



AIR FORCE TACTICS, TECHNIQUES, AND PROCEDURES 3-32.18

9 February 2024

RAPID AIRFIELD DAMAGE RECOVERY WAREHOUSE AND GROUND TRANSPORTATION OPERATIONS



DEPARTMENT OF THE AIR FORCE

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**BY ORDER OF THE
SECRETARY OF THE AIR FORCE**

**AIR FORCE TACTICS, TECHNIQUES,
AND PROCEDURES 3-32.18**



9 February 2024

Tactical Doctrine

**RAPID AIRFIELD DAMAGE RECOVERY WAREHOUSE
AND GROUND TRANSPORTATION OPERATIONS**

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This publication supports Air Force Instruction (AFI) 10-210, *Prime Base Engineer Emergency Force (BEEF) Program*, AFI 24-301, *Ground Transportation*, AFPAM 10-219, Volume 4, *Airfield Damage Repair Operations*, and Air Force Doctrine Publication 3-34, *Engineer Operations*. It provides tactics, techniques and procedures (TTP) for Rapid Airfield Damage Recovery (RADR) warehouse and ground transportation operations. This publication applies to the Regular Air Force, the Air Force Reserve, and the Air National Guard. This publication does not apply to the United States Space Force. Refer recommended changes and questions about this publication to the Office of Primary Responsibility using the Department of the Air Force (DAF) Form 847, *Recommendation for Change of Publication*; route DAF Forms 847 from the field through the appropriate functional chain of command and Major Command publications/ forms managers. Ensure all records generated as a result of processes prescribed in this publication adhere to AFI 33-322, *Records Management and Information Governance Program* and are disposed in accordance with the Air Force Records Disposition Schedule, which is located in the Air Force Records Information Management System.

SUMMARY OF CHANGES

This document has been revised and should be completely reviewed. In addition to updating terminology and references, the publication title was changed to include ground transportation operations; Table 1.2 was changed to show primary and suitable substitute manning positions for the Warehouse Team; and “ground transportation operations” was incorporated throughout to address an important element of RADR operations.

APPLICATION: This publication is intended for civil engineer and ground transportation personnel performing RADR warehouse and ground transportation operations. 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 AFCEC Reachback Center or CE Dash (with contact info) for resolution. Contact the Reachback Center at 850-283-6995, Toll Free at 888-232-3721, Defense Switched Network 523-6995, or Email at AFCEC.RBC@us.af.mil. **Attachment 2** provides links to engineer Reachback resources and other useful sites.

SCOPE: This publication provides TTPs to perform RADR warehouse and ground transportation operations after an attack. It provides resource requirement information for such things as manpower, vehicle, equipment, repair material, and preparatory actions such as actions taken prior to an attack and before commencing warehouse activities. Finally, the publication describes warehouse setup and ground transportation delivery operations during airfield recovery operations.

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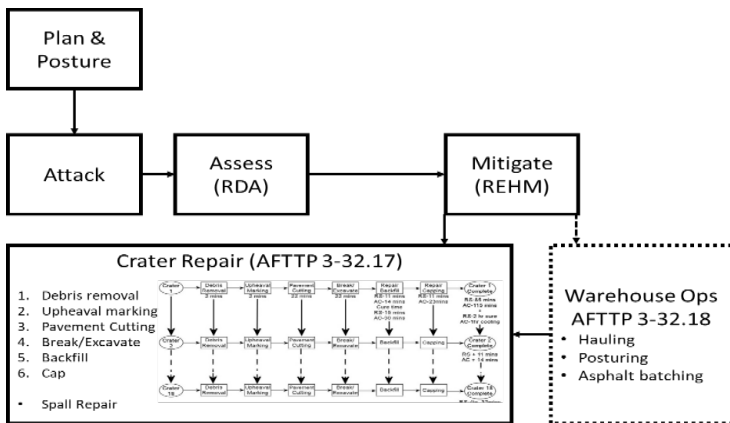
Chapter 1

INTRODUCTION

1.1. Overview. Rapidly recovering an airfield requires the efficient storage, movement, and delivery of repair materials; this role falls to warehouse and ground transportation operations (GTO) personnel. They ensure repair materials are accounted for, ready for use, and delivered in a timely manner.

1.1.1. In regard to RADR, the term warehouse refers to a process (**Figure 1.1**), not necessarily a physical warehouse facility. The warehouse is an area for staging and storing repair materials needed to recover the airfield. A fully prepared hard surface is not required for the warehouse location. At a minimum, a semi-prepared surface is required for staging repair materials. The warehouse forklift should not be used when the warehouse location is not located on a fully prepared hard surface. Telehandler forklifts will only be used on unprepared surfaces. If an all-terrain forklift is available, it can be used on any surface.

Figure 1.1. Overview Rapid Airfield Damage Recovery (RADR) Process.



1.1.2. Flowable-fill and rapid-setting concrete super sacks are delivered to War Reserve Materiel storage in containers that may be double-stacked and centrally stored during peacetime. When threat of attack increases, containers are unstacked (if applicable), dispersed to locations within a seven-minute, one-way travel time to the airfield operating surfaces. Seven-minute travel time is calculated by the mode of transportation used to transport flowable-fill and rapid-setting concrete super sacks from the storage location to the operational location. Containers will be placed in such a way as not to interfere with airfield geometric criteria outlined in Unified Facilities Criteria 3-260-01, *Airfield and Heliport Planning and Design*. Spare containers may be arranged to provide hardening and splinter protection where required. Stockpiles of traditional repair materials such as crushed stone should also be located within seven minutes travel time to the airfield operating surfaces.

1.2. Warehouse and Ground Transportation Operations (GTO) Unit Type Codes (UTCs). Table 1.1 identifies vehicle and material UTCs required for warehouse and GTO.

Table 1.1. RADR Warehouse and GTO UTCs.

4FWWH-Warehouse Vehicles	Quantity Per Capability			
	Small	Med.	Large	Very Lg
Semi-Tractor Truck	1	3	5	7
Warehouse Forklift, 6K	1	3	5	7
Telehandler Forklift, 10K	2	6	10	14
Trailer, 20-T, 38' Flatbed	3	9	15	21
Dump Truck, 10-T	3	9	15	21
4FWCM-Concrete Cap Materials	Small	Med.	Large	Very Lg
*Flowable-Fill Super Sacks	60	180	300	420
*Rapid-setting Concrete Super Sacks	48	144	240	336
Citric Acid (50-lb bags)	2	6	10	14
4FWAB-ADR Asphalt Repair Material	Small	Med.	Large	Very Lg
*Flowable-Fill Super Sacks	84	252	420	588
*Pelletized Asphalt Super Sacks	48	144	240	336

4FWCW-Cold Weather Concrete Additive	Quantity Per Capability			
	Small	Med.	Large	Very Lg
Aluminum Sulfate (50-lb Buckets)	70	210	350	490
*Super sacks are delivered in 20-foot International Standards Organization (ISO) shipping container, 12 per container.				

1.3. Manning. There is no dedicated personnel UTC for the warehouse and ground transportation team; the eight personnel are presented through existing Prime BEEF or Ground Transportation personnel UTCs. **Table 1.2** lists warehouse and GTO manning and their responsibilities.

Table 1.2. Warehouse Team Manning and Responsibilities.

Position	Primary	Suitable Subs ¹	Veh./Equip./Tools
Lead	32E	3E671-Senior Non-Commissioned Officer	None
Operator	2T1X1	3E1X1, 3E6X1	Telehandler
Operator	2T1X1	3E1X1, 3E6X1	Telehandler
Operator ²	2T1X1	3E1X1, 3E6X1	Warehouse forklift
Operator	2T1X1	3E2X1, 3E3X1	Tractor-trailer (three 20-ton flatbed trailers)
Operator	3E0X2	3E2X1, 3E3X1, 3E4X1, 3E4X3	Dump Truck
Operator	3E0X2	3E2X1, 3E3X1, 3E4X1, 3E4X3	Dump Truck
Operator	3E0X2	3E2X1, 3E3X1, 3E4X1, 3E4X3	Dump Truck

1. Any augmentee qualified on specific equipment can be an operator.
2. If warehouse operations conducted on unimproved surface, the warehouse forklift operator may not be required unless there is an all-terrain forklift available. The exception is a 2T1X1 Amn may not be used to support other airfield damage repair team requirements.

1.3.1. The Warehouse Lead supervises warehouse operations and manages delivery of repair materials (i.e., flowable-fill, crushed stone, hot-mixed asphalt, rapid-setting concrete, water, and spall repair material) to the crater and spall repair teams and keeps track of materiel usage within each warehouse. The Warehouse Lead reports status to the Logistics Chief, who typically resides in the Civil Engineer Unit Control Center.

1.3.1.1. The initial material requirements are generated from damage inputs processed through the Geospatial Expeditionary Planning Tool. The Upheaval Marking Crew reports dimensions of surveyed repair patches to the supporting Logistics Chief (located in the Civil Engineering Unit Control Center) for comparison to initial Geospatial Expeditionary Planning Tool estimates to verify sufficient stocks of repair material are available. After excavation, the spotter reports actual repair volume (width x length x depth) to the supporting Warehouse Lead to determine if sufficient repair material is on hand; material procurement, production, substitution, and delivery must be adjusted accordingly when different than the initial Geospatial Expeditionary Planning Tool estimates.

1.3.1.2. Warehouse Leads report on-hand material quantities, usage, and shortages to the Logistics Chief to provide an overall material status so actions may be initiated to share, acquire, or produce additional materiel as required. Also, the Warehouse Leads inform the Logistics Chief when warehouse members have completed their primary tasks and are available to assist elsewhere.

1.3.1.3. Typically, one warehouse supports one Repair Team performing either concrete or asphalt capped repairs. When supporting asphalt repairs, the Warehouse-1 Lead manages asphalt production and delivery. They determine the number of plants required to meet the required tonnage, when to start production to ensure asphalt is ready for placement, but not stockpiled too long to limit cooling, and when to begin plant shutdown. He or she also manages the delivery schedules from the batch plants to appropriate repair zone.

1.3.1.4. Warehouse teams support batch plants by hauling hot-mixed asphalt with dump trucks from the batch plants to the appropriate repair zones. They may also

haul asphalt (reclaimed asphalt pavement or virgin asphalt blocks referred to as “cookies”) from storage to the batch plant if stockpiles are not collocated with the batch plant.

1.3.1.5. The team’s dump truck operators may not always be fully employed during the recovery process, especially when asphalt repairs are not required. In these instances, dump truck operators may be directed to assist activities such as hauling trash (such as empty super sacks) and/or foreign object debris from the airfield. They may also assist with refilling water trailers.

1.3.1.6. Once RADR operations are complete and the warehouse team’s assistance is not needed elsewhere, the team should begin reconstitution duties such as refilling warehouse containers with repair material, refueling vehicles, and replenishing stockpiles. Specifically, complete the following actions:

- Replenish repair materials (i.e., super sacks, crushed stone, etc.)
- Load repair materials on trailers and dump trucks if more attacks are anticipated.
- Perform vehicle post operational inspections and take appropriate action for any discrepancies found.
- Refuel vehicles.
- Clean and prep dump truck beds for asphalt loads.
- Return vehicles to their duty locations or staging areas.

1.4. General Safety Considerations. In standard and nonstandard construction practices, there are multiple known risk factors in performing Rapid Airfield Damage Recovery (RADR) duties. It is vital to protect workers from hazards such as high-pressure subsystems and components, harmful solvents and adhesives, and silica dust.

1.4.1. The risks and safety factors involved with materials and operations should be identified prior and briefed to all personnel that could be involved.

1.4.2. A key responsibility of supervisors is to ensure personnel have and wear the necessary PPE and individual protective equipment (IPE) for the working environment. Unsafe field operations while conducting RADR could cause long and short-term injuries, health issues, disable equipment, and negatively affect the mission.

1.5. Published Guidance. Review applicable safety standards and technical manuals for additional safety requirements before performing RADR operations. Guidance can be found in the following subparagraphs. Compliance with Technical Order warnings and cautions is essential.

1.5.1. DAFMAN 91-203, *Air Force Occupational Safety, Fire, and Health Standards*, lists PPE for selected CE activities. Although Technical Orders and other job-related publications address proper wear and use of PPE and IPE, workers ultimately have the responsibility to properly use, inspect, and care for protective equipment assigned.

1.5.2. Consult AFI 48-137, *Respiratory Protection Program* for training documentation procedures and inhalation guidance. Refer to 29 CFR 1910.133, *Eye and Face Protection*, AFI 48-127, *Occupational Noise and Hearing Conservation Program*, 29 CFR 1910.134, *Respiratory Protection* and 29 CFR 1926.1153, *Respirable Crystalline Silica Standard for Construction* for additional guidance and information.

1.5.3. Handlers and users of any polymeric repair material should ensure a Safety Data Sheet from the manufacturer always accompanies the material. Before use, review and follow the Safety Data Sheet guidance for personal protective equipment and other safety precautions.

1.5.4. In accordance with Air Force Medical Readiness Agency Bioenvironmental Engineering (AFMRA/SG3PB) Policy Memo dated 30 Sept. 2020, “Commanders have the discretion to elect the use of the Joint Service General Purpose Mask M50 series protective mask as approved by Bioenvironmental Engineering or a

National Institute for Occupational Safety and Health certified respirator for “Training events Only”. PPE is identified in **Table 1.3**.

1.6. Personal Protective Equipment (PPE). Supervisors should coordinate with the Bioenvironmental Engineering Flight and the Wing Safety office on the PPE needed to perform RADR operations. Brief safety procedures and appropriate PPE before operations and verify that all PPE has been approved for the work to be performed. See **Table 1.3**. For a list of PPE for typical RADR operations.

Note: Breathing crystalline silica dust is a serious health hazard. Those performing duties where they may be exposed to silica dust should wear appropriate PPE (including respiratory and eye protection) according to Commander’s guidance.

Table 1.3. Listing of Typical PPE by Operation.

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

Operation or Equipment	Typical PPE Required
Concrete Saw	Safety-toe boots Eye protection Hearing protection Respiratory protection* Gloves
Concrete Mixer	Safety-toe boots Eye protection Respiratory protection* Hearing protection
Portable Power Tools	Eye protection Hearing protection Respiratory protection*
Paint Striping	Safety-toe boots Eye protection Hearing protection Respiratory protection* Gloves Coveralls
*-N-95, P-95, and R-95 respirator or M50, as directed by Commander.	

Chapter 2

CONCRETE REPAIRS

2.1. Overview. The Warehouse Team delivers 3,000-pound super sacks (~1 cubic yard) of flowable-fill and rapid-setting concrete when supporting concrete repairs. It may also haul crushed stone and/or choke ballast when repairs have been over-excavated or when flowable-fill and/or rapid-setting concrete supplies are depleted.

2.2. Process. During pre-attack actions, enough super sacks are unloaded from the shipping containers to load the three warehouse trailers. The flatbed trailers are loaded with 13 super sacks, mixture additives, and a wet weather kit if needed (**Figure 2.1**). Preferably, the remaining sacks are unloaded as needed during unexploded ordnance mitigation and positioned to be ready for loading (**Figure 2.2**).

Note: When a telehandler forklift is not available to unload containers, connect the end of two chains near the bottom of the racks and the other end of chains to a prime mover (e.g., loader, truck, compact track loader) and drag them to the end of the container to allow a non-extendable forklift to unload them.

Note: Each sack is transported from the manufacturer in a metal rack. Sacks should be removed from the racks and the racks should remain at the warehouse location. Do NOT deliver sacks to the airfield still in the metal racks.

Note: Two Inclement Weather Kit containers replace two super sacks when applicable.

Note: To ease removal of sacks from containers, a makeshift ramp (**Figure 2.3**) may be constructed to assist with the forklift entering and exiting the container.

Figure 2.1. Example Warehouse Pre-Attack Layout.

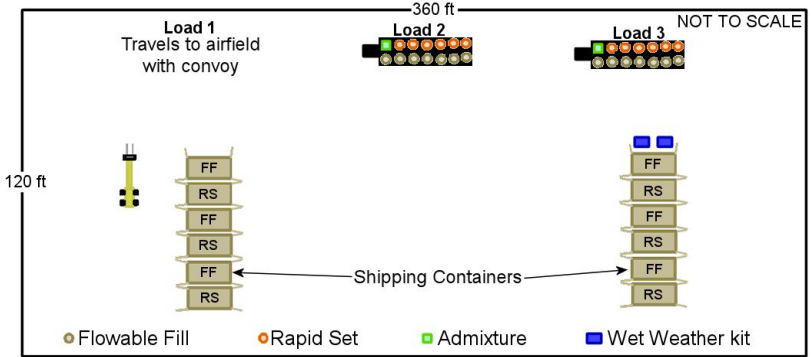


Figure 2.2. Example Warehouse Post-Attack Layout.

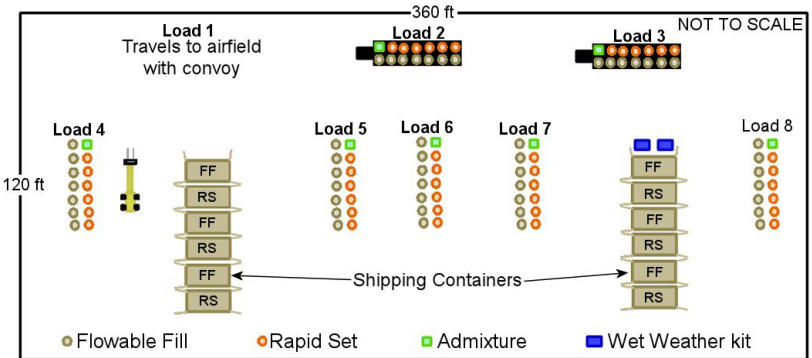


Figure 2.3. Expedient Ramp used to Unload Repair Material Containers.

2.2.1. **Table 2.1** depicts flowable-fill consumption rate and **Table 2.2** represents the rapid-setting concrete consumption rate.

Table 2.1. Flowable-Fill Consumption Rate under Rapid-setting Concrete Cap.

$L \times W$	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15
8	2.49	2.64	2.80	2.96	3.11	3.27	3.42	3.58	3.73	3.89	4.04	4.20	4.36	4.51	4.67
8.5	2.64	2.81	2.98	3.14	3.31	3.47	3.64	3.80	3.97	4.13	4.30	4.46	4.63	4.79	4.96
9	2.80	2.98	3.15	3.33	3.50	3.68	3.85	4.03	4.20	4.38	4.55	4.73	4.90	5.08	5.25
9.5	2.96	3.14	3.33	3.51	3.69	3.88	4.06	4.25	4.43	4.62	4.80	4.99	5.17	5.36	5.54
10	3.11	3.31	3.50	3.69	3.89	4.08	4.28	4.47	4.67	4.86	5.06	5.25	5.44	5.64	5.83
10.5	3.27	3.47	3.68	3.88	4.08	4.29	4.49	4.70	4.90	5.10	5.31	5.51	5.72	5.92	6.13
11	3.42	3.64	3.85	4.06	4.28	4.49	4.71	4.92	5.13	5.35	5.56	5.78	5.99	6.20	6.42
11.5	3.58	3.80	4.03	4.25	4.47	4.70	4.92	5.14	5.37	5.59	5.81	6.04	6.26	6.48	6.71
12	3.73	3.97	4.20	4.43	4.67	4.90	5.13	5.37	5.60	5.83	6.07	6.30	6.53	6.77	7.00
12.5	3.89	4.13	4.38	4.62	4.86	5.10	5.35	5.59	5.83	6.08	6.32	6.56	6.81	7.05	7.29
13	4.04	4.30	4.55	4.80	5.06	5.31	5.56	5.81	6.07	6.32	6.57	6.83	7.08	7.33	7.58
13.5	4.20	4.46	4.73	4.99	5.25	5.51	5.78	6.04	6.30	6.56	6.83	7.09	7.35	7.61	7.88
14	4.36	4.63	4.90	5.17	5.44	5.72	5.99	6.26	6.53	6.81	7.08	7.35	7.62	7.89	8.17
14.5	4.51	4.79	5.08	5.36	5.64	5.92	6.20	6.48	6.77	7.05	7.33	7.61	7.89	8.18	8.46
15	4.67	4.96	5.25	5.54	5.83	6.13	6.42	6.71	7.00	7.29	7.58	7.88	8.17	8.46	8.75

Table 2.2. Rapid-setting Super Sack Consumption Rate for 10-Inch Cap.

<i>L x W</i>	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15
8	2.13	2.27	2.40	2.53	2.67	2.80	2.93	3.07	3.20	3.33	3.47	3.60	3.73	3.87	4.00
8.5	2.27	2.41	2.55	2.69	2.83	2.98	3.12	3.26	3.40	3.54	3.68	3.83	3.97	4.11	4.25
9	2.40	2.55	2.70	2.85	3.00	3.15	3.30	3.45	3.60	3.75	3.90	4.05	4.20	4.35	4.50
9.5	2.53	2.69	2.85	3.01	3.17	3.33	3.48	3.64	3.80	3.96	4.12	4.28	4.43	4.59	4.75
10	2.67	2.83	3.00	3.17	3.33	3.50	3.67	3.83	4.00	4.17	4.33	4.50	4.67	4.83	5.00
10.5	2.80	2.98	3.15	3.33	3.50	3.68	3.85	4.03	4.20	4.38	4.55	4.73	4.90	5.08	5.25
11	2.93	3.12	3.30	3.48	3.67	3.85	4.03	4.22	4.40	4.58	4.77	4.95	5.13	5.32	5.50
11.5	3.07	3.26	3.45	3.64	3.83	4.03	4.22	4.41	4.60	4.79	4.98	5.18	5.37	5.56	5.75
12	3.20	3.40	3.60	3.80	4.00	4.20	4.40	4.60	4.80	5.00	5.20	5.40	5.60	5.80	6.00
12.5	3.33	3.54	3.75	3.96	4.17	4.38	4.58	4.79	5.00	5.21	5.42	5.63	5.83	6.04	6.25
13	3.47	3.68	3.90	4.12	4.33	4.55	4.77	4.98	5.20	5.42	5.63	5.85	6.07	6.28	6.50
13.5	3.60	3.83	4.05	4.28	4.50	4.73	4.95	5.18	5.40	5.63	5.85	6.08	6.30	6.53	6.75
14	3.73	3.97	4.20	4.43	4.67	4.90	5.13	5.37	5.60	5.83	6.07	6.30	6.53	6.77	7.00
14.5	3.87	4.11	4.35	4.59	4.83	5.08	5.32	5.56	5.80	6.04	6.28	6.53	6.77	7.01	7.25
15	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	7.00	7.25	7.50

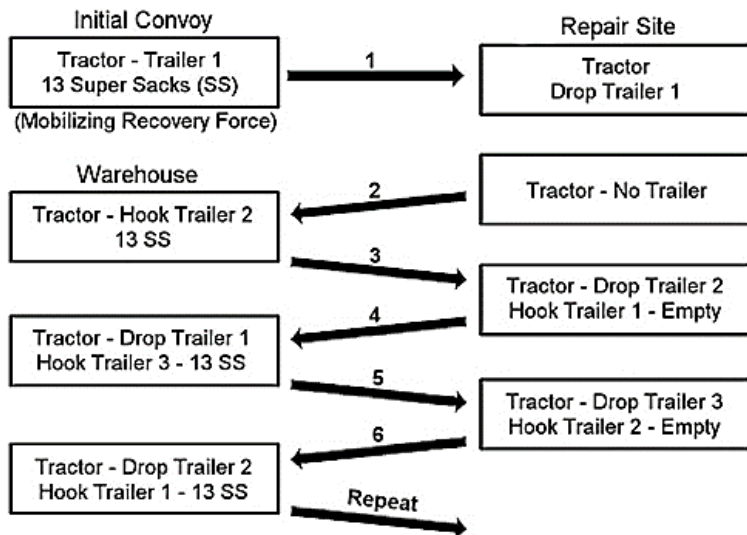
2.2.2. The Geospatial Expeditionary Planning Tool report generated by the Airfield Damage Assessment Team provides projected crater repair dimensions. The Warehouse Lead determines if sufficient repair materials are available and prepares the appropriate load plans and delivery schedules. The Repair Team reports the dimensions of the repairs, including depth, after the repair excavations are complete. If a warehouse lacks sufficient materials, materials may be transferred from warehouses with surplus materials.

2.2.3. The standard load configuration is: seven flowable-fill and six rapid-setting concrete sacks (**Figure 2.2**). Eight loads are expected for 18 repairs. The first load contains only flowable-fill (and wet weather kits as needed) and travels to the airfield with the initial convoy as the recovery force is mobilized. The last load configuration is adjusted to meet the calculated repair material required. If actual repair sizes are larger than projected repair sizes, material delivery quantities are

adjusted accordingly. The last trailer delivered to the repair zone will be unloaded as needed. Additives and wet weather kit will be included in repair material deliveries as needed. See **Figure 2.4** for the material transfer sequence.

2.2.4. Upon arrival at the warehouse area, or if sheltered at the warehouse area during the attack, perform a post attack reconnaissance sweep around the warehouse. Report any unexploded ordnance or damage to the Civil Engineering Unit Control Center.

Figure 2.4. Material Transfer Sequence.



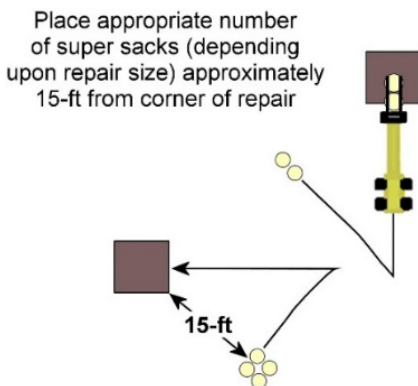
2.2.5. As excavation is completed on each repair, the Repair Team Lead calls in the depth of the repair to the Warehouse Lead to verify the appropriate amount of repair material was delivered. If necessary, adjustments are made.

Step 1: The first material trailer (13 flowable-fill super sacks) is hauled to the airfield with the repair team as they convoy to the airfield after the attack.

Step 2: Upon arrival at the repair zone, the operator disconnects the trailer at the location selected by the Repair Team Lead. After disconnecting the trailer, the driver returns to the warehouse to pick up the next load of material. Then upon arrival at the repair zone, the operator disconnects the trailer at the location selected by the Repair Team Lead.

Step 3: The warehouse telehandler operator at the repair zone unloads super sacks from warehouse trailers and places them in a designated location identified by the Repair Team Lead. If the next loaded trailer has not arrived at the repair zone by the time the previous trailer is unloaded, the warehouse telehandler operator may assist the repair team by placing the appropriate number of flowable-fill super sacks, identified by the Repair Team Lead, diagonally from a repair corner approximately 15 feet away (**Figure 2.5**). This placement leaves room for pavement cutting, breaking, and excavating processes if not already complete. Align super sack handles so the backfill crew telehandler forks can slide through both sacks without readjusting position.

Figure 2.5. Super Sack Placement.



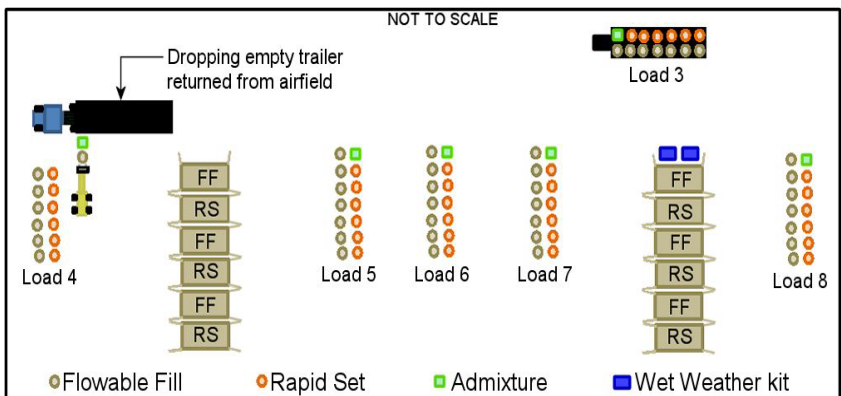
Step 4: When the tractor-trailer operator returns to the storage location, he/she immediately connects to the trailer carrying the second load and delivers it to the repair zone.

Step 5: The tractor-trailer operator positions the loaded trailer at the next identified drop location near the repair zone. After disconnecting the second load, the driver connects to the empty trailer that carried the first load and returns to the warehouse to pick up the third loaded trailer.

Step 6: As soon as the second trailer is positioned at the repair zone, the telehandler operator begins unloading and staging the second load of super sacks. The trailer is unloaded before load 3 arrives.

Step 7: When the tractor-trailer operator arrives at the warehouse, he/she drops the empty trailer in a location that provides the most efficient location for loading load 4 (Figure 2.6).

Figure 2.6. Empty Trailer Dropped for Load 4.



Step 8: The tractor-trailer driver then connects to the third loaded trailer and delivers the load to the airfield.

Step 9: Warehouse telehandler operator begins loading the empty trailer with load 4 and is finished by the time the truck returns to drop the next empty trailer.

Note: To save time, sacks are not typically strapped down. The tractor-trailer operator should stay aware of this lack of restraint to prevent losing sacks during sharp turns.

Step 10: This process continues until all repair materials are delivered.

2.2.6. If asphalt repairs are not underway, the three dump trucks are available for hauling crushed stone or choke-ballast, supporting the Foreign Object Debris Team to remove debris and trash (e.g., empty super sacks and pallets) from the airfield as needed, or replenish water as required.

Note: When all super sacks (flowable-fill backfill and rapid-setting concrete capping material) have been delivered and unloaded, the Warehouse telehandler operator on the airfield is tasked to directly support the Repair Team where needed.

2.2.7. The Warehouse Lead informs the RADR Officer in Charge when personnel have finished their tasks and are idle so they may be loaned to other crews as necessary.

Chapter 3

ASPHALT REPAIRS

3.1. Overview. The Warehouse Team delivers flowable-fill and asphalt when supporting asphalt cap repairs. Total volume of material is determined by the number and size of repairs. It may also haul crushed stone and/or choke ballast as needed. The flowable-fill staging and asphalt production areas may or may not be collocated but should each be within seven minutes driving time to the airfield operating surfaces.

3.2. Process.

3.2.1. Flowable-Fill. Three trailers are loaded with 13 super sacks of flowable-fill each. The first trailer travels to the airfield with the initial convoy. To initially determine total loads required, see **Table 3.1** for flowable-fill consumption rates under an asphalt cap.

Table 3.1. Flowable-Fill Consumption Rate under Asphalt Cap.

<i>L x W</i>	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15
8	3.56	3.78	4.00	4.22	4.44	4.67	4.89	5.11	5.33	5.56	5.78	6.00	6.22	6.44	6.67
8.5	3.78	4.01	4.25	4.49	4.72	4.96	5.19	5.43	5.67	5.90	6.14	6.38	6.61	6.85	7.08
9	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	7.00	7.25	7.50
9.5	4.22	4.49	4.75	5.01	5.28	5.54	5.81	6.07	6.33	6.60	6.86	7.13	7.39	7.65	7.92
10	4.44	4.72	5.00	5.28	5.56	5.83	6.11	6.39	6.67	6.94	7.22	7.50	7.78	8.06	8.33
10.5	4.67	4.96	5.25	5.54	5.83	6.13	6.42	6.71	7.00	7.29	7.58	7.88	8.17	8.46	8.75
11	4.89	5.19	5.50	5.81	6.11	6.42	6.72	7.03	7.33	7.64	7.94	8.25	8.56	8.86	9.17
11.5	5.11	5.43	5.75	6.07	6.39	6.71	7.03	7.35	7.67	7.99	8.31	8.63	8.94	9.26	9.58
12	5.33	5.67	6.00	6.33	6.67	7.00	7.33	7.67	8.00	8.33	8.67	9.00	9.33	9.67	10.00
12.5	5.56	5.90	6.25	6.60	6.94	7.29	7.64	7.99	8.33	8.68	9.03	9.38	9.72	10.07	10.42
13	5.78	6.14	6.50	6.86	7.22	7.58	7.94	8.31	8.67	9.03	9.39	9.75	10.11	10.47	10.83
13.5	6.00	6.38	6.75	7.13	7.50	7.88	8.25	8.63	9.00	9.38	9.75	10.13	10.50	10.88	11.25
14	6.22	6.61	7.00	7.39	7.78	8.17	8.56	8.94	9.33	9.72	10.11	10.50	10.89	11.28	11.67
14.5	6.44	6.85	7.25	7.65	8.06	8.46	8.86	9.26	9.67	10.07	10.47	10.88	11.28	11.68	12.08
15	6.67	7.08	7.50	7.92	8.33	8.75	9.17	9.58	10.00	10.42	10.83	11.25	11.67	12.08	12.50

Step 1: Upon arriving at the repair zone, the trailer is dropped at the location identified by the Repair Team Lead. After disconnecting the trailer, the driver returns to the warehouse to pick-up the next loaded trailer.

Step 2: The Warehouse Team telehandler operator on the airfield unloads the super sacks as soon as the first trailer is positioned. The first load should be unloaded before load 2 arrives.

Step 3: The tractor-trailer operator returns to warehouse and picks up trailer 2.

Step 4: The tractor-trailer operator drops trailer 2 at the next identified location near the repair zone. The driver connects to the empty trailer (load 1) and returns to the warehouse to pick up the third loaded trailer.

Step 5: The telehandler operator at the repair site begins unloading and staging the second load of super sacks. This trailer should be emptied before trailer 3 arrives.

Step 6: Upon arrival at the warehouse, the tractor-trailer operator drops the empty trailer in a location that provides the most efficient location for loading load 4.

Step 7: The tractor-trailer operator connects to the third loaded trailer and delivers the load to the designated repair zone.

Step 8: Forklift operators at the warehouse immediately begin loading empty trailer with load 4.

Step 9: This process continues until all repair materials are delivered.

Note: When all super sacks (flowable-fill backfill) have been delivered and unloaded, the warehouse telehandler operator at the repair zone is tasked to support the Repair Team where needed.

Step 10: Warehouse Lead informs the RADR Officer in Charge when deliveries are complete, and personnel are idle so they may be loaned to other crews as necessary.

3.2.2. Asphalt. The Warehouse 1 Lead manages the start of asphalt batching, production, hold times (trucks and stockpiles), deliveries, and reports status to the Logistics Chief. Therefore, Batch Teams should keep the Warehouse 1 Lead informed of their production, stockpiling process, and dump truck load times; and dump truck operators should inform the Warehouse 1 Lead of deliveries. **Table 3.2** provides the consumption rate for asphalt and **Table 3.3** provides the production rates for asphalt. Dump truck operators stage with the Asphalt Batch Team (one batch team can support one or two repair teams). Dump truck operators should spray truck beds with release agent before loading asphalt in trucks. The release agent and sprayer are located in the Repair Team's RADR tool trailer.

Table 3.2. Asphalt Consumption Rate for 4-Inch Cap (Tons).

WxL	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15
8	1.58	1.68	1.78	1.88	1.98	2.08	2.18	2.28	2.38	2.48	2.58	2.68	2.78	2.88	2.98
8.5	1.68	1.79	1.89	2.00	2.10	2.21	2.31	2.42	2.52	2.63	2.73	2.84	2.95	3.05	3.16
9	1.78	1.89	2.00	2.12	2.23	2.34	2.45	2.56	2.67	2.78	2.90	3.01	3.12	3.23	3.34
9.5	1.88	2.00	2.12	2.23	2.35	2.47	2.59	2.70	2.82	2.94	3.06	3.17	3.29	3.41	3.53
10	1.98	2.10	2.23	2.35	2.48	2.60	2.72	2.85	2.97	3.09	3.22	3.34	3.47	3.59	3.71
10.5	2.08	2.21	2.34	2.47	2.60	2.73	2.86	2.99	3.12	3.25	3.38	3.51	3.64	3.77	3.90
11	2.18	2.31	2.45	2.59	2.72	2.86	2.99	3.13	3.27	3.40	3.54	3.68	3.81	3.95	4.08
11.5	2.28	2.42	2.56	2.70	2.85	2.99	3.13	3.27	3.42	3.56	3.70	3.84	3.98	4.13	4.27
12	2.38	2.52	2.67	2.82	2.97	3.12	3.27	3.42	3.56	3.71	3.86	4.01	4.16	4.31	4.46
12.5	2.48	2.63	2.78	2.94	3.09	3.25	3.40	3.56	3.71	3.87	4.02	4.18	4.33	4.49	4.64
13	2.57	2.73	2.90	3.06	3.22	3.38	3.54	3.70	3.86	4.02	4.18	4.34	4.50	4.67	4.83
13.5	2.67	2.84	3.01	3.17	3.34	3.51	3.68	3.84	4.01	4.18	4.34	4.51	4.68	4.84	5.01
14	2.77	2.95	3.12	3.29	3.47	3.64	3.81	3.98	4.16	4.33	4.50	4.68	4.85	5.02	5.20
14.5	2.87	3.05	3.23	3.41	3.59	3.77	3.95	4.13	4.31	4.49	4.67	4.84	5.02	5.20	5.38
15	2.97	3.16	3.34	3.53	3.71	3.90	4.08	4.27	4.46	4.64	4.83	5.01	5.20	5.38	5.57

Table 3.3. Asphalt Production and Consumption Rates.

Batch Plant	Hourly Prod. Rate (tons)*	Repair Team	Hourly Consump. Rates**	Surplus/ Deficit Per Hr (tons)	Prod. Start Time	Min. Prod. Time (hrs)
1	14	1	9 tons	+ 5	2.5 hrs after release (1 hr before need)	2.57
1	14	2	18 tons	- 4	1.5 hrs after release (2 hrs before need)	5.15
2	28	3	27 tons	+ 1	2 hrs after release (1.5 hrs before need)	3.85
3	42	5	45 tons	- 3	1.5 hrs after release (2 hrs before need)	4.28
4	56	7	63 tons	- 7	0.5 hr after release (3 hrs before need)	4.5

*One batch plant using two asphalt recyclers, each one capable of 7 tons per hr.

**Assumes 8.5 ft x 8.5 ft x 4 inch repair @ 150 lbs/ft³ mat density.

Step 1: The Repair Team Lead informs the Warehouse 1 Lead that pavement breaking is about to commence. The Warehouse 1 Lead directs the supporting batch plant to begin batching operations and loading dump trucks as asphalt is produced to ensure asphalt is ready and available at the designated repair site

when needed. The Warehouse 1 Lead is notified as each dump truck is being filled.

Note: When all available dump trucks are loaded, stockpile additional asphalt as it is produced. A rule of thumb for the maximum hold time for a stockpile, being consistently added to, in temperate and dry weather conditions is three hours. There is no rule of thumb for cold weather conditions; stockpiles must be constantly monitored in cold weather to ensure the stockpiles are used before cooling below useable temperatures. Projects are scheduled to determine more definitive stockpile hold times and will be added to this publication when projects are complete.

Step 2: The Repair Team Lead requests asphalt from the Warehouse 1 Lead as the first repair's backfill is nearing completion. The Warehouse 1 Lead directs the first dump truck delivery of asphalt.

Step 3: Upon arrival at the repair site, asphalt is dumped directly into the repair when directed. Care must be taken with a full load to prevent over-filling the repair.

Step 4: After dumping the load, the dump truck operator returns to the asphalt batch plant to be reloaded and waits for direction to deliver the next load.

Step 5: Warehouse Lead informs the RADR Officer in Charge when personnel have finished their tasks and are idle so they may be loaned to other crews as necessary.

Note: Only two dump trucks are required to maintain asphalt supply for one Repair Team. If not needed, the third dump truck may be used to support other hauling operations where needed.

Chapter 4

CRUSHED STONE REPAIRS

4.1. Crushed Stone Transport. If crushed stone is required due to shortage of flowable-fill and/or rapid-setting concrete, the dump trucks are used as needed to haul crushed stone from stockpiles to the airfield.

4.2. Asphalt Cap. Dump trucks stockpile crushed stone at the repair zone prior to the commencement of hauling asphalt. Once asphalt hauling begins, one dump truck may still be used to support crushed stone backfill operations if necessary.

4.3. Full Crushed Stone Repairs. Dump truck operators haul crushed stone and ballast rock for these repairs. In addition, if fighter aircraft are supported the tractor-trailer operator delivers FOD covers to cap the crushed stone repairs. Technical Order 35E2-5-1-WA-1, *Crushed Stone Crater Repair and Line-of-Sight Profile Measurement for Rapid Runway Repair*, describes crushed stone repair procedures.

Chapter 5

EXPEDITIOUS SPALL REPAIR CREW RESUPPLY

5.1. Overview. Spall repair is occurring simultaneously with crater repair. The installation's RADR capability (i.e., small, medium, large, or very large) and the scope of spall damage on the Minimum Airfield Operating Surface will determine how many spall repair crews will be resupplied. In addition, the spall repair crews' vehicle configuration will determine how often repair material resupply is required.

Note: Water will be resupplied by Repair Team's water trucks.

5.2. Manning. Suggest the warehouse forklift operator, with unused spall repair personnel, resupply repair material for the spall repair crews.

5.3. Vehicles. There are no dedicated vehicles for resupplying the spall crews. Crews should determine vehicles that will be used during recovery prior to hostilities commencing. Some potential vehicle options are identified below.

5.3.1. Back-hoe. Repair materials may be loaded in a back-hoe bucket (from the Base Expeditionary Airfield Resources [BEAR] vehicle set) and delivered to the spall repair crews.

5.3.2. Front-End Loader. Repair materials may be loaded in a front-end loader bucket (from a Repair Team's Capping Crew if asphalt repairs are not required, or from the BEAR vehicle set) and delivered to the spall repair crews (See AFPAM 10-219V4 for complete descriptions of airfield damage repair teams).

5.3.3. Trencher Trailer and Tow Vehicle. Repair materials may be loaded on the BEAR Trencher trailer and delivered to the spall repair crews.

5.3.4. Warehouse Telehandler and Warehouse Forklift. After all crater repair material loads have been loaded on flatbed trailers, the telehandler and/or warehouse forklift may assist with resupplying the spall repair crews.

5.3.5. Warehouse Tractor and Trailer. After all crater repair materials have been delivered to the airfield, the warehouse tractor and one trailer may assist with resupplying the spall repair crews.

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DCS/Logistics, Engineering & Force Protection

Attachment 1**GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION*****References***

29 CFR 1910.133, *Eye and Face Protection*, 22 November 2023

29 CFR 1910.134, *Respiratory Protection*, 22 November 2023

29 CFR 1926.1153, *Respirable Crystalline Silica Standard for Construction*, 22 November 2023

Air Force Doctrine Publication 3-34, *Engineer Operations*, 6 October 2021

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

AFI 48-127, *Occupational Noise and Hearing Conservation Program*, 26 February 2016

AFI 48-137, *Respiratory Protection Program*, 12 September 2018

DAFMAN 91-203, *Air Force Occupational Safety, Fire and Health Standards*, 25 March 2022

AFI 24-301, *Ground Transportation*, 22 October 2019

AFI 33-322, *Records Management and Information Governance Program*, 28 July 2021

AFPAM 10-219V4, *Airfield Damage Repair Operations*, 28 May 2008

Technical Order 35E2-5-1-WA-1, *Crushed Stone Crater Repair and Line-of-Sight Profile Measurement for Rapid Runway Repair*, 27 August 2007

Unified Facilities Criteria 3-260-01, *Airfield and Heliport Planning and Design*, 4 February 2019

Prescribed Forms

No prescribed forms are implemented in this publication.

Adopted Forms

DAF Form 847, *Recommendation for Change of Publication*

Abbreviations and Acronyms

AFI—Air Force Instruction

AFPAM—Air Force Pamphlet

BEAR—Base Expeditionary Airfield Resources

BEEF—Base Engineer Emergency Force

DAF—Department of the Air Force

DAFMAN—Department of the Air Force Manual

FOD—Foreign Object Debris

GTO—Ground Transportation Operation

IPE—Individual Protective Equipment

OPR—Office of Primary Responsibility

PPE—Personal Protective Equipment

RADR—Rapid Airfield Damage Recovery

TTP—Tactics, Techniques, and Procedures

UTC—Unit Type Code

Office Symbols

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

AF/A4CXB—Air Force Directorate of Civil Engineers, Readiness Division, Prime BEEF Branch

Terms

Airfield—An area prepared for the accommodation (including any buildings, installations, and equipment), landing, and takeoff of aircraft.

Base Expeditionary Airfield Resources (BEAR)—These are the vital equipment and supplies necessary to beddown and support combat forces at austere locations where little or no infrastructure exists.

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.

Debris—Material ejected from the crater including broken pavement and soil. Debris is some-times usable as backfill material particularly for large crater repair, but for small crater or spall repair it is generally not advisable.

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

Minimum Airfield Operating Surface—The combined requirement for airfield surfaces for both runway and access routes. The Minimum Operating Strip is part of this surface.

Minimum Operating Strip—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. This surface is the smallest area to be repaired to launch and/or recover aircraft after an attack. Selection depends 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. 2. In common usage, especially when applied to lower military units, a duty assigned to an individual or unit; a task. 3. The dispatching of one or more aircraft to accomplish one particular task.

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

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.

Runway—A defined rectangular area of an airfield, prepared for the landing and takeoff 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.

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

Support—1. The action of a force that aids, protects, complements, or sustains another force in accordance with a directive requiring such action. 2. A unit that helps another unit in battle. 3. An element of a command that assists, protects, or supplies other forces in combat.

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

Attachment 2

ENGINEER REACHBACK AND OTHER USEFUL LINKS

Table A2.1. Useful Organizational and Product Links.

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