE-UCC is charged with controlling all CE airfield recovery actions. With considerable increases in equipment, manpower, and vehicles, asset tracking is more crucial than during the legacy Rapid Runway Repair operations. The EOC Director advises the CE representative of installation mission resource priorities as personnel and equipment are now shared across recovery teams and recovery operations are not limited to the confines of the airfield.

3.7. RADR Officer in Charge (OIC). The RADR OIC is the primary facilitator between the CE-UCC Commander, Logistics Chief, Crater Chief, and the Support Chief. The OIC assists RADR teams by addressing problems they cannot resolve themselves. The OIC does this by requesting support from other RADR teams, or through the CE UCC Commander when support is required from sources external to CE. The RADR OIC must work closely with Operations Personnel (3E6X1) to track personnel, vehicles, equipment, and materials (materials will be tracked by the Logistics Chief and updates reported to the RADR OIC) and ensure resupply actions happen in a timely manner to support future requirements. The OIC is

typically located in the CE-UCC or alternate UCC but may travel to the airfield to observe or assist RADR operations. The RADR OIC notifies the airfield manager when all recovery actions are complete and the MAOS is ready to be opened.

3.8. Logistics Chief. The Logistics Chief manages operations of the warehouses and batch plants. The Logistics Chief's primary responsibility is to make certain logistics teams (i.e., warehouse and batch teams) are completing their assigned tasks as effectively as possible and to help remove obstacles that negatively impact their operations. The Logistics Chief is typically located in the CE-UCC or Alternate UCC but may travel to the warehouses and/or batch plants to observe or assist operations. The Logistics Chief directly contacts the Crater or Support Chiefs when logistics teams require their assistance. The Logistics Chief contacts the RADR OIC when support is needed from external organizations (e.g., fuels, vehicle maintenance, etc.). In addition to tracking repair materials (e.g., backfill material, capping material, FOD covers, etc.), the Logistics Chief also manages asphalt production including reclaimed asphalt pavement (RAP) stockpiles, batch start times, batched hot mix quantities, hot mix maximum hold times, and delivery schedules. Finally, the Logistics Chief notifies the RADR OIC when logistics teams have completed their primary tasks and are available to assist elsewhere.

3.9. Warehouse Leads. Warehouse Leads manage the delivery of repair materials (e.g., flowable fill, crushed stone backfill, rapid-set concrete) to the crater repair teams and keep track of materiel usage within their warehouse. Sufficient repair material must be on hand, produced, and/or delivered on-time to meet rigid repair timelines.

3.9.1. The initial material requirements are generated from damage inputs processed through GeoExPT. Repair teams report the pavement upheaval marking dimensions to the supporting Warehouse Lead for comparison with the GeoExPT reports. After debris is excavated, the excavation spotter reports actual crater volume to the supporting Warehouse Lead. Material procurement, production and delivery must be adjusted accordingly to ensure sufficient repair materials are available.

3.9.2. Warehouse Leads report material quantities, usage, and shortages to the Logistics Chief so actions may be initiated to share, acquire, or produce additional materiel if shortages are expected. Warehouse Leads inform the Logistics Chief when warehouse members have completed their primary tasks and are available to assist elsewhere.

3.9.3. Warehouse 1 Lead manages the start of asphalt batching, production, hold times (trucks and stockpiles), deliveries, and reports status to the Logistics Chief.

3.10. Batch Plant Team Lead. The Batch Plant Leads manage asphalt production for applicable repairs and ensures produced asphalt is loaded in warehouse dump trucks to be delivered to the airfield at appropriate times. Each plant supports two repair teams and receives directions from the Warehouse 1 Lead on when to begin and stop production. Raw asphalt material (e.g., cookies or RAP) inventory, production, hold times, and deliveries are reported to the Logistics Chief so actions may be initiated as needed to share material with other batch plants, acquire, or produce additional materiel if shortages are expected.

3.11. Crater Chief. The Crater Chief actively manages all MAOS crater and spall repair operations. The Crater Chief is responsible for the overall convoy brief and works with the RADR OIC and Logistics and Support Chiefs to determine convoy lineup. The Crater Chief's primary responsibility is ensuring the crater and spall repair crews are progressing in a timely manner and to address disruptions such as equipment breakdowns, material shortages, or personnel problems. The Crater Chief typically is located on the airfield to monitor and assist RADR operations. The Crater Chief communicates with the Logistics Chief and Support Chief when support is required from, or needed by, logistics and support teams. The Crater Chief communicates with the Logistics Chief when support is needed from the Warehouses or Batch Plants. The Crater Chief contacts the RADR OIC when support may be needed from external organizations (e.g., fuels, additional vehicle or manning requests). Finally, the Crater Chief notifies the RADR OIC when crater team crews have completed their primary tasks and are available to assist elsewhere.

3.12. Support Chief. The Support Chief manages the five support teams' operations (i.e., FOD, Marking, Emergency Airfield Lighting System [EALS], aircraft arresting system [AAS], and Water and Fuel Expedient Repair System [WaFERS]) and informs them when they should proceed to the airfield to begin work. The Support Chief's primary responsibility is to make certain the support teams complete their assigned tasks as effectively as possible and to help remove obstacles that negatively impact their operations. The Support Chief is typically located on the airfield to monitor and/or assist the support teams. The Support Chief directly contacts the Crater Chief or Logistics Chief when support teams require their assistance. The Support Chief contacts the RADR OIC when support is needed from external organizations (e.g., fuels, vehicle maintenance, etc.). Finally, the Support Chief notifies the RADR OIC when support teams have completed their primary tasks and are available to assist elsewhere.

Chapter 4

MANNING

4.1. Overview. Personnel UTCs to perform RADR also perform beddown or Base Operating Support-Integrator missions. See the CE Supplement to the War and Mobilization Plan-1 (WMP-1) for personnel UTCs required to perform the RADR mission. **Table 4.1** identifies manning required for each RADR capability to finish repairs in 6.5 hours (not counting Damage Assessment and Response Teams [DARTs], 3E7, 3E8, or 3E9 personnel). Personnel are not counted twice where individuals transfer to other teams after initial duties have been completed (their radios are distributed as needed). The 16-person (not counting DARTs, 3E7, 3E8, or 3E9 personnel) control center manning is depicted in **Figure 4.1**. An additional two RADR C2 personnel (Crater Chief and Support Chief), totaling 18, are identified in **Figure 4.2**, which illustrates an example of the 75 person Small RADR Capability. In total, 93 persons are required for a Small RADR Capability (minus ADATs, DARTs, 3E7, 3E8, or 3E9). **Table 4.2** identifies approximate time to complete repairs with different number of teams.

4.2. Force Presentation. RADR force presentation is provided through Civil Engineer beddown UTCs whether employed at home station (fight-in-place) and augmented by UTCs from other locations, or UTCs tasked through the Joint Operation Planning and Execution System at forward operating bases. Therefore, all traditional CE personnel will receive airfield damage repair/RADR training to ensure required skill sets are available when needed. In addition, EOD manning is determined by enemy threat and risk, and therefore may not necessarily be adequate for the RADR mission at a particular location. In these instances, additional EOD UTCs should be tasked to support the RADR mission.

4.2.2. See the Civil Engineer Supplement to the WMP-1, Attachment 1, for a full listing of CE personnel UTCs that may be tasked to execute RADR capabilities.

4.2.3. Where RADR capabilities are postured (whether at contingency locations or main operating bases), use Functional Force Module tables in the WMP-1,

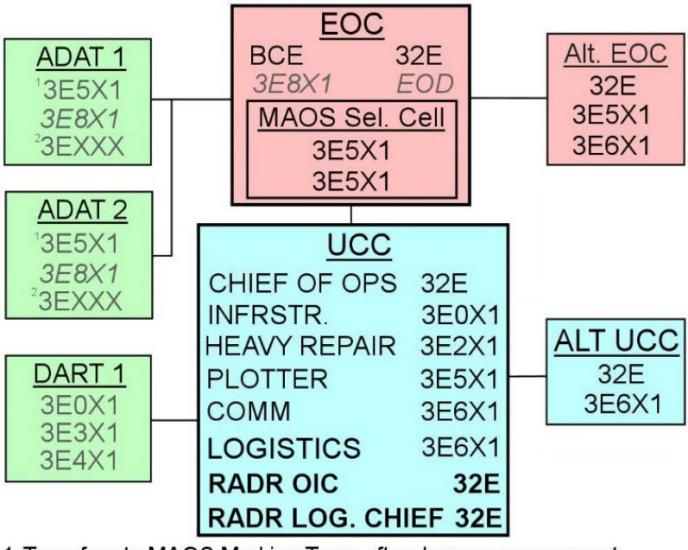
Appendix 14, Attachment 4, to identify additional manpower requirements needed to support the RADR mission.

Note: RADR Warehouse manning includes Ground Transportation (2T1XX) personnel to operate forklifts and tractor-trailers (see **Figure 4.2**).

Table 4.1. RADR Manning Numbers by Capability.

Team	Small	Medium	Large	Very Large
C2 + RADR OIC/Chiefs	18	18	18	18
Crater Repair	29	87	145	203
FOD Removal	8	8	8	8
Warehouse	8	24	40	56
Batch	3	6	9	12
MAOS Marking	6	6	6	6
EALS	6	6	6	6
AAS	12	12	12	12
WaFERS	3	3	3	3
Total	**93**	**170**	**247**	**324**
Note: Personnel numbers in this table are for the RADR mission only. Additional personnel are required to perform DART, 3E7, 3E8, or 3E9 duties.				

Figure 4.1. Example RADR C2 Center Structure.



1-Transfers to MAOS Marking Team after damage assessment
2-Transfers to Repair Team (saw spotters) after damage assessment

Figure 4.2. Example Manning for Small RADR Capability.

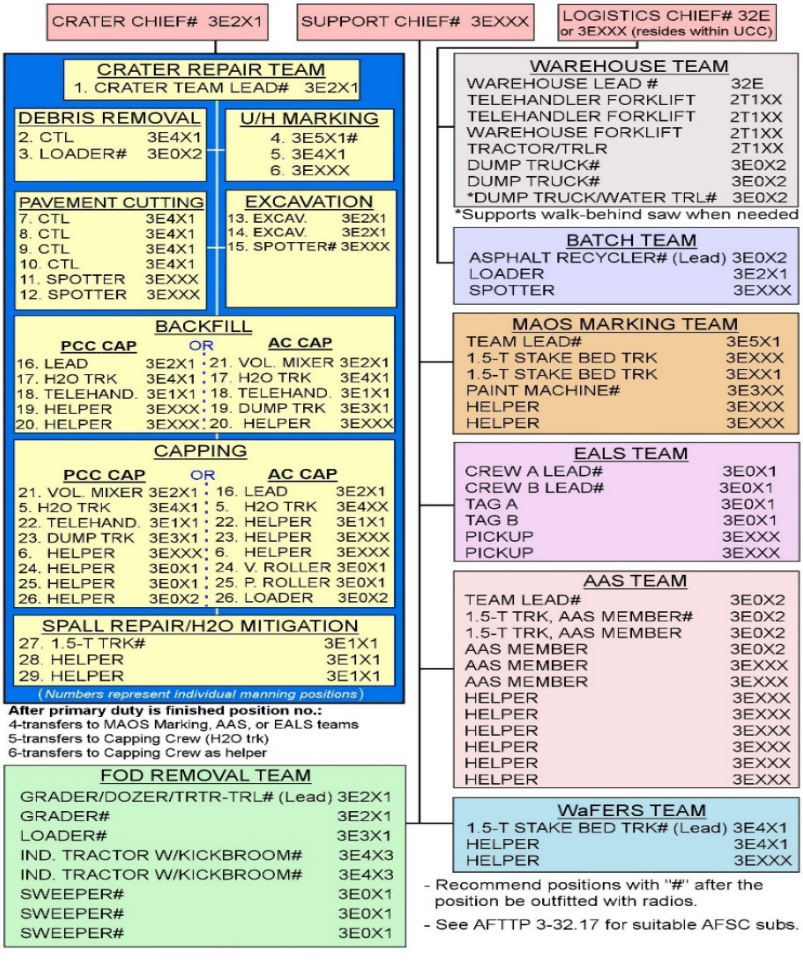


Table 4.2. Approximate Crater Repair Production Numbers.

Crater Repair Matrix												
Large Crater (30')	Small Crater (8.5')	RADR Capability	Estimated Repair Time (Hours)										
			6.5	7	8	9	10	11	12	13	14	15	16
			Number of Crater Repair Teams/Equipment UTCs										
2	18	Small	1	1	1	1	1	1	1	1	1	1	1
4	24	Small + 1	2	2	1	1	1	1	1	1	1	1	1
4	30	Small + 1	2	2	2	1	1	1	1	1	1	1	1
4	36	Small + 1	2	2	2	2	1	1	1	1	1	1	1
6	42	Med.	3	3	2	2	2	2	1	1	1	1	1
6	48	Med.	3	3	2	2	2	2	2	1	1	1	1
6	54	Med.	3	3	3	2	2	2	2	2	1	1	1
8	60	Med. + 1	4	3	3	2	2	2	2	2	1	1	1
8	66	Med. + 1	4	4	3	3	2	2	2	2	2	2	2
8	72	Med. + 1	4	4	3	3	3	2	2	2	2	2	2
10	78	Large	5	4	4	3	3	2	2	2	2	2	2
10	84	Large	5	5	4	3	3	3	2	2	2	2	2
10	90	Large	5	5	4	3	3	3	2	2	2	2	2
12	96	Large + 1	6	5	4	4	3	3	3	2	2	2	2
12	102	Large + 1	6	5	4	4	3	3	3	3	2	2	2
12	108	Large +1	6	6	5	4	4	3	3	3	2	2	2
14	114	Very Lg.	7	6	5	4	4	3	3	3	3	2	2
14	120	Very Lg.	7	6	5	4	4	3	3	3	3	2	2
14	126	Very Lg.	7	7	5	5	4	4	3	3	3	3	2

1 = 1 crater repair team, 1 warehouse team, and 1 batch plant team if required.
2 = 2 crater repair teams, 2 warehouse teams, and 1 batch plant team if required.
3 = 3 crater repair teams, 3 warehouse teams, and 2 batch plant teams if required.
4 = 4 crater repair teams, 4 warehouse teams, and 2 batch plant teams if required.
5 = 5 crater repair teams, 5 warehouse teams, and 3 batch plant teams if required.
6 = 6 crater repair teams, 6 warehouse teams, and 3 batch plant teams if required.
7 = 7 crater repair teams, 7 warehouse teams, and 4 batch plant teams if required.

Note: UTC for one repair team has enough consumables to repair approximately 18 craters. Crater numbers in this table assume sufficient consumables (e.g. saw teeth, blades) are available.

Chapter 5

STATUS REPORTING

5.1. Overview. Status reports are initiated to keep leadership apprised of personnel accountability and progress of recovery actions. Example status reporting and personnel tracking sheets are provided in **Attachment 3**.

5.2. Personnel Status. To keep radio traffic to a minimum, RADR personnel use the following procedures to report personnel status:

5.2.1. When RADR personnel permanently transfer, or are temporarily loaned, to another RADR team, the losing Team Lead contacts the gaining Team Lead to notify them personnel are transferred to their team. When the personnel arrive, the gaining Team Lead notifies the losing Team Lead the personnel have safely arrived. In this scenario, the personnel status change is not up channeled to the RADR OIC/UCC as all RADR personnel are still accounted for and still assigned to RADR.

5.2.2. However, if personnel are injured, killed, or become missing, the status is reported up the chain to the RADR OIC as soon as discovered. The RADR OIC keeps the personnel status updated on his/her status sheet (see **Attachment 3**) as called in by the RADR Chiefs and immediately reports the status changes to the UCC.

5.2.3. If/when the UCC requests a periodic dead/injured/missing/extra (DIME) report (**NOT** initiated after a significant event such as an attack) the RADR OIC reports the latest status change documented on his/her status sheet.

5.2.4. After a significant event (such as an attack) the RADR Chiefs initiate a DIME report from their respective Team Leads, using a personnel status sheet such as the one provided in **Attachment 3**, and report the results to the RADR OIC. The RADR OIC reports the RADR totals to the UCC.

5.2.5. Use the "Extra" column in the DIME report to document when personnel from other units shelter-in-place or engineers are transferred or loaned to complete tasks other than RADR (e.g., sent to respond to a non-RADR emergency tasking such as isolating a fallen high voltage electrical cable posing danger to base personnel), or when non-CE personnel from another unit are loaned to support RADR operations. For example: if three non-RADR persons were added to a team, the "E" would be reported as "plus" (+) 3 followed by the Personnel Support to Contingency Operations (PERSCO) numbers of the extra persons. Conversely, if three persons were removed (i.e., transferred or loaned outside RADR operations) from a team, the "E" would be reported as "minus" (-) 3 followed by the PERSCO numbers of the three persons removed and their new location if known. When reporting is complete, numbers in the "E" column are summed and, if they balance (i.e. "0") all personnel are accounted for. When figures do not balance, a review of all reports should identify where extra personnel are located and a call is made to determine if the extra personnel are the missing persons. If applicable, use the remarks column to document when individuals are expected to return to their RADR duties.

5.3. Recovery Status. Again, to keep radio traffic to a minimum and to provide a better overall picture of the recovery picture, recovery status reporting is task-based, not percentage-based as in legacy Rapid Runway Repair procedures. See **Attachment 3** for an example RADR Progress Report Worksheet.

5.3.1. Each Crater Repair Team Lead reports to the Crater Chief as each repair crew completes their primary task.

5.3.2. Support Teams with a continual mission give status updates as milestones are completed (e.g., trailer loading complete or material hauling complete). It may not be possible to complete support processes in order (e.g., Emergency Airfield Lighting System (EALS) team could report "Delta" before "Charlie", etc.).

5.3.3. The Support, Logistics, and Crater Chiefs pass along the status to the RADR OIC in the CE UCC where status boards/IRAA are updated.

Chapter 6

FIELD FUELING STATIONS

6.1. Overview. Repair and ancillary teams are expected to conduct recovery operations for up to seven hours; therefore, many of the vehicles involved in the process will require refueling before operations are complete (see **Table 6.1** for RADR vehicle fuel consumption rates). If available, select suitable locations to stage fuel trucks for refueling RADR vehicles during the recovery process. If fuel trucks are not available, develop a refueling plan to be supported by the Logistics Readiness Squadron (LRS). See **Attachment 2** for an example of a refueling plan.

Table 6.1. RADR Vehicles Diesel/JP-8 Fuel Consumption Rate.

Vehicle	Fuel Capacity (gallons)	GPH Burn Rate	Operating Hours Per Tank (hours)
Compact Track Loader	25.0	3.7	6.70
Volumetric Mixer	60.0	2.3	26.00
Asphalt Recycler	84.8	15.0	5.60
1500 Gallon Water Truck	100.0	6.8	14.70
CD54B Vibratory Roller	50.0	2.9	17.24
M318D Wheeled Excavator	79.3	4.8	16.50
Telehandler Forklift	39.6	4.5	8.80
Tractor Mounted Sweeper	20.0	4.3	4.60
Vacuum Sweeper	50.0	6.5	7.60
4 CY Loader	51.5	4.0	12.80
10 Ton Dump Truck	60.0	6.8	8.80
10 Ton Tractor	100.0	6.8	8.80
Dozer	127.0	9.5	13.30
Grader	90.9	6.7	13.50
Warehouse Forklift	15.0	2.1	7.10
Pneumatic Roller	104.0	4.0	26.00

Note: Late model diesel fuel-operated vehicles may require Diesel Exhaust Fluid.

6.2. Motor Gasoline (MOGAS). Many general purpose vehicles and several small MOGAS engines (e.g. mud pumps, generators) may be required to support recovery operations. Ensure a sufficient supply of MOGAS is available (at least 500 gallons for a small capability, 900 gallons for a medium capability, 1,300 gallons for a large capability, and 1,700 gallons for a very large capability).

Chapter 7

RADR VEHICLE MAINTENANCE WHILE IN WRM

7.1. General Information. War Reserve Materiel vehicle assets are managed in accordance with AFI 25-101, *War Reserve Materiel (WRM)*, and AFI 24-302. In addition to requirements identified in those publications, below are maintenance actions for RADR-unique equipment and vehicles in WRM.

7.2. Vehicle Maintenance Requirements while Stored in WRM. The following maintenance actions should be performed on RADR-unique equipment and vehicles while stored in WRM, as coordinated with the 441st Vehicle Support Chain Operations Squadron (VSCOS).

7.2.1. If no technical order or manufacturer guidance for operational inspections exist for equipment stored, the following guidance applies. Perform a pre-operational inspection that consists of, at a minimum, a check of and/or adding engine oil/pump oil, coolant, and hydraulic fluid. Inspect tire conditions and air pressures; check operation of lights, horns, alarms, and perform corrosion control as necessary. Correct any discrepancies prior to operating the equipment. Functionally operate all vehicle/equipment and conduct a general condition inspection for overall condition, leaks, and damage. Once operational inspection/checkout actions are complete, document and prepare for storage. Equipment will not be returned to storage until all discrepancies/malfunctions have been corrected and documented.

7.2.2. Refer to individual equipment technical orders or manufacturer's manuals for guidance in preparing equipment for storage. If technical orders or manuals do not include guidance for storage preparation, prepare the equipment in the following manner. Drain all fuel from unit's engine fuel tank. Leave engine oil in crankcase at operating level. Disconnect batteries, remove and maintain batteries in a ready state by periodic charging and rotating use during inspection/ operational checkout. Open air valves, grease exposed cylinders, and cover assets to protect from environment conditions if possible.

7.2.3. Vehicles maintained in active storage should be functionally tested semi-annually by CE personnel with assistance of vehicle maintenance personnel.

7.2.4. To assist with compact track loader and excavator attachment maintenance while in storage, attachments may be configured on RADR attachment trailers as shown in **Figure A4.2**; however, trailers must be reloaded in the survivability configuration during pre-attack actions as shown in **Figure A4.1**.

7.2.5. Perform the following when equipment is stored in freezing temperatures:

7.2.5.1. Drain water from tanks and plumbing, leave water valves open, and use compressed air to remove water that does not drain by gravity.

7.2.5.2. Verify battery electrolyte is filled to the indicated level. Ensure battery terminals are free of debris and rust. Consider removing batteries from equipment, store them inside a building or warehouse, and keep batteries charged using a trickle charger. Avoid charging a frozen battery as it will normally explode.

7.2.5.3. Maintain proper tire pressures.

7.2.5.4. Keep fuel tanks full to prevent condensation inside the tanks (Exception: drain volumetric mixer fuel tanks). Consider using an approved diesel fuel treatment/stabilizer to keep fuel liquefied and to remove moisture from lines. After adding the fuel treatment/stabilizer, run the engine for a few minutes to circulate the additives to the pump and fuel injectors.

7.2.5.5. Properly grease all lubrication points to prevent moisture from building up. Remember to use low-temp lube as recommended by manufacturers.

7.2.5.6. Monthly, check all fluid levels and add enough fuel to start the machine and run it until the engine reaches working temperature. Remove grease from the hydraulic cylinder pistons, and carefully operate the hydraulic controls, making sure they function properly. When finished, lightly recoat the hydraulic cylinder pistons with grease and drain remaining fuel.

Chapter 8

PREPARATORY ACTIONS

8.1. Pre-Threat Actions. These are actions that may require days to complete and therefore should be accomplished before an immediate threat is recognized.

8.1.1. Conduct an airfield survey using as-built drawings and on-site inspections to determine pavement types and thicknesses, whether or not load transfer devices (dowels) or reinforcing bars are present within concrete pavement, and shoulder/overrun construction features. Document location and depth of any utility, pipe, drain or structural element that are beneath any airfield pavements. If as-built drawings are unavailable locally, request airfield survey data from the Air Force Civil Engineer Center Reach Back Center at DSN 523-6995, Commercial 850-283-6995, or afcec.rbc@us.af.mil. If no survey data is found, airfield damage may reveal whether or not load transfer devices are present. Otherwise, treat the first repair as if load transfer devices are not present and adjust if necessary.

8.1.2. Conduct airfield profile measurements and dynamic cone penetrometer readings every 200-feet along the runway edges to determine locations with suitable slope and California Bearing Ratio for aircraft arresting system installations and suitable locations for Precision Approach Path Indicator (PAPI) installations. Perform the measurements from the runway edges out to 300-feet from the runway's centerline.

8.1.3. Obtain a dozen cans each of red and black spray marking paint (and lumber crayons for inclement weather, located in the RADR tool trailer) to be used by the Upheaval Marking Crew to mark pavement cut lines. It is also used by the Excavation Crew to mark lines for backfill levels within a repair, and to mark the excavation level on the excavator's bucket to assist the spotter in determining when excavation has reached the appropriate depth.

8.1.4. Obtain a dozen tubes of construction adhesive to be used by the Capping Crew to attach expansion joint board to adjacent slabs of a rapid large crater repair.

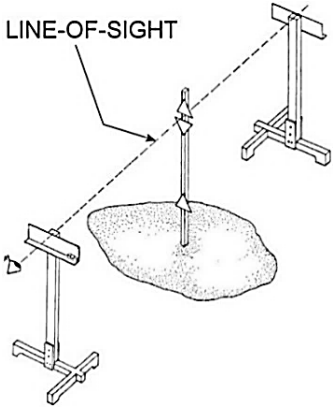
8.1.5. Acquire a case of two-cycle oil for power equipment (e.g., blowers in inclement weather kit) and store in RADR Tool Trailer.

8.1.6. If an asphalt capability is going to be utilized at the location, locally obtain at least 40 tons of asphalt (RAP, cookies, etc.) when the airfield includes asphalt pavement.

8.1.7. Ensure crushed stone stockpiles are sufficient.

8.1.8. Ensure line-of-sight measurement devices (**Figure 8.1**) are in the RADR Tool Trailer upon receiving UTC 4FWCR. If devices are missing or damaged, construct devices using specifications found in T.O. 35E2-5-1.

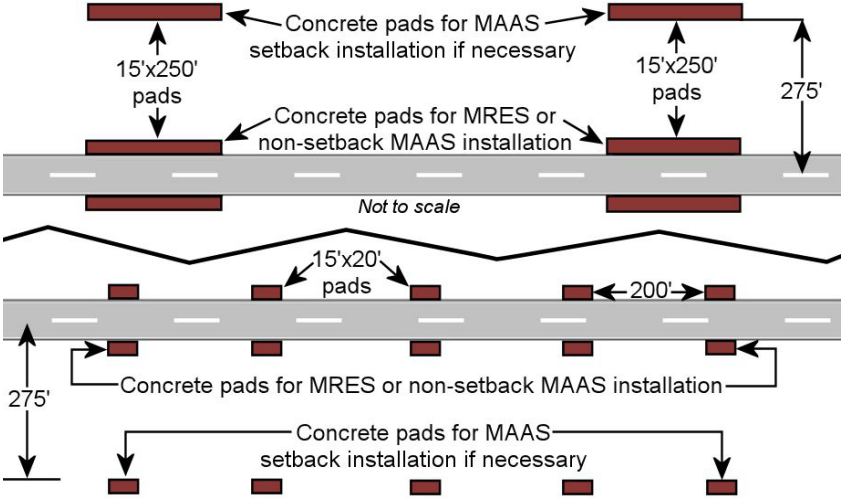
Figure 8.1. Profile Measurement Devices.



8.1.9. Marry prime movers with the designated item to be towed to ensure there is no coupling or clearance issues. Also, ensure light and brake connections are compatible. Implement corrective actions as necessary.

8.1.10. If the installation supports heavy airframes (e.g. airlift, tankers) and has soil that makes driving cruciform stakes extremely difficult (e.g. coral, rock, caliche), consider constructing concrete pads (aligned with pads constructed at the runway shoulder for Mobile Runway Edge Sheave [MRES] installations) for anchoring Mobile Aircraft Arresting System (MAAS) trailers for setback installations (see **Figure 8.2** for example configurations). Make these pads the same dimensions and aligned with pads along runway's edges. For design considerations, consult the Air Force Civil Engineer Reach Back Center at DSN 523-6995, Commercial 850-283-6995, or afcec.rbc@us.af.mil.

Figure 8.2. Example AAS Installation Pads.



8.1.11. RADR asphalt recyclers have the ability to utilize RAP to create asphalt crater capping materials. All peacetime paving projects at installations with a RADR requirement should consider utilizing airfield mix in normal peacetime construction projects so it can be milled or recycled if needed for RADR. For design considerations, consult the Air Force Civil Engineer Reach Back Center at DSN 523-6995, Commercial 850-283-6995, or afcec.rbc@us.af.mil.

8.1.12. There are not enough prime movers in the RADR vehicle sets to tow all trailers and towable equipment to the airfield when convoying to the repair areas after attack. Therefore, work with the unit vehicle control officer to coordinate with LRS to develop a memorandum of agreement to provide a tractor-trailer and driver to assist with delivering trailers and equipment to the airfield and dedicated vehicle mechanics to assist with RADR operations after an attack.

8.1.13. Coordinate with airfield management to determine potential aircraft types that may use the airfield, aircraft operational weights, and aircraft operations modes (e.g. arrestment, take-off only, evacuation, short take-off, vertical landing), and aircraft dispersal plans as these impact MAOS selection and may affect RADR preposition layouts.

8.1.14. Coordinate with Security Forces on RADR dispersal locations and potential haul routes to prevent friendly-fire incidents.

Note: Routes may require breaching of a fence or other barrier to the flightline.

8.1.15. Coordinate with Transportation for vehicle maintenance support protocols.

8.1.16. Coordinate RADR refueling plans with Fuels.

8.1.17. Coordinate with all units, including LRS, that may supply manpower, equipment/vehicles, or materials to augment CE during recovery efforts to ensure accounting, marshaling, and transfers are efficient and effective.

8.2. Attack Preparation Actions. These are actions taken when indications and warnings inform the commander of an adversary's preparation and intent to conduct offensive operations.

8.2.1. Retrieve line-of-sight measurement devices (see **Figure 8.1**) in the RADR Tool Trailer and load devices in vehicle designated to transport Upheaval Marking Crew to the airfield.

8.2.2. Load work-tool attachment trailers as illustrated in **Figure A4.1**.

8.2.3. Retrieve fuel cans and two-cycle oil from RADR Tool Trailer, fill fuel cans, and place fuel cans and oil in Inclement Weather and Spall Kits.

8.2.4. Fill water trailers, water skids, and volumetric mixer water tank(s). Do NOT load mixer with repair material until repair types are known (i.e., concrete or asphalt caps).

Note: Flowable fill and rapid-setting concrete perform best when mixed with water between 70°F and 80°F. Indoor storage or mechanical heating devices may be required to keep water at this temperature. Maintain water at or above 50°F in cold weather locations in order to eliminate the need to use accelerants or to increase cure times. Currently, fresh water is required, however, testing using sea water is ongoing and may be a viable option in the future. Stay informed.

8.2.5. Inspect vehicles and equipment for serviceability and fill fuel tanks.

8.2.6. Disperse vehicles and equipment per installation dispersal plan to include dispersing repair materials to warehouse operating locations.

8.2.7. Repeated attacks should be anticipated. The probability of these continued attacks will diminish as Allied air superiority is obtained. Proper planning should include the protection of repair personnel, material, vehicles, and equipment against repeated attacks on the airfield.

8.2.8. Run a minimum of one yard of material through the volumetric mixer to ensure proper operation and correct settings; thoroughly clean mixer afterwards. Also, stock the mixer catwalk with any required admixtures.

Note: Some volumetric mixers have experienced seized water pumps upon removal from WRM. Recommend full operational test of all volumetric mixers (and asphalt recyclers) before accepting from WRM. If pump is seized, WRM maintenance personnel should perform corrective action by disassembling pump, replacing the shear pin, and lubricating all lubrication points.

8.2.9. Break 2.5-inch-thick stockpiled asphalt cookies to a size less than 15 inches by 15 inches.

8.2.10. If stockpiled sand is wet, move a bucket load where it can dry, and stay dry, for use with the sand spreader in the inclement weather kit.

8.2.11. See AFTTP 3-32.17 for attack recovery action and mobilizing the repair force.

Chapter 9

RETURN TO NORMAL OPERATIONS

9.1. Overview. This phase begins when an appropriate authority directs the return to normal operations. Depending upon recovery actions after the attack, tasks may be added to a shop's normal operations.

9.2. Shop Tasks. The following are tasks for specific shops returning to normal operations after attack. **Note:** May not be all inclusive.

9.2.1. Pavements & Construction Equipment Shop. The following tasks should be performed after returning to normal operations after an attack:

- Extend the MOS/MAOS to full operational capabilities.
- Inspect and maintain airfield repairs.
- Reform permanent spall repairs to expedient spall repairs.
- Remove debris pushed off the airfield during repairs.
- Schedule to make semi-permanent repairs permanent.

9.2.2. Electrical Systems Shop. Once the EALS is installed and operational, the following tasks should be part of normal operations:

- Conduct periodic inspections and preventative maintenance on operational EALS in accordance with T.O. 35F5-3-17-1, *Lighting System, Airfield, Emergency*.
- Develop and refueling plan for EALS generators.
- Blackout the EALS system when an attack is imminent and directed by leadership.
- Schedule repair/installation of permanent airfield lighting system.

9.2.3. Electrical Power Production Shop. Once the MAAS/MRES are installed and operational, the following tasks should be part of normal operations:

- Conduct periodic inspections and preventative maintenance on MAAS/MRES in accordance with T.O. 35E8-2-10-1, *Mobile Aircraft Arresting System* and T.O. 35E8-2-5-1, *Operation and Maintenance Instructions – Aircraft Arresting System Model BAK-12*.
- Perform periodic inspections and preventative maintenance on EALS generators.

9.2.4. Engineering.

- Update base map.
- Update facility and infrastructure maps.
- Track repair patch pass counts and update airfield pavement maps.

9.2.5. Structures Shop. Plan to restore permanent airfield markings.

9.2.6. Water & Fuel Systems Maintenance Shop. Periodically inspect repairs and plan to make expedient repairs permanent.

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DCS/Logistics, Engineering & Force Protection

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

DAFI 10-2501, *Air Force Emergency Management Program*, 16 October 2023

AFI 10-209, *RED HORSE Program,* 11 June 2019

AFI 10-210, *Prime Base Engineer Emergency Force (BEEF) Program*, 25 October 2023

AFI 24-302, *Vehicle Management*, 21 February 2020

AFI 25-101, *War Reserve Materiel (WRM)*, 27 August 2019

AFI 33-322, *Records Management and Information Governance Program,* 23 March 2020

AFMAN 10-2502, *Air Force Incident Management System (AFIMS) Standards and Procedures*, 13 September 2018

AFPAM 10-219V3, *Civil Engineer Contingency Response and Recovery Procedures*, 7 May 2015

Technical Order 35E2-5-1, *Crushed Stone Crater Repair Instructions and Line-of-Sight Measurement Procedures*, 27 August 2007

Technical Order 35E8-2-5-1, *Operation and Maintenance Instructions – Aircraft Arresting System Model BAK-12,* 29 March 2001

Technical Order 35E8-2-10-1, *Mobile Aircraft Arresting System*, 28 July 2016

Technical Order 35F5-3-17-1, *Lighting System, Airfield, Emergency*, 6 June 2014

AFTTP 3-32.5V6, *Explosive Ordnance Disposal (EOD) Unexploded Explosive Ordnance (UXO) Response Operations*, 10 October 2023

Civil Engineer Supplement to the War Mobilization Plan-1, 17 April 2020

AFTTP 3-32.5V10, *Explosive Ordnance Disposal (EOD) Rapid Airfield Damage Recovery (RADR) And Explosive Hazards Mitigation (EHM)*, 13 March 2023

AFTTP 3-32.11, *Airfield Damage Assessment after Attack*, 18 May 2022

AFTTP 3-32.12, *Minimum Airfield Operating Surface Selection and Repair Quality Criteria*, 3 May 2024

AFTTP 3-32.17, *Rapid Airfield Crater and Spall Repair,* 10 October 2023

AFTTP 3-32.18, *Rapid Airfield Damage Recovery Warehouse and Ground Transportation Operations*, 9 February 2024

AFTTP 3-32.19, *Rapid Airfield Damage Recovery-Asphalt Batch Plant Operations,* 24 September 2018

Prescribed Forms

No prescribed forms are implemented in this publication.

Adopted Forms

DAF Form 847, *Recommendation for Change of Publication.*

Abbreviations and Acronyms

AAS—aircraft arresting system

ADAT—Airfield Damage Assessment Team

ADR—Airfield Damage Repair

AFCEC—Air Force Civil Engineer Center

AFI—Air Force Instruction

AFMAN—Air Force Manual

AFSC—Air Force Specialty Code

AFTTP—Air Force Tactics, Techniques, and Procedures

AM-2—Airfield Matting

BEEF—Base Engineer Emergency Force

C2—command and control

CCDR—combatant commander

CE—Civil Engineer

CE-UCC—Civil Engineer Unit Control Center

CTL—compact track loader

DAF—Department of the Air Force

DAFI— Department of the Air Force Instruction

DART—Damage Assessment and Repair Team

DIME—dead, injured, missing, extra

DTG—distance to go

EALS—Emergency Airfield Lighting System

EOC—Emergency Operations Center

EOD—explosive ordnance disposal

ESF—Emergency Support Function

FOD—foreign object debris

FRP—Fiber-reinforced Polymer

GeoExPT—Geospatial Expeditionary Planning Tool

IRAA—Installation Recovery after Attack

LRS—Logistics Readiness Squadron

MAAS—Mobile Aircraft Arresting System

MAOS—minimum airfield operating surface

MOS—minimum operating strip

MMC—Mass Mechanical Clearance

MRES—Mobile Runway Edge Sheave

OIC—officer in charge

PAPI—Precision Approach Path Indicator

PCC—Portland concrete cement

PERSCO—Personnel Support to Contingency Operations

RADBO—recovery of airbases denied by ordnance

RADR—Rapid Airfield Damage Recovery

RAP—reclaimed asphalt pavement

RED HORSE—Rapid Engineer Deployable Heavy Operational Repair Squadron Engineer

RDR—Rapid Damage Repair

REHM—Rapid Explosive Hazard Mitigation

T.O.—technical order

TTP—tactics, techniques, and procedures

UCC—Unit Control Center

UTC—Unit Type Code

UXO—unexploded explosive ordnance

VSCOS—Vehicle Support Chain Operations Squadron

WaFERS—Water and Fuel Expeditionary Repair System

WMP—War Mobilization Plan

WRM—War Reserve Materiel

Office Symbols

AF/A4C—Director of Civil Engineers

441 VSCOS—441st Vehicle Support Chain Operations Squadron

Terms

Adversary—A party acknowledged as potentially hostile to a friendly party and against which the use of force may be envisaged.

Airfield—An area prepared to accommodate (including any buildings, installations, and equipment) landing, and takeoff of aircraft.

Air Tasking Order—A method used to task and disseminate to components, subordinate units, and command and control agencies projected sorties, capabilities and/or forces to targets and specific missions. Normally provides specific instructions to include call signs, targets, controlling agencies, etc., as well as general instructions. Source: JP 3-30.

Airfield Damage Assessment—Locating, classifying, and measuring the damage (camouflet, crater, spall, and UXO) on the airfield operating surfaces.

Airfield Damage Assessment Team (ADAT)—An airfield recovery team, typically located in or near the EOC and directed by the ESF 3, used to identify and locate airfield damage and UXO following an attack. Their initial efforts are normally targeted towards the airfield proper; but can also be employed elsewhere as deemed necessary. The ADAT usually consists of one engineering technician and two EOD technicians. A CE member trained as an EOD assistant may replace one of the EOD technicians when two are unavailable for ADAT. The ADAT should be equipped with an armored vehicle and communications enabling them to report their observations to the MAOS Selection Cell. The ADAT damage reports must be as accurate as possible as this information is used in MAOS selection.

Anti-access—Action, activity, or capability, usually long-range, designed to prevent an advancing enemy force from entering an operational area.

Application—1. The system or problem to which a computer is applied. 2. In the intelligence context, the direct extraction and tailoring of information from an existing foundation of intelligence and near real time reporting.

Area of operations—An operational area defined by a commander for land, air and maritime forces that should be large enough to accomplish their missions and protect their forces.

Assessment—1. A continuous process that measures the overall effectiveness of employing capabilities during military operations. 2. Determination of the progress toward accomplishing a task, creating a condition, or achieving an objective. 3. Analysis of the security, effectiveness, and potential of an existing or planned intelligence activity.

Camouflet—cavities formed from a deep underground burst with minimal surface rupture.

Center—An enduring functional organization, with a supporting staff, designed to perform a joint function within a joint force commander's headquarters.

Chain of command—The succession of commanding officers from a superior to a subordinate through which command is exercised. Also called command channel.

Combatant Commander (CCDR)—A commander of one of the unified or specified combatant commands established by the President.

Command and Control (C2)—The exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission. C2 functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission.

Contingency—An emergency involving military forces caused by natural disasters, terrorists, subversives, or by required military operations. Due to the

uncertainty of the situation, contingencies require plans, rapid response and special procedures to ensure the safety and readiness of personnel, installations, and equipment.

Contingency Location—A non-enduring location outside of the United States that supports and sustains operations during named and unnamed contingencies or other operations as directed by appropriate authority and is categorized by mission life-cycle requirements as initial, temporary, or semi-permanent.

Contingency Operation—A military operation that is either designated by the Secretary of Defense as a contingency operation or becomes a contingency operation as a matter of law.

Control—Authority that may be less than full command exercised by a commander over part of the activities of subordinate or other organizations.

Convoy—A group of vehicles organized for the purpose of control and orderly movement with or without escort protection that moves over the same route at the same time and under one commander.

Crater—The pit, depression, or cavity formed in the surface of the earth by an explosion. It may range from saucer-shaped to conical, depending largely on the depth of burst.

Damage Assessment—1. The determination of the effects that attacks have on targets. 2. (DOD only) A determination of the effect of a compromise of classified information on national security. 3. (AF/CE) The process of identifying and locating damage and unexploded ordnance following an attack. Damage assessment activities generally are separated into two categories: airfield pavements and facility/utility.

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

Emergency Operations Center (EOC)—The physical location at which the coordination of information and resources to support incident management (on-scene operations) activities normally takes place. An EOC may be a temporary facility or may be located in a more central or permanently established facility, perhaps at a higher level of organization within a jurisdiction. EOCs may be

organized by major functional disciplines (e.g., fire, law enforcement, medical services), by jurisdiction (e.g., federal, state, regional, tribal, city, county), or by some combination thereof. (NIMS)

Emergency Support Functions— Used by the Air Force, federal government and many state governments as the primary mechanism at the operational level to organize and provide assistance. ESFs align categories of resources and provide strategic objectives for their use. ESFs utilize standardized resource management concepts such as typing, inventorying, and tracking to facilitate the dispatch, deployment, and recovery of resources before, during, and after an incident. (NRF.) For further information on ESFs and their function in the Air Force, refer to AFMAN 10-2502 Attachment 2.

Equipment—In logistics, all nonexpendable items needed to outfit or equip an individual or organization.

Explosive Hazard—Any hazard containing an explosive component to include unexploded explosive ordnance (including land mines), booby traps (some booby traps are nonexplosive), improvised explosive devices (which are an improvised type of booby trap), captured enemy ammunition, and bulk explosives.

Explosive Ordnance—All munitions containing explosives, nuclear fission or fusion materials, and biological and chemical agents.

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

Facility—A real property entity consisting of one or more of the following: a building, a structure, a utility system, pavement, and underlying land.

Force—An aggregation of military personnel, weapon systems, equipment, and necessary support, or combination thereof.

Hazard—A condition with the potential to cause injury, illness, or death of personnel; damage to or loss of equipment or property; or mission degradation.

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

Intelligence—The product resulting from the collection, processing, integration, evaluation, analysis, and interpretation of available information concerning foreign nations, hostile or potentially hostile forces or elements, or areas of actual or potential operations.

Main Operating Base—A facility outside the United States and US territories with permanently stationed operating forces. Main operating bases are characterized by command and control structures, enduring family support facilities, and strengthened force protection measures.

MAOS Selection—The process of plotting damage and UXO locations on an airbase runway map and using this information to select a portion of the damaged runway which can be repaired most quickly to support aircraft operations.

Minimum Airfield Operating Surface (MAOS)—The combined requirement for airfield surfaces for both runway and access routes. For example, the MOS is part of the MAOS.

Minimum Operating Strip (MOS)—1. A runway which meets the minimum requirements for operating assigned and/or allocated aircraft types on a particular airfield at maximum or combat gross weight. 2. The MOS is the smallest amount of area to be repaired to launch and recover aircraft after an attack. Selection of this MOS will depend upon mission requirements, taxi access, resources available, and estimated time to repair. For fighter aircraft, the typically accepted dimensions are 5,000 feet long by 50 feet wide.

Mission—1. The task, together with the purpose, that clearly indicates the action to be taken and the reason therefore. (JP 3-0) 2. In common usage, especially when applied to lower military units, a duty assigned to an individual or unit; a task. (JP 3-0) 3. The dispatching of one or more aircraft to accomplish one particular task. (JP 3-30)

Mitigation— Activities providing a critical foundation in the effort to reduce the loss of life and property from natural and/or manmade disasters by avoiding or

lessening the impact of a disaster and providing value to the public by creating safer communities. Mitigation seeks to fix the cycle of disaster damage, reconstruction, and repeated damage. These activities or actions, in most cases, will have a long-term sustained effect. (NIMS)

Objective—1. The clearly defined, decisive, and attainable goal toward which an operation is directed. 2. The specific goal of the action taken which is essential to the commander's plan.

On Hand—The quantity of an item that is physically available in a storage location and contained in the accountable property book records of an issuing activity.

Ordnance—Explosives, chemicals, pyrotechnics, and similar stores, e.g., bombs, guns and ammunition, flares, smoke, or napalm.

Pavement Upheaval—The vertical displacement of the airfield pavement around the edge of an explosion-produced crater. The pavement upheaval is within the crater damage diameter, but is outside the apparent crater diameter. In other words, it is that part of the pavement out of "flush" tolerance which is elevated above the adjacent undamaged surface.

Personnel—Those individuals required in either a military or civilian capacity to accomplish the assigned mission.

Personnel Accountability—The process of identifying, capturing, and recording the personal identification information of an individual usually through the use of a database.

Procedures—Standard, detailed steps that prescribe how to perform specific tasks.

Recovery—The development, coordination, and execution of service- and site-restoration plans for impacted communities and the reconstitution of government operations and services through individual, private-sector, nongovernmental, and public assistance programs that: identify needs and define resources; provide housing and promote restoration; address long-term care and treatment of affected persons; implement additional measures for community restoration; incorporate

mitigation measures and techniques, as feasible; evaluate the incident to identify lessons learned; and develop initiatives to mitigate the effects of future incidents.

Recovery Operations—Operations conducted to search for, locate, identify, recover, and return isolated personnel, human remains, sensitive equipment, or items critical to national security.

RED HORSE—Wartime structured Air Force units providing a heavy engineer capability that is mobile, rapidly deployable, and largely self-sufficient for limited periods of time.

Response—Activities that address the short-term, direct effects of an incident. Response includes immediate actions to save lives, protect property, and meet basic human needs. Response also includes the execution of emergency operations plans and of incident mitigation activities designed to limit the loss of life, personal injury, property damage, and other unfavorable outcomes. As indicated by the situation, response activities include: applying intelligence and other information to lessen the effects or consequences of an incident; increased security operations; continuing investigations into the nature and source of the threat; ongoing public health and agricultural surveillance and testing processes; immunizations, isolation or quarantine; and specific law enforcement operations aimed at preempting, interdicting or disrupting illegal activity and apprehending actual perpetrators and bringing them to justice.

Runway—A defined rectangular area of an airfield, prepared for the landing and takeoff run of aircraft along its length. A runway is measured from the outer edge of the thresholds from one end of the runway to the others. The width of the runway is typically measured from the outer edge of the load-bearing pavement on one side to the outer edge of the load-bearing pavement on the other side. In some cases the runway may be measured from the outside edge of the runway marking line on one side to the outside edge of the marking line on the other side and any remaining load bearing pavement is considered shoulder.

Sortie—In air operations, an operational flight by one aircraft.

Source—A person, thing, or activity from which information is obtained.

Spall—Pavement damage that does not penetrate through the pavement structure to the underlying base course. A spall damage area could be up to 1.5 meters (5 feet) in diameter.

Staging—Assembling, holding, and organizing arriving personnel, equipment, and sustaining materiel in preparation for onward movement.

System—A functionally, physically, and/or behaviorally related group of regularly interacting or interdependent elements; that group of elements forming a unified whole.

Tactics—The employment and ordered arrangement of forces in relation to each other.

Task—A clearly defined action or activity specifically assigned to an individual or organization that must be done as it is imposed by an appropriate authority.

Taxiway—A specially-prepared or designated path on an airfield or heliport, other than apron areas, on which aircraft move under their own power to and from landing, takeoff, service, and parking areas.

Techniques—Non-prescriptive ways or methods used to perform missions, functions, or tasks.

Threat—An indication of possible violence, harm, or danger.

Unexploded Explosive Ordnance (UXO)—Explosive ordnance which has been primed, fuzed, armed, or otherwise prepared for action, and which has been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installations, personnel, or material, and remains unexploded either by malfunction or design.

Unidirectional Minimum Operating Strip (MOS)—A condition where, for whatever reason, aircraft takeoff and land on the MOS in only one direction. If that condition is not temporary, approach lights and strobes are required only at the approach end, and place distance-to-go markers and their lights only on the right side of the runway.

Unit—1. Any military element whose structure is prescribed by competent authority. 2. An organization title of a subdivision of a group in a task force.

Unit Type Code (UTC)—A Joint Chiefs of Staff developed and assigned code, consisting of five characters that uniquely identify a “type unit.”

Attachment 2

RADR VEHICLE REFUELING PLAN EXAMPLE

Table A2.1. Example Vehicle Refueling Plan.

Time	Team & Work Area	Location	Duration (Minutes)	Vehicles To Refuel	Estimated Gallons
12:00	Airfield, Zone 1, Repair Team 1	309' to 1188' runway 06L	30	CTLs, Telehandlers	112
12:30	Airfield, Zone 2, Repair Team 2	3221' to 4150' runway 06L	30	CTL's, Telehandlers	129
13:00	Airfield, FOD Team	Call CE UCC for location	30	Kick brooms and Vacuum sweepers	154
13:30	Airfield, Zone 3, Repair Team 3	5777' to 6481' runway 06L	30	CTL's, Telehandlers	145
15:00	Batch Plant 1 and Warehouse 1	Off of the West Perimeter Road, North of the airfield	20	Asphalt Recyclers, Warehouse Forklift and Telehandler	109
15:20	Warehouse 2	In the vicinity of Bldg 2552, located outside of the NW corner of the airfield	10	Bagellas, Warehouse Forklift and Telehandler	25
15:30	Batch Plant 2 and Warehouse 3	Intersection of East Perimeter Road and 38th Street	15	Warehouse Forklift and Telehandler	109

Time	Team & Work Area	Location	Duration (Minutes)	Vehicles To Refuel	Estimated Gallons
16:05	Airfield, Zone 1, Repair team 1	309' to 1188' runway 06L	30	CTL's, Telehandlers	130
16:35	Airfield, Zone 2, Repair team 2	3221' to 4150' runway 06L	30	CTL's, Telehandlers	130
17:05	Airfield, FOD Team	Call CE UCC for location	30	Kick brooms and Vacuum sweepers	125
17:35	Airfield, Zone 3, Repair Team 3	5777' to 6481' runway 06L	30	CTL's, Telehandlers	130
Note: Items in grey will only be required on the airfield if the team is still in operation		Total refuel gallons estimated during repair			1914
		Total refuel gallons estimated after reconstitution			5950

Attachment 3

RADR TEAM STATUS CHARTS

Table A3.1. RADR OIC Personnel Accountability Sheet.

RADR OIC Personnel Accountability Sheet											
Team	CE Personnel					Augmented From External Unit					Notes
	Assigned	Dead	Injured	Missing	Extra	Assigned	Dead	Injured	Missing	Extra	
RADR Chiefs	3										
Repair 1	29										
Repair 2	29										
Repair 3	29										
Repair 4	29										
Repair 5	29										
Repair 6	29										
Repair 7	29										
Warehouse 1	8										
Warehouse 2	8										
Warehouse 3	8										
Warehouse 4	8										
Warehouse 5	8										
Warehouse 6	8										
Warehouse 7	8										

RADR OIC Personnel Accountability Sheet											
Team	CE Personnel					Augmented From External Unit					Notes
	Assigned	Dead	Injured	Missing	Extra	Assigned	Dead	Injured	Missing	Extra	
Batch 1	3										
Batch 2	3										
Batch 3	3										
Batch 4	3										
FOD	8										
Marking	6										
EALS	6										
AAS	12										
WaFERS	3										
Totals	**309**										

Table A3.2. Crater Chief Personnel Accountability Sheet.

RADR Crater Chief Personnel Accountability Sheet											
Team	**CE Personnel**					**Augmented From External Unit**					**Notes**
	Assigned	**Dead**	**Injured**	**Missing**	**Extra**	**Assigned**	**Dead**	**Injured**	**Missing**	**Extra**	
Repair 1	28										
Repair 2	28										
Repair 3	28										
Totals	**84**										

Table A3.3. Logistics Chief Personnel Accountability Sheet.

RADR Logistics Chief Personnel Accountability Sheet											
Team	**CE Personnel**					**Augmented From External Unit**					**Notes**
	Assigned	**Dead**	**Injured**	**Missing**	**Extra**	**Assigned**	**Dead**	**Injured**	**Missing**	**Extra**	
Warehouse 1	8										
Warehouse 2	8										
Warehouse 3	8										
Batch 1	3										
Batch 2	3										
Totals	**30**										

Table A3.4. Support Chief Personnel Accountability Sheet.

RADR Support Chief Personnel Accountability Sheet											
Team	**CE Personnel**					**Augmented From External Unit**					**Notes**
	Assigned	**Dead**	**Injured**	**Missing**	**Extra**	**Assigned**	**Dead**	**Injured**	**Missing**	**Extra**	
FOD	8										
Marking	6										
EALS	6										
AAS	12										
WaFERS	3										
Totals	**35**										

Table A3.5. Crater Repair Team 1 Personnel Accountability Sheet.

Crater Repair Team 1 Lead Personnel Tracking Sheet						
Name/Rank/AFSC	**Crew/Position**	**PERSCO #**	**Loaned to**	**Loan from**	**Return**	**Status/Location**
1.	Team Lead					
2.	Debris Removal					
3.	Debris Removal					
4.	Marking					
5.	Marking (Backfill & Capping)					
6.	Marking (Backfill & Capping)					
7.	Pavement Cutting					
8.	Pavement Cutting					
9.	Pavement Cutting					
10.	Pavement Cutting					
11.	Pavement Cutting					
12.	Pavement Cutting					
13.	Breaking					
14.	Excavation					
15.	Excavation					
16.	Backfill					
17.	Backfill					
18.	Backfill					
19.	Backfill					
20.	Capping					
21.	Capping					
22.	Capping					
23.	Capping					

Crater Repair Team 1 Lead Personnel Tracking Sheet						
Name/Rank/AFSC	**Crew/Position**	**PERSCO #**	**Loaned to**	**Loan from**	**Return**	**Status/Location**
24.	Capping					
25.	Capping					
26.	Capping					
27.	Spall Repair					
28.	Spall Repair					
29.	Spall Repair					
Loaned From Others						

Table A3.6. Batch Team 1 Personnel Accountability Sheet.

Batch Team 1 Lead Personnel Tracking Sheet						
Name/Rank/AFSC	**Crew/Position**	**PERSCO #**	**Loaned to**	**Loan from**	**Return**	**Status/Location**
1.	Team Lead Recycler					
2.	Loader					
3.	Spotter					
Loaned From Others						

Table A3.7. FOD Team Personnel Accountability Sheet.

FOD Team Lead Personnel Tracking Sheet						
Name/Rank/AFSC	**Crew/Position**	**PERSCO #**	**Loaned to**	**Loan from**	**Return**	**Status/Location**
1.	Team Lead, Grader, Dozer, Tractor-trailer					
2.	Grader					
3.	Loader					
4.	Ind. Tractor w/kick broom					
5.	Ind. Tractor w/kick broom					
6.	Sweeper					
7.	Sweeper					
8.	Sweeper					
Loaned From Others						

Table A3.8. Warehouse Team Personnel Accountability Sheet.

Warehouse Team Lead Personnel Tracking Sheet						
Name/Rank/AFSC	**Crew/Position**	**PERSCO #**	**Loaned to**	**Loan from**	**Return**	**Status/Location**
1.	Team Lead					
2.	Telehandler F/L					
3.	Telehandler F/L					
4.	Warehouse F/L					
5.	Tractor-trailer					
6.	Dump Truck					
7.	Dump Truck					
8.	Dump Truck					
Loaned From Others						

Table A3.9. MAOS Marking Team Personnel Accountability Sheet.

MAOS Marking Team Lead Personnel Tracking Sheet						
Name/Rank/AFSC	**Crew/Position**	**PERSCO #**	**Loaned to**	**Loan from**	**Return**	**Status/Location**
1.	Team Lead					
2.	Stake Bed Truck					
3.	Stake Bed Truck					
4.	Paint Machine					
5.	Helper					
6.	Helper					
Loaned From Others						

Table A3.10. EALS Team Personnel Accountability Sheet.

EALS Team Lead Personnel Tracking Sheet						
Name/Rank/AFSC	**Crew/Position**	**PERSCO #**	**Loaned to**	**Loan from**	**Return**	**Status/Location**
1.	Team Lead					
2.	P/U Truck					
3.	P/U Truck					
4.	Helper					
5.	Helper					
6.	Helper					
Loaned From Others						

Table A3.11. AAS Team Personnel Accountability Sheet.

AAS Team Lead Personnel Tracking Sheet						
Name/Rank/AFSC	**Crew/Position**	**PERSCO #**	**Loaned to**	**Loan from**	**Return**	**Status/Location**
1.	Team Lead					
2.	Stake Bed Truck					
3.	Stake Bed Truck					
4.	AAS Member					
5.	AAS Member					
6.	AAS Member					
7.	Helper					
8.	Helper					
9.	Helper					
10.	Helper					
11.	Helper					
12.	Helper					
Loaned From Others						

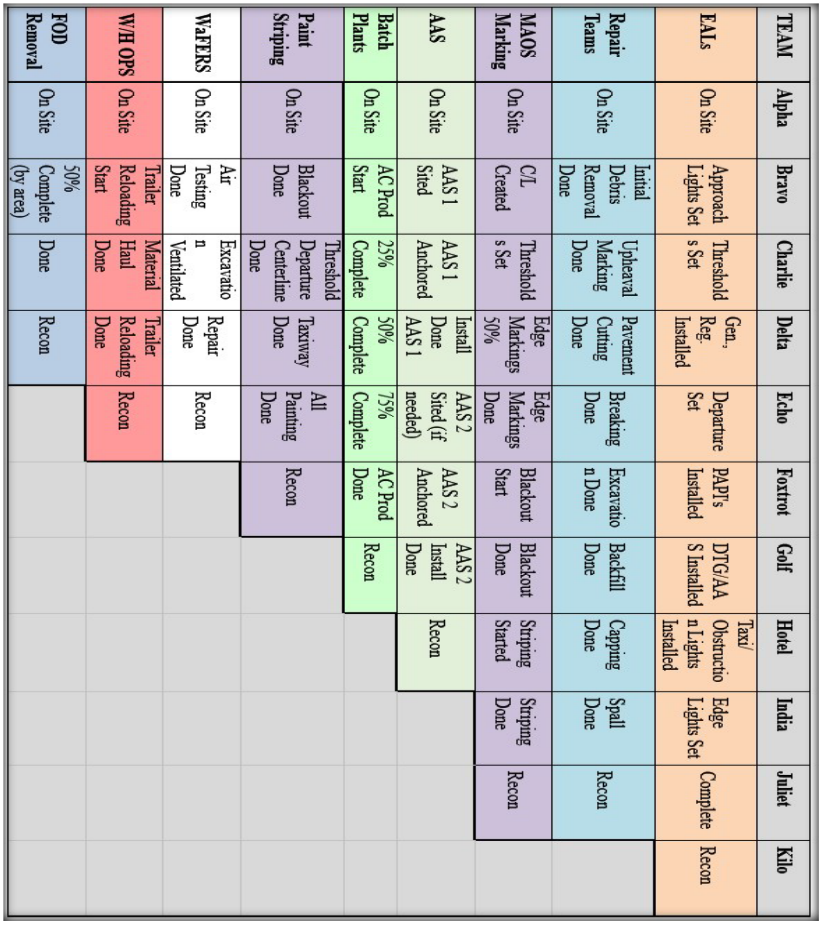
Table A3.12. WaFERS Team Personnel Accountability Sheet.

WaFERS Team Lead Personnel Tracking Sheet						
Name/Rank/AFSC	**Crew/Position**	**PERSCO #**	**Loaned to**	**Loan from**	**Return**	**Status/Location**
1.	Team Lead, Stake Bed Truck					
2.	Helper					
3.	Helper					
Loaned From Others						

Table A3.13. RADR Progress Report Worksheet.

Team	Reporting Checkpoint										
	Alpha	Bravo	Charlie	Delta	Echo	Foxtrot	Golf	Hotel	India	Juliet	Kilo
EALS-1											
EALS-2											
Repair Team 1											
Repair Team 2											
Repair Team 3											
Marking											
Paint Striping											
AAS											
WaFERS											
Warehouse 1											
Warehouse 2											
Warehouse 3											
FOD											
Batch 1											
Batch 2											
WaFERS											

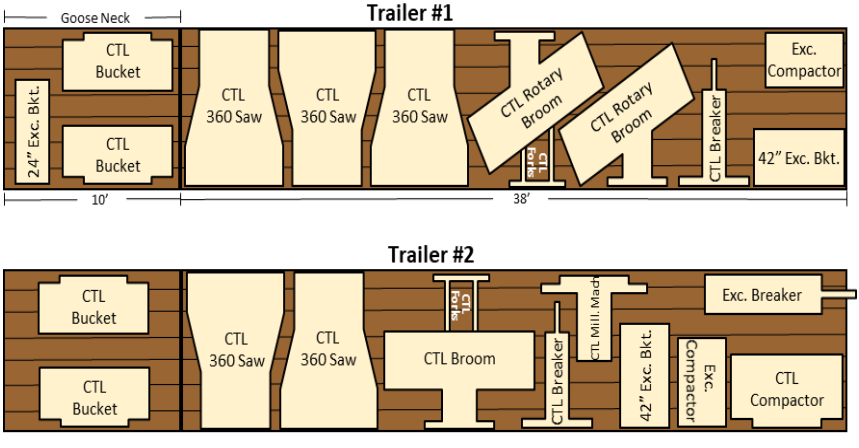
Figure A3.1. Reporting Checkpoint Key.



Attachment 4

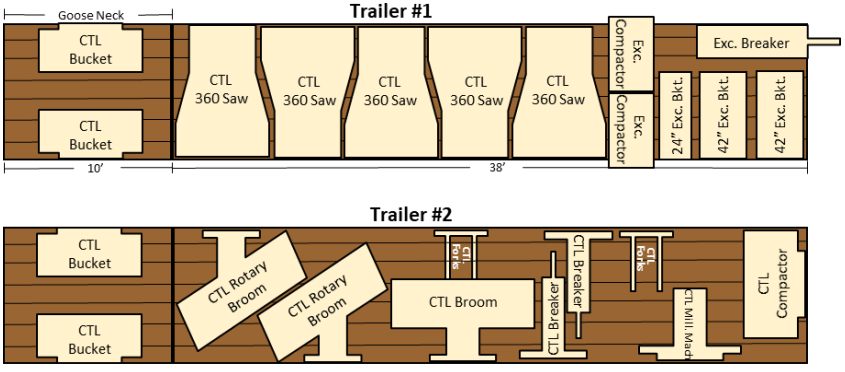
WORK TOOL ATTACHMENT TRAILER LOAD PLAN

Figure A4.1. Work Tool Attachment Load Plan.



Note: Divide like items and attachments between trailers for survivability (dimensions may change without notice).

Figure A4.2. Optional Work Tool Attachment Load Plan While in Storage.



Note: This configuration assists with CTL and excavator attachment maintenance while in storage; however, trailers must be reloaded in the survivability configuration as shown in Figure A4.1 during pre-attack phase.

Attachment 5

ENGINEER REACHBACK AND OTHER USEFUL LINKS

Table A5.1. Useful Organizational and Product Links.

Engineer Reachback
Air Force Civil Engineer Center (AFCEC): https://www.afcec.af.mil/
CE DASH (AFCEC Technical Support Portal): https://usaf.dps.mil/teams/CEDASH/scripts/homepage/home.aspx
CE Playbooks: https://www.ceplaybooks.com
AFCEC Reachback Center: email at AFCEC.RBC@us.af.mil
AF Publications and Forms: https://www.e-publishing.af.mil/
AF Design Guides (AFDG): https://www.wbdg.org/ffc/af-afcec
DOD Supplemental Technical Documents (TSPWG M): https://www.wbdg.org/ffc/dod/supplemental-technical-documents
Whole Building Design Guide (WBDG): https://www.wbdg.org/
US Army Corp of Engineers Official Publications, http://www.publications.usace.army.mil/Home.aspx
Unified Facilities Criteria (UFC): https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc
Unified Facilities Guide Specifications (UFGS): https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs
USACE Reachback Operations Center (UROC): https://uroc.usace.army.mil
USACE Protective Design Center: https://intelshare.intelink.gov/sites/pdc/SitePages/Home.aspx

Engineer Reachback
Army Publications and Forms: https://armypubs.army.mil/
Navy Doctrine Library System: https://doctrine.navy.mil/default.aspx
DOD Issuances: https://www.esd.whs.mil/DD/DoD-Issuances/
Joint Publications: https://jdeis.js.mil/my.policy