AIR FORCE TACTICS, TECHNIQUES, AND PROCEDURES 3-32.16

20 JANUARY 2017

SUSTAINING AIRFIELD PAVEMENT AT ENDURING CONTINGENCY LOCATIONS

DEPARTMENT OF THE AIR FORCE

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BY ORDER OF THE SECRETARY OF THE AIR FORCE

AIR FORCE TACTICS, TECHNIQUES AND PROCEDURES 3-32.16

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Tactical Doctrine

SUSTAINING AIRFIELD PAVEMENTS AT ENDURING CONTINGENCY LOCATIONS

OPR: AFCEC/CXX

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PURPOSE: To provide tactics, techniques and procedures (TTP) to effectively maintain airfield pavements during enduring contingency operations. These TTPs help ensure continuance of the combatant commander's mission over a predetermined, or indefinite, period of time. This publication supports Air Force Instruction (AFI) 10-210, *Prime Base Engineer Emergency Force (BEEF) Program*, Air Force Pamphlet (AFPAM) 10-219, Volume 4, *Airfield Damage Repair Operations*, and Air Force Doctrine Annex 3-34, *Engineer Operations*. Ensure that all records created as a result of processes prescribed in this publication are maintained IAW Air Force Manual (AFMAN) 33-363, *Management of Records*, and disposed of IAW the Air Force Records Disposition Schedule (RDS) in the Air Force Records Information Management System (AFRIMS). Refer recommended changes and questions about this publication to the Office of Primary Responsibility (OPR) using the AF Form 847, *Recommendation for Change of Publication*; route AF Forms 847 from the field through the appropriate functional chain of command.

APPLICATION: This publication applies to Regular Air Force, Air National Guard (ANG), and Air Force Reserve Command (AFRC) Civil Engineer personnel performing airfield pavement sustainment operations during

contingencies. This document is authoritative but not directive. The TTPs found in this publication take precedence over those found in other nondirective publications. Applicable AFIs take precedence when this publication and AFIs conflict.

SCOPE: This Air Force TTP describes expedient airfield pavement maintenance and repair actions to include expeditionary equipment and materials, repair and maintenance of cement-stabilized soil surfaces and chemical dust control for airfields. The TTPs in this publication focus on expeditionary operations in austere conditions and do not reflect permanent repairs in all cases.

Note: The use of name or mark of any specific manufacturer, commercial product, commodity, or service in this publication does not imply endorsement by the Air Force.

Chapter 1

INTRODUCTION

1.1. Background. Airfield pavement repairs lasting several years are routinely achieved at main operating bases. Conversely, repairs at contingency locations using procedures outlined in UFCs have failed sooner than would normally be anticipated. Specifically, repairs in apron areas have achieved life spans in excess of 12 months, but often last less than eight months on runways and primary taxiways.

1.1.1. Many repairs at contingency locations involve large, non-uniformly shaped repairs loaded shortly (within a few hours) after placement. While many problems can be traced to inadequate preparation of the repair, some problems arise from curing techniques, material selection, and early loading. High operational tempo at these locations require the use of extremely rapid-setting materials and early loading of repairs which tend to create additional stress in the repair not present at main operating bases using ordinary Portland cement mixes.

1.1.2. An investigation of premature repair failures was initiated to determine their cause and to develop corrective actions to achieve enduring repairs in contingency locations. This publication includes the tactics, techniques and procedures (TTPs) resulting from that investigation.

1.2. Scope. This handbook contains information on current practices for the repair of airfield pavements at contingency locations. It contains information on the UTC 4FWSP, Sustainment Pavement Repair (SuPR) Kit, including its intended purpose, kit contents, and setup procedures. It provides repair guidance for rigid pavements, flexible pavements, and cement-stabilized soil surfaces. Lastly, chemical dust control for airfields is discussed.

Chapter 2

Sustainment Pavement Repair (SuPR) Kit

2.1. Introduction. The SuPR Kit (Unit Type Code [UTC] 4FWSP) provides quality airfield sustainment capabilities during contingency operations.

2.1.1. The SuPR Kit, when combined with trained engineers, provides commanders with the capability to rapidly produce long lasting, durable airfield pavement repairs. In most cases the airfield pavement may be opened to aircraft traffic in less than two hours after completion of repairs. The kit contains equipment and materials to rapidly remove damaged pavement without disrupting the substrate. It also contains specialized equipment to repair pavement in the vicinity of aircraft arresting systems to eliminate aircraft tail-hook skip. The kit contains rapidly setting repair materials that attain required strength within 90 minutes and are less sensitive to field conditions than most other products. Such expedient repairs are virtually impossible to achieve without the use of the equipment and materials in this specialized kit.

2.1.2. Airfield pavement at contingency locations may need significant repairs before receiving mission aircraft, beddown forces, or materiel. In this instance, either a RED HORSE (RH) advanced echelon repair team or a RH small horizontal construction team, depending upon airbase accessibility, deploys with their appropriate equipment UTCs, alongside contingency response forces, in an "open the airbase" scenario. They perform a minimum number of expedient airfield surface repairs to establish a minimum airfield operating surface (MAOS) for cargo aircraft.

2.1.3. Aircraft then deliver equipment, personnel and materials necessary for Prime Base Engineer Emergency Force (Prime BEEF), or RH engineers, to establish the airbase. In this phase, engineers improve the previous expedient repairs made by RH and extend the MAOS to achieve initial operating capability (IOC) of assigned mission aircraft. Subsequently, airfield sustainment capabilities must exist until Basic Expeditionary Airfield Resources (BEAR) vehicles, equipment and materials arrive and a supply chain established. The SuPR Kit provides this interim maintenance capability.

2.1.4. The pavement may only require minor repairs such as spall, joint and crack repairs before mission aircraft may arrive. Typically, Prime BEEF

personnel (RH may be tasked) deploy with the SuPR Kit to make the necessary minor repairs before cargo aircraft bring in BEAR vehicles and equipment.

2.1.5. The SuPR kit may be augmented with other Airfield Damage Repair (ADR) kits to enhance its effectiveness and reduce lifecycle logistics associated with ADR, and in particular sustainment repair capabilities. These augmentation kits should be tailored to local pavement types, distresses, and materials at the airfield.

2.1.6. When full allotment of BEAR vehicles and equipment arrive, Prime BEEF forces achieve full operational capability (FOC) of the airfield and transition into operate- and sustain-the-airbase missions. The SuPR kit remains in place until replacement vehicles, equipment, and materials essential to timely quality repair of airfield pavements has been received or the mission ends.

2.1.7. In addition, engineers may deploy to forward operating locations (FOLs) to perform minor airfield repairs where no engineer capability exists. The modular and scalable SuPR kit is ideally suited to provide this capability.

2.2. Description. This kit is a specialized equipment-and-materials-only UTC that provides Prime BEEF and RH teams the capability to sustain airfield pavements at contingency locations. The capability offers durable asphalt and concrete pavement maintenance and repairs (typically spall, joint/crack, small patch or single slab repairs). The Air Force Civil Engineer Center (AFCEC)/CXX is the Pilot Unit for this UTC. See the Mission Capability (MISCAP) Statement in **Attachment 2**.

2.2.1. The kit consists of five (5) 20-ft long by 8-ft wide by 8-ft tall freight containers with multi-use equipment deployable via air, land or sea. The kit includes two vehicles (compact track loader [CTL] and compact vibratory roller) that require diesel fuel and periodic maintenance. Major equipment and vehicles provided in the kit are:

- CTL with the following attachments (atchs): cold planer, concrete breaker, drum compactor, forks, multi-purpose bucket, rotary broom, turbine heated asphalt mixer
- vibratory compact roller, self-propelled, dual drum, 3-ton
- concrete and asphalt hand tools
- concrete mixer
- tow-behind air compressor

- two 6-kilowatt (kW) generators
- walk behind saw (60 hp), 18-42-inch blades
- walk behind saw (18 hp), 18-inch blade

2.2.2. There are three equipment containers (#1, #2, and #3) that open from each end and two repair material containers (#4 & #5) that have doors on all four sides. Containers are labeled in top left corner on both long ends (**Figure 2.1**). See **Attachment 3** for container inventories and diagrams (as kit items are discussed in this document the corresponding inventory item numbers will be included for clarity from this point forward). Containers have been certified air transportable on C-130s, C-17s, and C-5s. Individual empty and gross container weights are listed in **Table 2.1**.

Figure 2.1. Container Identification Label.

Table 2.1. Shipping Container Weights.

Container	Empty Weight (lbs)	Gross Weight (lbs)
Container #1	5,826	25,281
Container #2	5,826	18,400
Container #3	5,826	13,913
Container #4	6,250	29,910
Container #5	6,250	29,940

2.2.3. **Table 2.2** lists the quantities of basic repair material consumables and total repair capabilities. See **Attachment 3** for complete inventory of SuPR Kit.

Table 2.2. SuPR Kit Repair Material Quantity and Coverage.

Repair Material	Cont. #4	Cont. #5	Coverage (ft^3) per Bucket	Total Coverage (ft^3)
Rapid Set (5 Gal Bucket)	100	100	0.4	80
Flowable Fill (5 Gal Bucket)	50	50	0.4	40
Pelletized Asphalt (5 Gal Bucket)	100	100	0.3	60
Cold Patch (5 Gal Bucket)	22	22	0.7	30.8
Repair Material	**Cont. #4**	**Cont. #5**	**Coverage (ft)**	**Total (ft)**
Expansion Board (6”x1/2”x10’)	32	32	10	640
Expansion Board (4”x1/2”x10’)	32	32	10	640
3/4” Backer Rod	2	0	200	200
*Concrete Expansion Joint Sealant	6	6	12	144
Notes: *1/2” joint. - Waste not included in calculations. - 100 each load-transfer dowels, w/chairs, are stored in container #2.				

2.3. Siting and Layout. When siting the containers, clearances shown in **Table 2.3** are for unloading purposes.

Table 2.3. Clearances Required for Unloading Containers.

Container #	Ends	Sides
1	20-feet	*5-feet
2	20-feet	*5-feet
3	20-feet	*5-feet
4	20-feet	20-feet
5	20-feet	20-feet
*Required to fully open end doors (270°) and secure them to the side walls; may not be required in all instances.		

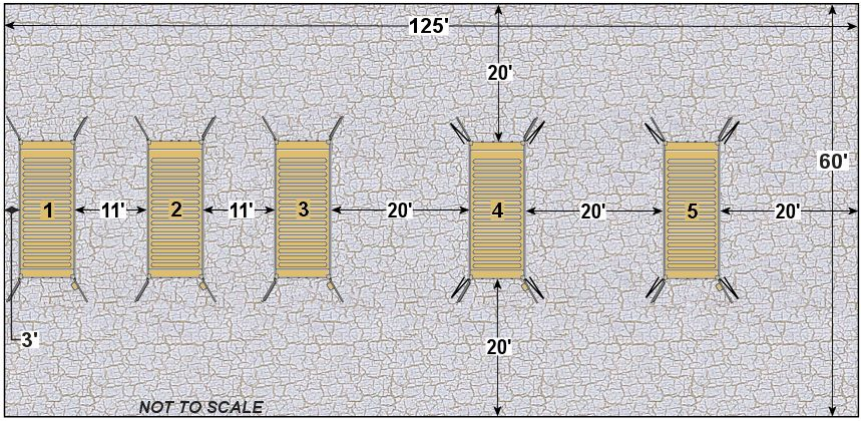
2.3.1. Many contingency locations have limited space for container setup; site them according to available space. Determine available square footage and choose an example in **paragraph 2.3.2** to fit available space and desired layout.

2.3.2. Place containers on improved or semi-improved surfaces capable of supporting weight of containers (i.e., up to 29k lbs). The layout area should be in a location with adequate drainage and is not prone to standing water or flooding. It is recommended a 20-foot clear zone, for material handling equipment, be available on both ends of equipment containers (1, 2, & 3) and a 20-foot clear zone be available on both ends and both sides of material containers (4 & 5), as all four sides open. **Figures 2.2** thru **2.6** provide layout configuration examples for the SuPR Kit; available space may dictate container layout configuration.

Note: Six 10' x 20' tarps located in container 4 (item #3, **Figure A3.18**) may be temporarily used to provide covered storage areas until more durable tarps/covers can be obtained. Recommend a locally acquired pole (e.g., camouflage netting pole with spreader) at least 9-foot tall be placed in the center of the tarps to shed rain.

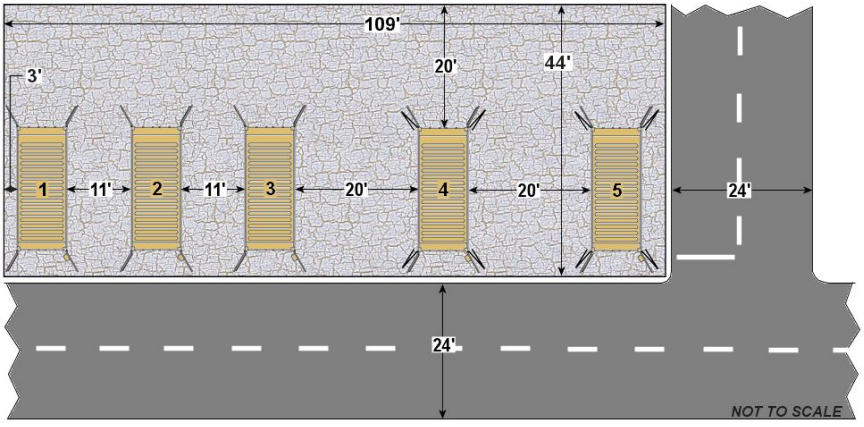
2.3.2.1. **Figure 2.2** demonstrates a 7,500 sq. ft. layout area. Tarps may be stretched between containers 1 and 2 and between containers 2 and 3 to provide two 11-ft by 20-ft covered storage and work areas.

Figure 2.2. Container Layout Example 1 (7,500 sq. ft.).



2.3.2.1.1. Required setup space may be reduced by siting containers near roads or parking lots. The road and parking lot may temporarily provide needed clearance around containers for loading/unloading. As **Figure 2.3** demonstrates, total space required for container setup is reduced from 7,500 sq. ft. in **Figure 2.2** to 4,796 sq. ft. by utilizing adjacent roads for loading/unloading clearance.

Figure 2.3. Siting Containers near Roads or Parking Lots (4,796 sq. ft.).



2.3.2.1.2. The footprint may be reduced even further (3,564 sq. ft.) if identical containers 4 and 5 are double-stacked. If, or when, the bottom container's supplies run low, it may be switched out with the top container for easy access.

2.3.2.1.3. **Figure 2.4** demonstrates a 5,934 sq. ft. layout. Utilizing the concept described in **paragraph 2.3.2.1.1** may reduce this layout to 3,380 sq. ft. If existing covered storage is not available for the equipment removed from the containers, a tarp may be attached to the outboard sides of containers 1 and/or 3 and supported on the other end with locally obtained poles/posts.

2.3.2.1.4. Layout configuration in **Figure 2.5** demonstrates stacking containers 4 and 5, which provides a layout footprint of 4,760 sq. ft. Footprint may be further reduced utilizing the concept in **paragraph 2.3.2.1.1** to 3,536 sq. ft. Covered storage may be constructed by attaching tarps on the outboard sides of containers 1 thru 3 and support the other ends with locally obtained poles/posts.

Figure 2.4. Container Layout Example 2 (5,934 sq. ft.).

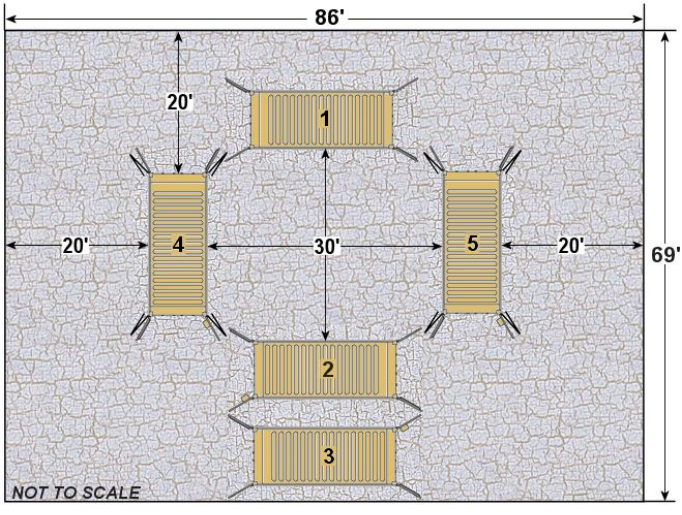
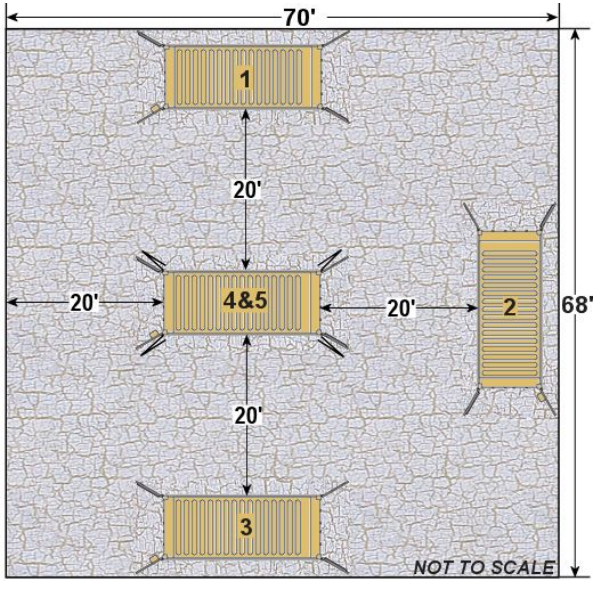
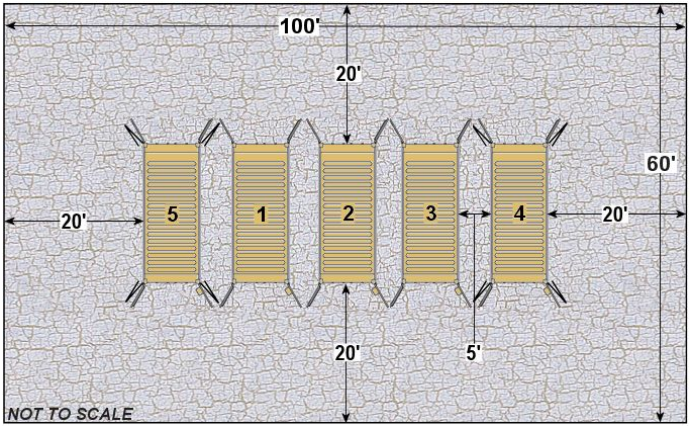


Figure 2.5. Container Layout Example (4,760 sq. ft.).



2.3.2.1.5. The layout configuration in **Figure 2.6** demonstrates how containers 4 and 5 may be placed on each end of a straight-line to keep the footprint to a minimum (6,000 sq. ft.). Access is provided to all repair materials by retrieving items from opposite sides of material containers. As supplies are depleted, containers 4 and 5 may be swapped to opposite ends of the straight line configuration to provide access to the other half of the containers. If covered storage space is required, additional space may be provided between containers 1, 2, and 3. Again, utilizing the concept in **paragraph 2.3.2.1.1** may reduce the layout footprint to 3,200 sq. ft.

Figure 2.6. Container Layout Example 4 (6,000 sq. ft.).



2.4. Container Lifting Procedures. When a rough terrain container handler (RTCH) is unavailable, fully loaded containers will be lifted by crane. Operators of Air Force special purpose vehicle/truck cranes shall be licensed in accordance with AFI 32-301, *Vehicle Operations*. Follow crane safety guidelines in AFI 91-203, *Air Force Consolidated Occupational Safety Instruction*. The crane operator will consult crane's load chart to ensure the load with rigging hardware does not exceed crane capabilities or safe working load. **Note:** Mission planner should determine if a crane or RTCH will be available at the unloading site when the SuPR kit arrives. If unavailable, the planner should make arrangements to have container handling assets available, whether organic or rental, with appropriate lifting capacity. At austere locations with only forklift capability, container items must be unloaded until at, or below, the capacity of the forklift before lifting.

2.4.1. A placard illustrating the configuration of the Spreader Bar Lifting Kit (container #1, item 23) is placed on the outside of each container (**Figure 2.7**). Remove spreader bar, turnbuckles and wire rope slings from container #1 (the container is marked on the end where the spreader bar lifting kit is located). The slings and turnbuckles are located in the CTL bucket attachment (container #1, item 21) and the spreader bar is located on the lower right wall next to the broom attachment (**Figure 2.8**).

Figure 2.7. Spreader Bar Lifting Kit Placard.

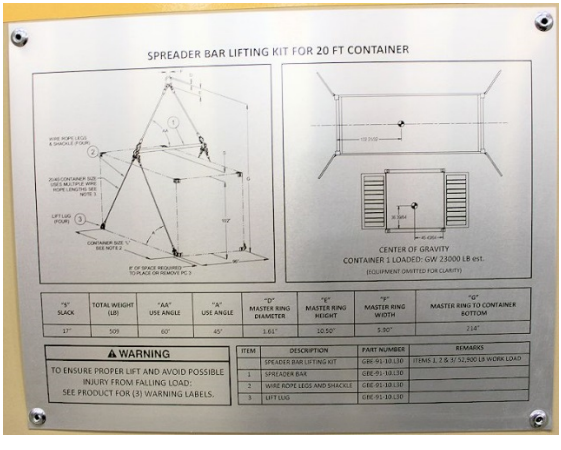
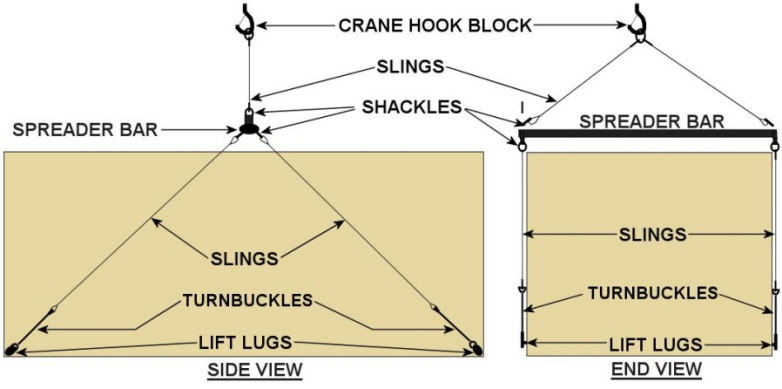


Figure 2.8. Removing Slings & Turnbuckles from CTL Bucket Attachment.

Note: Attempt to prevent dirt, gravel, or any type of debris from embedding between the sling's wire rope strands and independent wires.

2.4.2. Rig slings and spreader bar as illustrated in **Figure 2.9**. Shackles attach slings to spreader bar (**Figure 2.10**). Rotating Lift Lugs (**Figure 2.11**) connect turnbuckles to the container bottom, side corner fitting apertures (**Figure 2.11** shows slings connected to rotating lift lugs before turnbuckles were added to the kit). Rotating Lift Lugs with the Pre-Lift Safety Lock feature prevents unwanted fallout while Lugs are NOT under load. Insert the "toe" and twist the cross pin 90-degrees to lock and prepare to lift. Connect the lower end of slings to the upper end of turnbuckles. It is also recommended that lumber (typically 2" x 4" x 10') be placed between the sling and container, when available, as a cushion to prevent potential damage to the slings or container when lifted. **Note:** Ensure contents are secured before lifting containers.

Figure 2.9. Container Lifting Configuration.



Note: Adjust turnbuckles to level containers when balance is not centered. Connect turnbuckles between lifting lugs and slings.

Figure 2.10. Slings Connected to Spreader Bar.

Figure 2.11. Rotating Lift Lug.

LIFTING LUG READY FOR INSERTION

LIFTING LUG INSERTED AND LOCKED

2.5. Safety Items. The following safety items are included in the kit:

2.5.1. Each container has a first aid kit mounted on an end door (**Figure 2.12**).

Figure 2.12. First Aid Kit.

2.5.2. Applicable containers have a Material Safety Data Sheet (MSDS) binder stored on an end door (**Figure 2.13**).

Figure 2.13. MSDS Binder.

2.5.3. A flammable storage cabinet (item 42) is stored in container #3 opposite the breaker panel (**Figure 2.14**).

Figure 2.14. Flammable Storage Cabinet.

2.5.4. Wire Basket W2 (item 68) in container #3 contains the following safety items:

- Foam ear plugs, 100 pair
- Safety goggles, 12 each
- Safety glasses, 24 each
- Hard hat, 12 each
- Face shield, 4 each
- Ear muffs, 4 each
- Work gloves, 24 pair

2.6. Kit Setup. After positioning containers, recommend the following setup actions be performed to allow ready access to all kit components and to provide open work areas within containers #2 and #3. **Table 2.4** provides an abbreviated list of actions to setup the container for use. **Note:** Check all fluids and fill as necessary before operating any equipment/ vehicles.

2.6.1. If setting up in darkness, temporarily use small Honda portable generators (**Figure 2.15**) and portable telescoping lights from containers #2 (item 41) and #3 (item 44) to provide lighting.

Table 2.4. Container Rearrangement Actions.

No.	Nomenclature	Cont.	Item #	Move To	Comment
1	CTL	1	12	Back out of cont. 1	With forklift atch.
2	Rolling tool box	3	43	Cont. 1, CTL position	Move with CTL
3	Roller	3	34	Covered storage	Self-propelled
4	Upper pallet	2	10/25/49	Covered storage	Move with CTL
5	Wire baskets (8 ea)	2	29	Cont. 1 against walls	In front of tool box
6	Floor pallet, conc. saw	2	7/35	Covered storage	Move with CTL
7	Floor pallet, dowel drill	2	7/31	Covered storage	Move with CTL
8	Bucket attachment	1	21	Covered storage	Remove from pallet
9	Lifting slings	1	23B	Upper pallet (item 5)	Strap slings
10	Upper pallet w/slings	1	5	Original location	Move with CTL
11	Spreader bar	1	23A	Original location	After unloading
12	Air compressor	3	31	Covered storage	Use pintle-hook assy.
13	Wheelbarrows	2	24	Covered storage	By hand
14	Wheelbarrows	3	33	Covered storage	By hand
15	Concrete mixer	2	28	Covered storage	Use pintle-hook assy.

Figure 2.15. Generator for Telescoping Area Lighting.

2.6.1.1. Containers are prewired with four lights, one in each corner, a light switch on each end, and one convenience outlet next to a breaker panel (**Figure 2.16**). Power is provided by plugging a 25-foot twist lock extension cord (Basket H in container #2, item 29) to the receptacle on the side of equipment containers

(**Figure 2.17**), or on an end door of material containers, and plugging opposite end into a power source. Four extension cords are provided that may be connected together to extend the reach of the cords. When a commercial or BEAR electrical source is not available, the two 6-kW generators (**Figure 2.18**) in containers 2 (item 58) and 3 (item 56) may be used as a power source for the containers. The generators have only one 30 amp/120 volt receptacle; therefore, if more than one container requires power simultaneously, both generators will be required. Move extension cords between the containers as needed.

Figure 2.16. Container Electrical Components.

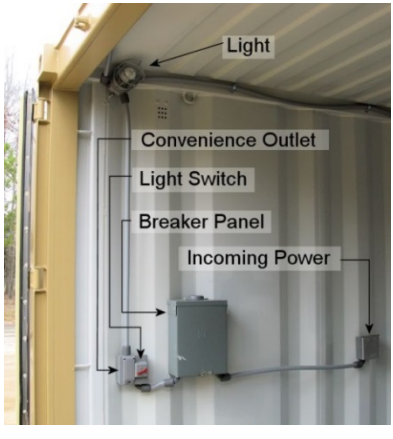
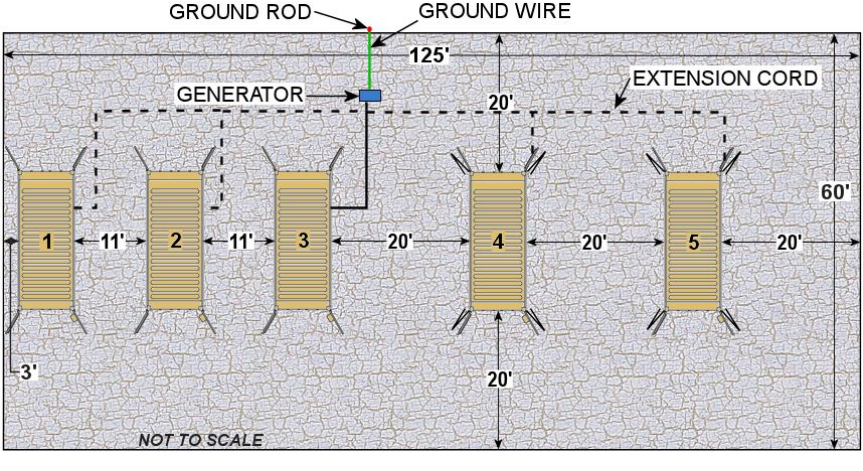


Figure 2.17. External Power Connection Point.

Figure 2.18. 6-kW Generator.

2.6.1.2. Ground the generator prior to connecting power to a container (**Figure 2.19**). A ground rod kit (ground rod, driver, connector, and ground wire) is located with each generator (container #2, items 60-63; and container #3, items 58-61). A ground rod driver is provided in container #3 (item 35). An electrician should test the grounding system to ensure earth grounding resistance is less than 25 ohms and all containers are bonded to the ground source with less than one ohm of resistance.

Figure 2.19. Container and Generator Grounding Scheme.



2.6.1.3. L5-20P to L5-30R plug adapters (**Figure 2.20**) may be used to power the containers from a BEAR 25-kW power distribution panel (PDP). They are located in container 2, wire basket H.

Figure 2.20. L5-20P to L5-30R Plug Adapter.

2.6.2. Remove the box containing operations and parts manuals from the cab of the CTL in container 1 and place in a convenient location protected from the weather. There are two binders containing hard copies, and a computer disk with electronic copies.

Note: Store all straps, chains and binders in their original container so they are readily available for repacking equipment and vehicles.

Note: Kit is delivered with forklift attachment installed on the CTL. Use caution when backing the CTL out of the container to prevent damage to other items.

2.6.3. Fuel CTL (item 12) and back it out of container 1 (**Figure 2.21**). Jumper cables are provided in container 2, wire basket G (item 29) if battery is dead.

Figure 2.21. Fueling CTL.

2.6.4. Using the CTL with fork attachment (item 22, attached to CTL), remove the rolling tool box (item 43) from container 3 (**Figure 2.22**) and place in container 1, where CTL was removed, with rear of box against the pallets with CTL attachment (**Figure 2.23**).

Figure 2.22. Removing Rolling Toolbox from Container 3.

Figure 2.23. Rolling Tool Box Repositioned in Container 1.

Note: Use ramps, strapped to door of containers 2 (item 11) or 3 (item 7), when removing wheeled vehicles and equipment from containers (**Figure 2.24**). Ensure ramp pins are placed in the matching holes on container floor to prevent ramps from slipping off the container floor during equipment removal.

Figure 2.24. Roller Backing Down Ramps.

Note: Organize equipment/vehicles removed from containers under covered storage in a manner that best suits local needs, either between containers 1, 2, and/or 3 or in a pre-existing covered storage area on the installation.

2.6.5. Fuel the roller (item 34), remove from container 3 and park under covered storage.

Note: When removing pallets from upper level, place wheel chocks (container 1, item 32) against container as shown in **Figure 2.25**. Otherwise, damage may occur to the hydraulic connection block on the CTL's lift arm if it contacts the top of the container.

Figure 2.25. Wheel Chocks in place to Prevent Connection Block Damage.

2.6.6. Using the CTL with fork attachment, remove upper pallets (item 10) with the cold planer (item 25) and asphalt mixer/burner (item 49) attachments from container 2, and store pallets with attachments under covered storage.

2.6.7. Remove wire baskets (item 29) from container 2 (**Figure 2.26**), stored beneath the area where the upper pallet (item 10) with cold planer and asphalt mixer/burner attachments were located, and place in container 1 as shown in **Figure 2.27**. Configure the wire baskets as shown in **Figure 2.28**.

Figure 2.26. Removing Wire Baskets from Container 2.

Figure 2.27. Wire Baskets Relocated in Container 1.

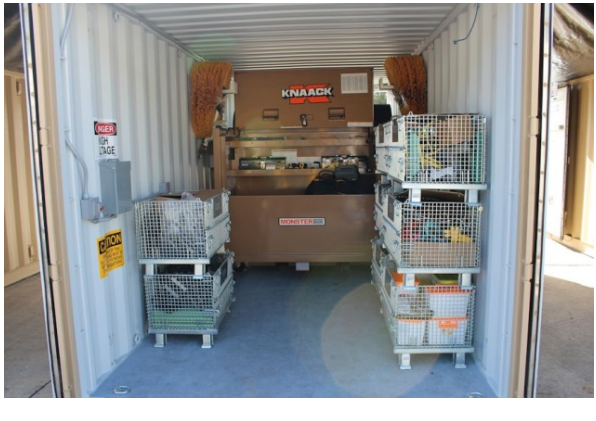
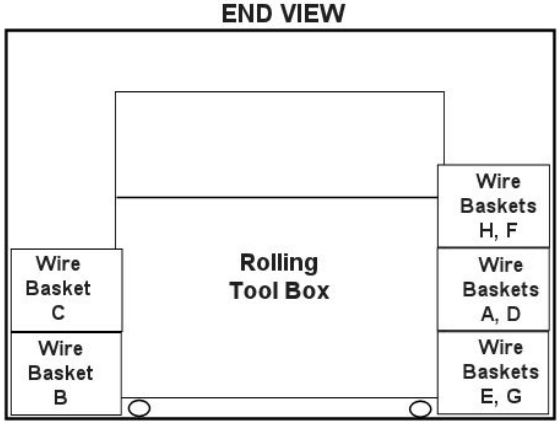


Figure 2.28. Wire Basket Configuration in Container 1.



2.6.8. Remove pallets (item 7) with large walk behind concrete saw (item 35) and dowel drill (item 31) from container 2, stored on opposite end from cold planer (**Figure 2.29**), and place under covered storage.

Figure 2.29. Walk-Behind Saw and Dowel Drill.

2.6.9. Remove upper pallet (item 5) securing CTL bucket attachment (item 21) in container 1. Remove bucket attachment from the pallet and place it under covered storage. Place lifting slings (item 23B) and turnbuckles (item 36) on the empty pallet and return the pallet to its original storage location (**Figure 2.30**); store spreader bar (item 23A) in its original storage location (**Figure 2.8**).

Figure 2.30. Container Lifting Slings Stored on Pallet.

2.6.10. Attach pintle-hook assembly (item 8), located in container 1 (**Figure 2.31**), to the CTL forks and tow the air compressor (item 31) out of container 3 (**Figure 2.32**) and park under covered storage.

Figure 2.31. Pintle-Hook Assembly (black) in Stored Location.

Figure 2.32. Towing Air Compressor out of Container 3.

2.6.11. Remove wheelbarrows from containers 2 (item 24) and 3 (item 33) and store under covered storage.

2.6.12. Temporarily remove 18-inch walk-behind concrete saw (item 36) and 6-kW generator (item 58) from container 2 (**Figure 2.33**). With pintle-hook assembly still attached to the CTL forks, remove the concrete mixer (item 28) and store under covered storage (**Figure 2.34**). (**Note:** Tow bar is stored in mixing drum and must be installed prior to towing.) Place 18-inch walk behind concrete saw and generator back in container 2.

Figure 2.33. Generator and 18-inch Saw.

Figure 2.34. Removing Concrete Mixer from Container.

2.6.13. After rearranging contents as described above, containers 1 thru 3 will resemble **Figure 2.35**. Containers 4 and 5 are not reconfigured. A wide view of all 5 containers after setup is shown in **Figure 2.36**.

Figure 2.35. View of Containers 1 thru 3 after Setup.

Figure 2.36. Container Layout after Setup.

2.7. Unique Items. While the majority of equipment and tools in this kit are common shop items used routinely during peacetime operations, there are a few unique items not commonly used by Prime BEEF members. The following sub-paragraphs describe these unique items.

2.7.1. **Vibratory Drum Compactor, Work Tool Attachment** (container 1, item 17). Experience has shown that this roller attachment (**Figure 2.37**) performs best when compacting crushed stone at lifts no higher than 3-inches.

Figure 2.37. Vibratory Drum Compactor, Work Tool Attachment.

2.7.2. **Asphalt Mixer/Burner.** The asphalt mixer/burner attachment (item 49) stored in container 2 (**Figure 2.38**) is new equipment the typical engineer has no experience operating; therefore, extreme caution should be taken when heating and placing materials. The attachment heats 400 lbs of mix to 340° Fahrenheit in just eight minutes. **Note:** The Operator's Manual was not available when kits were shipped, but may now be accessed and downloaded from the "08. ADR" folder located on the AFCEC Expeditionary Engineering SharePoint at https://cs3.eis.af.mil/sites/21340/default.aspx.

Figure 2.38. Asphalt Mixer/Burner.

2.7.2.1. Before using the attachment, inspect for warped drum, cracked drum welds, leaking fuel, damaged or frayed control wiring, and any other obvious discrepancies are corrected before operating.

2.7.2.2. Ensure any spilled fuel is wiped up before starting the heater.

2.7.2.3. There is a remote on/off switch with the attachment for safety purposes. After attaching to the CTL, run the heater on/off switch and wire through the CTL door opening (**Figure 2.39**) so it is accessible to the CTL operator, but does not interfere with entering or exiting the cab, or operation of the CTL. The weather stripping around the door provides cushioning and will not damage the wire when the door is closed.

2.7.2.4. Always fuel, or refuel, the heater when it is detached from the CTL.

2.7.2.5. Always have a spotter when heater is in use.

2.7.2.6. Pivot the burner out of the way and lock it with the set-pin when loading and unloading the drum.

Figure 2.39. Asphalt Heater Remote Switch.

2.7.2.7. Ensure the drum is rotating before igniting the heater to prevent drum warpage.

2.7.2.8. If the heater malfunctions for any reason, the operator may press the red EMERGENCY STOP button (**Figure 2.40**) on the side of the drum or the CTL operator may turn the heater off with the remote switch inside the CTL cab.

Figure 2.40. Asphalt Heater Red Emergency Stop Button.

2.7.2.9. To shutdown, empty mixer of all material, turn off both heater switches, turn off mixer switch, and disconnect electrical connections between the burner and CTL. Let drum cool before placing in storage.

2.7.3. **Hand-Held Concrete Chain Saw.** The hand-held concrete chain saws (item 15) stored in container #3 (**Figure 2.41**) is not typically used by Pavements and Construction Equipment Operators. The purpose of the chain saws is to square corners of the repairs, if necessary, after the repairs are sawed and excavated. A few operating and safety procedures are listed below.

Figure 2.41. Hand-held Concrete Chain Saw.

2.7.3.1. Only operate the chain saw as described by the manufacturer's manual. Follow all safety warnings and cautions in the manual.

2.7.3.2. Do not operate chain saw when fatigued.

2.7.3.3. Use safety footwear, snug-fitting clothing, protective gloves; eye, hearing and head protection devices; respiratory protection; and leggings when operating chain saws. Leggings are not included in the SuPR Kit, but are available in the chainsaw safety kit in UTC 4F9ET, *Basic Engineering Beddown/Sustainment Equipment Set*.

2.7.3.4. Attach the saw to a water source with pressure of not less than 20 pounds per square inch (psi).

2.7.3.5. For first time use, follow break-in procedures in the manufacturer's manual to prevent piston seizure.

2.7.3.6. Guard against kickback by holding the chain saw firmly with both hands and cut at high engine speeds...do not overreach.

2.7.3.7. Proper chain tension, especially for first cut, is extremely important. Over-tensioning of bar and chain, especially at high altitude, could result in severe loss of power output making initial cutting experience unsatisfactory.

2.7.3.8. Clean chain saw and follow maintenance guidelines after each use as described in the manufacturer's manual.

2.7.4. **Skid Steer Mounted Cold Planer.** The cold planer (**Figure 2.42**) tool attachment (container 2, item 25) may be used to rapidly remove unsound material and prepare the area for placing the repair material. See **Chapter 3** for guidance on repairing spalls with extremely rapid-setting repair materials.

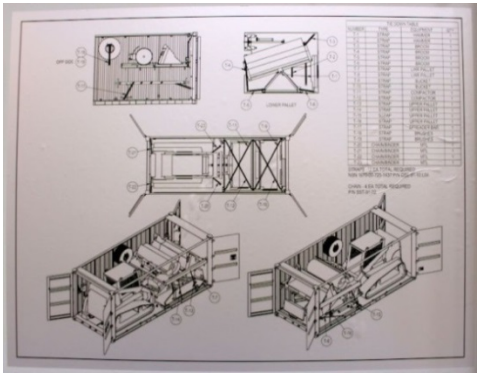
Figure 2.42. Cold Planer Tool Attachment.

2.7.5. **Scarifier (planer).** The scarifier (**Figure 2.43**) is ideal to level repairs with the surrounding surface to bring the repairs within smoothness criteria. It is especially useful to make repairs flush within 200 feet of an aircraft arresting system. It is also ideal for trip hazard repair, concrete and coatings removal, creating non-slip surfaces, and paint line and marking removal. The scarifier is located within container 2 (item 30).

Figure 2.43. Scarifier (Planer).

2.8. Repacking Instructions. Reconfigure the containers in reverse order of procedures in **paragraph 2.6**. Each container has a packing scheme placard (**Figure 2.44**) on the inside of the end doors. They illustrate component location and tie down procedures using straps or chains and binders.

Figure 2.44. Example Packing Scheme Placard.



2.8.1. There is also a bill of material placard (**Figure 2.45**) placed on the inside of the each container's end door that lists the contents, part numbers, and their quantities.

Figure 2.45. Example Bill of Material Placard (*contents subject to change*).

SUSTAINMENT PAVEMENT REPAIR (SuPR) KIT - CONTAINER 1 BILL OF MATERIAL

ITEM	PART NUMBER	QTY	NOMENCLATURE
1	BOI-20-20	1	CONTAINER ONE
2	404-208577-45	1	ELECTRICAL ASSEMBLY
3	FAC-90-02	2	HANGER BRACKET STRAPS
4	FAC-91-01	1	PALLET, ANGLE BRDOM/HYDR HAMMER
5	FAC-91-02	2	PALLET, BUCKET/COMPACTOR
6	FAC-92-06	2	BRACKET, SPREADER BAR
7	FAC-93-07	1	BRACKET, MSDS STOWAGE
8	FAC-94-08	1	PINTLE HOOK ASSEMBLY
9	GBE-91-10 L04	19	STRAP, RATCHET
10	GBE-91-10 L16	2	HOOK AND LOOP STRAP 1" WIDE
11	GBE-91-10 L17	5	MINI FOLDING STEP
12	GBE-91-10 L18	1	MULTI TERRAIN LOADER 279C
13	GBE-91-10 L19	1	BRACKET MOUNTING
14	GBE-91-10 L20	1	HOSE ASSEMBLY, CONNECTING LINES
15	GBE-91-10 L21	1	BROOM ATTACHMENT
16	GBE-91-10 L22	2	POLY BRUSH KIT
17	GBE-91-10 L23	1	DRUM, COMPACTOR CV18B
18	GBE-91-10 L24	1	HAMMER H65D S, PIN ON
19	GBE-91-10 L25	1	CHISEL TOOL
20	GBE-91-10 L26	1	MOIL TOOL
21	GBE-91-10 L27	1	BUCKET, CLAMSHELL
22	GBE-91-10 L28	1	FORK ATTACHMENT, 48" PALLET W/ CAR
23	GBE-91-10 L30	1	SPREADER BAR LIFTING BEAM KIT
24	GBE-91-10 L31	1	KIT, EMERGENCY MEDICAL, LG
25	GBE-92-10 L62	1	CAUTION LABEL
26	GBE-92-10 L63	1	DANGER LABEL
27	ILS-90-04	2	SIGN, WARNING
28	ILS-90-05	2	DANGER SIGN NO SMOKING
29	ILS-90-06	1	PLACARD, L/H & C/D
30	ILS-90-07	1	PLADARD, BOM
31	ILS-90-08	1	PLACARD, STRAPPING DIAGRAM
32	JHA-90-03	2	WHEEL CHOCK
33	SST-91-02	4	CHAIN, BINDER
34	GBE-93-10 L153	4	D-RING, SMALL
35	GBE-93-10 L154	4	D-RING, LARGE

2.8.2. Each wire basket has an attached label listing its contents (**Figure 2.46**).

Figure 2.46. Example Wire Basket Content List.

WIRE BASKET G CONTENTS			
PART NUMBER	NOMENCLATURE	QTY	UNIT
GBE-92-10.L74	MIG WELDER	1	EA
GBE-92-10.L75	WELDING HELMET	1	EA
GBE-92-10.L76	WELDING GLOVES	2	PR
GBE-92-10.L77	MIG WIRE	4	RL
GBE-92-10.L82	EXTENSION CORD 100'	5	EA
GBE-92-10.L87	SPACER	2	EA
GBE-92-10.L88	SPACER	2	EA
GBE-92-10.L137	1-1/4" GROUT RETAINING RINGS	100	EA
GBE-93-10.L213	20 FT JUMPER CABLES	1	EA

2.8.3. When strapping the shovels, brooms, etc., lace the straps through the D-rings between each set of brackets as shown in **Figure 2.47** to securely hold the items in place during transport.

Figure 2.47. Long Hand Tools Strapped to Container Wall.

Chapter 3

RIGID PAVEMENT MAINTENANCE AND REPAIR

3.1. Purpose. This chapter supplements guidance provided in Unified Facilities Criteria (UFC) 3-270-03, *Concrete Crack and Partial Depth Spall Repair*. It focuses on standard procedures for repairing spalls on Portland Cement Concrete (PCC) pavements and using extremely rapid-setting repair materials.

3.2. Background. Due to inherent thermal effects of expansion and contraction, rigid pavements must be constructed with joints at specific intervals to mitigate potential damage to the overall slab. While these joints serve to minimize pavement damage, they also introduce areas of structural weakness along the exposed joint edge. Over time, repeated loading from aircraft and/or support vehicles can cause deterioration in the joint regions and result in deep spalling requiring immediate repair. Spalls may also be a direct result of inadequate joint maintenance, improper construction methods, alkali-silica reactions (ASR), or munition damage. Spalls may be full or partial-depth damage, generating foreign object debris (FOD) that can cause damage to aircraft tires.

3.2.1. An investigation was initiated to identify applicable rapid-set materials, excavation equipment and procedures by which to construct a durable concrete spall repair within fifteen minutes or less. A cold planer is essential to meet this goal. However, when time permits, use of a concrete saw is effective.

3.2.2. While many problems can be traced back to problems with the preparation of spalls (many repairs at contingency locations involved large non-uniformly shaped repairs that were loaded within a few hours after placement), there are some problems that arise from curing techniques, material selection, and early loading. The need to use extremely rapid-setting materials and the early loading of repairs tend to create additional stress in the repair that are not present at other base locations using ordinary Portland cement mixes.

3.3. Scope. This chapter provides recommendations to extend spall repair life made on PCC pavements. While the goal is to achieve repairs typically lasting two years, these procedures do not guarantee achievement of this goal. Many external factors can affect the life span of the repair; however, following the recommendations within this chapter should consistently produce repairs that last longer than eight months.

3.3.1. Many recommendations found in this chapter are included in UFC 3-270-03; however, studies suggest some recommended procedures are not always fully implemented in the field due to insufficient time allowed on the airfield. This chapter includes recommendations to extend life of repairs when time on the airfield is limited.

3.3.2. **Paragraph 3.9** provides information on emergency repairs to rapidly reopen airfield pavement for airfield operations; however, these repairs are not expected to last more than a few passes or days.

Note: This chapter does not cover full-depth repairs (repairs with a depth greater than one-half of the pavement thickness).

Note: Expedient solutions to repair airfield surface damage associated with very short take-off and landing (VSTOL) aircraft was not available at the time of this publication. As expedient solutions become available, this publication will be updated to reference applicable publications containing this information.

3.4. Application. This document applies specifically to the repair of PCC airfield surfaces in expeditionary environments. The intended users of these procedures are Air Force base civil engineers (BCE); RED HORSE squadrons, and Prime BEEF units responsible for emergency repair of airfield pavements in an expeditionary environment.

3.5. Summary of Material Test Data. Based on tests performed by the Air Force Research Laboratory (AFRL) in the summer of 2007, the following hydraulic cement-based products provided the best performance in several key tests: CTS Cement Rapid Set DOT Repair Mix; Pre-Blend's Premium Patch; BASF's Thoroc 10-60; SikaQuick 2500 Rapid Mortar; Dayton Superior's HD-50; and Euclid Chemical's Versaspeed. These products provided the best performance (comparing cement products; polymers not compared) at early ages (1.5 to 4 hours) in several critical areas. These areas included bond, compressive, tensile and flexural strength, set times and strength consistency.

3.6. General Guidance and Information. Most spalls result from debris that enters a joint or crack; therefore, it is important to clean and seal all cracks and joints. In general, it is important to identify and address the root cause of the pavement distress or the pavement and repair will continue to deteriorate.

3.6.1. **Long-Lasting Repairs.** There are four areas requiring particular attention to ensure long-lasting repairs.

3.6.1.1. Maintain integrity of joints or cracks.

- Repair material must not bridge a joint or crack. Pouring repair material across a joint or crack and then making a partial depth cut after the material has set to re-establish the joint or crack is insufficient. Tests using this approach have resulted in failures in as little as 24 hours.
- When making repairs next to joints or cracks, the joint or crack must be sealed with a small pliable bead of caulk or other equivalent seal material to prevent the intrusion of grout or epoxy into the crack or joint.
- When making repairs next to joints, repair material must not be placed so that it is in direct contact with the adjacent slab. A compressible spacer must be placed in the joint. Tests conducted on spall repairs where such a spacer was not included resulted in failures within 48 hours.
- Failure to properly clean out and seal the joint or crack will reduce the life expectancy of the repair.

3.6.1.2. Ensure spall repairs rest on clean, sound material.

3.6.1.3. Allow repair material enough time to cure. This is at least two hours when the ambient air temperature is above 75 degrees Fahrenheit (75°F [24°C]) when using materials listed in **paragraph 3.9** (check manufacturer's recommendations). Additional cure time will increase probability of the patch lasting up to and beyond two years. When temperature is below 75°F (24°C), amount of unloaded cure time (including mix time) will increase. The amount of increase in time varies with materials, core temperature of pavement, and curing technique. In general a compressive strength in excess of 2,700 psi is desired before loading. See manufacturer's recommendations on minimum pavement temperatures for placing repairs.

3.6.1.4. Maintain a proper geometry and size for repair. The largest repair dimension without a joint should be no more than 8 feet (2.4 meters). The Primary reason limiting the repair dimension is due to the rapid setting materials used in a contingency environment. In the event a repair dimension exceeds 8 feet, the repair must be broken into two or more individual repairs. These repairs can be accomplished at the same time, but must be separated at the time the material is placed by using a form or insert (backer board), or it must be separated by saw cutting once the material has cured for at least two hours but

not more than three days. For spall repairs located at the edge of a slab, the repair must be separated as previously stated with the exception, where the repair abuts an existing joint, the existing joint shall be restored as originally designed.

3.6.2. **Materials and Procedures.** It is important to select the right repair materials and procedures to provide a long-lasting repair.

3.6.2.1. Emergency Repairs. Emergency repairs are required when there is insufficient time to properly repair the airfield using conventional materials/ techniques. This type repair may fail in a short period of time, perhaps after only a few aircraft passes. Therefore, such repairs require constant monitoring and will require replacement with a permanent repair at the earliest opportunity.

3.6.2.2. Full-depth Repairs. Full-depth repairs are required when the unsound portion of the pavement extends below the mid-height of the slab, or if the spall is located on a section of slab prone to movement due to a lack of base support or lack of dowels for load transfer across a joint or crack. Also, a full-depth repair should be considered when a spall occurs on a corner break.

3.6.2.3. Partial-depth repairs. Partial-depth repairs are placed when repairing an area one-half the thickness of the slab or less, and the remainder of the slab on which the repair is placed is not prone to movement. When spalls are located on a crack in a slab, the crack should be treated as a joint. Furthermore, load transfer across the crack should be restored in accordance with Chapter 10 of UFC 3-270-04, *Concrete Repair*, or the life of the repair will be shortened.

3.6.3. **General Product Selection Considerations.**

3.6.3.1. **Cure Time.** Polymeric materials should be selected for spall repair when rapid curing is necessary; a typical requirement is the ability to support aircraft traffic in one hour or less. Manufacturer-recommended cure times range from ten minutes to eight hours for most polymeric repair materials. The testing protocol described herein should initially assume that manufacturer-recommended cure times are accurate. Note that cure times are most often a function of environmental conditions, especially temperature, so cure times may vary from the laboratory to the field.

3.6.3.2. **Shelf Life.** Some polymeric repair materials have a very limited shelf life, as reported by the manufacturer, so particular attention should be given to shelf life when selecting a material. Shelf life typically ranges from three

months to two years, and depends on storage conditions such as temperature, humidity, and the integrity of packaging.

3.6.3.3. **Surface Preparation.** Surface preparation of the damaged concrete should be practiced according to the repair material manufacturer. Common recommendations are removing loose debris by either sandblasting or high-pressure water, followed by blowing with compressed air. Some repairs require saw-cutting to eliminate feathered edges. Many materials require the application of a primer to the concrete surface before applying the repair material. Some repair materials are designed to immediately follow the priming step, while some require that the primer coat be allowed to fully cure before repairing.

3.6.3.4. **Fillers.** While some polymeric repair materials comprise particular aggregates or fillers that are supplied with the resin, others are designed to use local aggregates which must be acquired independently by the user. Manufacturers' recommendations regarding aggregate selection and preparation should be followed.

3.6.3.5. **Safety.** Safety hazards, such as fire/explosion hazards, toxicity, and reactivity, are associated with many polymeric repair materials. Suppliers, handlers, and users of any polymeric repair material should ensure an MSDS from the manufacturer always accompanies the material. Before use, users should review and follow the MSDS guidance for personal protective equipment and other safety precautions.

3.6.4. **Materials.** The following materials have been tested and have performed well in several repair environments. The effectiveness of these materials can be increased by storing materials inside an air-conditioned space for at least 48 hours before use and when any required mixing water is heated or cooled to 72°F (22°C) before use.

3.6.4.1. CTS Cement Rapid Set DOT Repair Mix (National Stock Number [NSN] 5610-01-564-7710, CAGE-CD #: 4NFR3), may be used if ambient air temperature is between 32°F and 100°F (0°C and 38°C). Work time is approximately 10 to 15 minutes at 72°F (22°C). This material may be extended with aggregate. A mortar or concrete drum mixer may be used to mix this material, but is not recommended at temperatures above 70°F (21°C) due to rapid setting. This material may be troweled. It cannot be poured in lifts.

- Part Number: 511 655
- Shelf Life: One year

- Minimum Order: 1 Pallet (50 each 55-lb bags)
- Cost: $21 per bag (plus shipping)
- Extension: Up to 100% by mass, clean, uniform 3/8” pea gravel
- Yield: 55lb bag yields 0.5 cu ft; full extension yields 0.9 cu ft
- Potential Source POC: Frank Senatore, CTS Cement, 11065 Knott Avenue, Suite A, Cypress, CA 90630, (800) 929-3030 Ext. 130
- Web Site: http://www.rapidset.com/home.asp

3.6.4.2. Thoroc 10-60 (NSN 5610-01-564-7710, CAGE-CD #: 98898), BASF Building Systems, formerly Degussa Building Systems, may be used if the ambient air temperature is between 40°F and 90°F (4°C and 32°C) (estimated). For temperatures above 90°F (32°C), consider using Thoroc 10-61 which provides a long work time at very high temperatures (10-61 is not recommended for temperatures below 50°F [10°C] due to much longer set times). Work time for Thoroc 10-60 is approximately 15 minutes at 70°F (21°C). This material may be extended with aggregate. A mortar or concrete drum mixer can be used to mix this material, but is not recommended at temperatures above 70°F (21°C) due to rapid setting. This material may be troweled. It cannot be poured in lifts.

- Shelf Life: nine months
- Minimum Order: 50-lb bags, 3,000-lb bulk bags
- Cost: $24.97 per 50-lb bag, $1,485.00 per 3,000-lb bulk bag(plus shipping)
- Extension: Up to 50% (by weight) 0.375 inch (9.53 millimeter) pea gravel
- Yield: 1 bag yields 0.43 cu ft (0.012 m3)
- Potential Source: BASF Building Systems, 889 Valley Park Drive, Shakopee, MN 55379, (800) 243-6739, (800) 433-9517
- Web Site: http://www.basfbuildingsystems.com

3.6.4.3. Thoroc 10-61 (NSN 5610-01-564-7710, CAGE-CD #: 98898), BASF Building Systems, formerly Degussa Building Systems, best results occur if the ambient air temperature is above 50 °F (10 °C); temperatures below this value retard setting. Work time for Thoroc 10-61 is approximately 15 minutes at temperatures of 70 °F (21 °C) and above. This material may be extended with aggregate. A drill/paddle or mortar/concrete drum mixer can be used to mix this material at a minimum of three minutes to ensure homogeneity. This material is trowel-able. It cannot be placed in lifts.

- Shelf Life: Nine months
- Minimum Order: 50-lb bags, 3,000-lb bulk bags
- Cost: $24.27 per 50-lb bag; $1,213.27 per 3,000-lb bag (plus shipping)
- Extension: Up to 50% (by weight) 0.375 inch (9.53 millimeter) pea gravel
- Yield: 50-lb bag yields 0.43 cu ft (0.012 m3)
- Potential Source: BASF Building Systems, 889 Valley Park Drive, Shakopee, MN 55379, (800) 243-6739, (800) 433-9517

3.6.4.4. Premium Patch: Pre-Blend Product, Inc., (NSN not available) may be used if the ambient air temperature is between 20°F and 100°F (-7°C and 38°C). For temperatures above 80°F (27°C), the repair area must be cooled by soaking the areas and leaving it saturated surface dry (SSD); use ice water for mixing. Work time is approximately 15 minutes at 70°F (21°C). For temperatures below 40°F (4°C), heat the repair area, use 90°F (32°C) mixing water, and cover with a curing blanket for two hours. This material must be extended with 60% (by weight) 0.375-inch (9.53-millimeter) washed, dry pea gravel for patches deeper than 2 inches (50 millimeters). A mortar or concrete drum mixer cannot be used to mix this material. This material may be troweled. It cannot be poured in lifts.

- Part Number: Premium Patch
- Shelf Life: One year
- Minimum: Order: 1 Pallet (50 each 50-lb bags)
- Cost: $16 per 50-lb bag plus shipping
- Yield: 1 bag yields 0.43 cu ft (0.012 m3); extension with 30lbs pea gravel yields 0.61 cu ft (0.017 m3)
- Potential Source: Pre-Blend Products Inc., 100 Den Fairless Drive, Fairless Hills, PA 19030, (215) 295-6004
- Web Site: http://www.preblend.com

3.6.4.5. Dayton Superior HD-50, (NSN not available) is a flowable fiber-reinforced material that may be used if the ambient air temperature is between 10°F and 100°F (-12°C and 38°C). Work time is approximately 15 minutes at 72°F (22°C). This material may be extended with aggregate. A mortar mixer can be used to mix this material, but is not recommended at temperatures above 70°F (21°C) due to rapid setting. This material may be troweled. It cannot be poured in lifts.

- Shelf Life: One year

- Minimum Order: None (1 pallet contains 60 each 55-lb bags)
- Cost: $28 per bag
- Extension: Up to 60% (by weight) 0.375 inch (9.53 millimeter) pea gravel; bonding agent may be required
- Yield: 1 bag yields 0.42 cu ft (0.012 m3); extension with 30 lbs pea gravel yields 0.60 cu ft (0.017 m3)
- Potential Source: Ram Tool & Supply, 1411 Moylan Road, Panama City Beach, FL 32407, (850) 230-4700
- Web Site: http://www.daytonsuperior.com/chemical/index.htm

3.6.4.6. Versaspeed, Euclid Chemical Company, (NSN not available) may be used if the ambient air temperature is between 20 °F and 85 °F (-7°C and 29°C). Work time is approximately 15 minutes at 72°F (22°C). For temperatures above 85°F (29°C), use Versaspeed LS. This material must be extended with up to 25lbs (11.3 kilograms) per bag of 0.75-inch (19- millimeter) washed pea gravel for patches deeper than 2 inches (50 millimeters). A mortar mixer can be used to mix this material, but is not recommended at temperatures above 65°F (18°C) due to rapid setting. This material may be troweled. It cannot be poured in lifts. This product is very sensitive to the amount of water used. Graduated measuring containers will be required.

- Shelf Life: Two years
- Minimum Order: 1 Pallet (50 each 50-lb bags) (1 bag yields 0.37 cu. ft. [0.01 m3])
- Cost: $21 per 50-lb bag plus shipping
- Extension: Up to 50% washed, SSD 3/8 pea gravel
- Yield: 1 bag yields 0.37 cu ft (0.01 m3); extension of 25 lbs of aggregate yields 0.52 cu ft (0.015 m3)
- Potential Source: Euclid Chemical Company, 19218 Redwood Road, Cleveland, OH 44110, (216) 531-9222, (800) 321-7628
- Web Site: http://www.euclidchemical.com

3.6.4.7. Pavemend 15.0 (NSN 6850-01-500-6996) may be used in ambient air temperatures up to 120°F (49°C), but should not be used if the temperature is below 30°F (-1°C). Work time is seven to nine minutes at 72°F (22°C). This material cannot be extended with aggregate. This material should never be mixed in a mortar or concrete drum mixer—it sets up too quickly. This material is self-leveling and can be poured in lifts.

- Shelf Life: Three years in original, unopened bucket

- Minimum Order: 1 Pallet (36 each 5-gallon buckets)
- Cost**:** $60 / bucket
- Extension: Cannot be extended with aggregate.
- Yield: 11.0 lb (4.99 kg) bag yields 0.12 cu ft (0.0034 m3); 45.0lb (20.4 kg) bucket yields 0.42 cu ft (0.012 m3)
- Potential Source POC: Michelle Crowder, 1500 North Beauregard Street, Suite 320, Alexandria, VA 22311, (804) 556-5159
- Web Site: http://www.ceratechinc.com/

3.6.4.8. Pavemend TR (NSN 5610-01-564-7710, CAGE-CD #: 1ZJZ4) should not be used if the ambient air temperature is above 90°F (32°C), and may be used in temperatures down to 0°F (-18°C). Work time is three to six minutes at 72°F (22°C). This material may be extended by up to 100% aggregate by weight. This material should be mixed with a drill and paddle or in a rotating drum mixer (for aggregate extension). Mix until critical temperature of 90°F is reached. Never mix for less than three (3) minutes. For drum mixing, refer to manufacturer-provided time chart. This material is semi-self-leveling and may be troweled. This material can be poured in lifts.

- Shelf Life: One (1) year in original, unopened bag; three (3) years in original, unopened bucket
- Minimum Order: 1 Pallet (36 each 5-gal buckets), 46 lbs / cu ft (0.012 m3) / bucket
- Cost: $60 / bucket
- Extension: May be extended with up to 100% aggregate (by mass)
- Yield: 12.0 lb (5.44 kg) bag yields 0.12 cu ft (0.0034 m3); 47.0lb (21.3 kg) bucket yields 0.43 cu ft (0.012 m3)
- Potential Source POC: Michelle Crowder, 1500 North Beauregard Street, Suite 320, Alexandria, VA 22311, (804) 556-5159
- Web Site: http://www.ceratechinc.com/

3.6.4.9. Pavemend VR (NSN not available) should not be used if the ambient air temperature is above 100°F (38°C) (this material is not recommended if the temperature is above 90°F [32°C]), and may be used in temperatures down to 0°F (-18°C). Work time is two to three minutes at 72°F (22°C). This material may be extended by up to 100% aggregate by weight. This material should be mixed with a drill and paddle. Mix until critical temperature of 80 °F is reached. Never mix for less than three (3) minutes. This material is self- leveling and can be poured in lifts.

- Shelf Life: Three (3) years in original unopened bucket
- Minimum Order: 1 Pallet (36 each 5-gal buckets
- Cost: $60 / bucket
- Extension: May be extended up to 100% aggregate (by mass)
- Yield: 5 gallon bucket yields 0.42 cu ft (0.012 m3)
- Potential Source: Michelle Crowder, 1500 North Beauregard Street, Suite 320, Alexandria, VA 22311, (804) 581-8397
- Web Site: http://www.ceratechinc.com/

3.6.4.10. Pave Patch 3000 (NSN not available) is a polymer which requires a dry surface for placement. This is a three-part mix which must be stored between 50°F and 90°F (10°C and 32°C). This material may be used in ambient air temperatures from 40°F to 100°F (4°C to 38°C). The material must be conditioned to a temperature between 65°F and 80°F (18°C and 27°C) before use. The working time is 20 minutes at 72°F (22°C). The cure time increases dramatically as temperature decreases. This material is not recommended for use if the temperature is below 60°F (16°C) unless you have more than four hours before the first load application. It cannot be extended with aggregate. It can be cleaned before it sets using mineral spirits. A mortar mixer can be used but is not recommended due to the restrictive cleanup requirements. Instead, mix the material for two (2) to three (3) minutes in 5-gal buckets using heavy-duty drill and paddle. This material may be troweled. It cannot be poured in lifts.

- Shelf Life: One year
- Minimum Order: None
- Cost: $80 / Bucket (0.5 cu ft [0.014 m3] Kit) (plus shipping) or $150 / Bucket (1 cu ft [0.028 m3] Kit) (plus shipping)
- Extension: May not be extended with aggregate.
- Yield: 50 lb bag yields 0.41 cu ft (0.016 m^3)
- Potential Source POC: Charles Smith, Silicon Specialties, Inc. (SSI), 430 South Rockford, Tulsa, OK 74120, (918) 271 – 2210
- Web Site: www.conspecmkt.com

3.6.4.11. SikaQuick 2500 (NSN not available) is a polymer which requires a dry surface for placement. This is a three-part mix which must be stored between 50 °F and 90 °F (10 °C and 32 °C). This material may be used in ambient air temperatures from 40 °F to 100 °F (4 °C to 38 °C). The material must be conditioned to a temperature between 65 °F and 80 °F (18 °C and 27 °C) before use. The working time is 15 minutes at 70 °F (21.1 °C). The cure time increases

dramatically as temperature decreases. This material is not recommended for use if the temperature is below 60 °F (16 °C) unless you have more than four hours before the first load application. It may be extended with up to 25-30 lbs (11.34-13.60 kg) aggregate. It can be cleaned before it sets using mineral spirits. Mix in an appropriate sized mortar mixer. This material is trowel-able. It cannot be placed in lifts.

- Shelf Life: One (1) year in original, unopened bag
- Minimum Order: No minimum
- Cost: $27.00 / 50 lb (22.7 kg) bag
- Extension: May be extended with up to 25-30 lbs aggregate per bag; recommended only for repairs greater than one (1) inch in depth.
- Yield: 50 lb bag yields 0.43 cu ft (0.012 m3); extension of 25-30 lbs (11.34-13.60 kg) aggregate yields 0.60-0.63 cu ft (0.017-0.0178 m3)
- Potential Source: Sika Corporation, 201 Polito Avenue, Lyndhhurst, NJ 07071, 800-933-7452
- Web Site: http://www.sikaconstruction.com

3.6.4.12. Futura 15 (NSN not available) is a polymer which requires a dry surface for placement. This is a three-part mix which must be stored between 50 °F and 90 °F (10 °C and 32 °C). The material must be conditioned to a temperature between 65 °F and 80 °F (18 °C and 27 °C) before use. The working time is 20 minutes at 72 °F (22 °C). The cure time increases dramatically as temperature decreases. This material is not recommended for use if the temperature is below 60 °F (16 °C) unless you have more than four hours before the first load application. It may be extended with up to 50% aggregate by mass. It can be cleaned before it sets using mineral spirits. A mortar-type mixer should be used. Mix only complete bags. This material is trowel-able. It cannot be placed in lifts.

- Shelf Life: One (1) year when stored on pallets in cool, dry area
- Minimum Order: No minimum
- Cost: $17.45 / 50 lb (22.7 kg) Bag
- Extension: May be extended by adding up to 50% aggregate (by mass); recommended only for repairs greater than two (2) inches in depth; do not add any admixtures
- Yield: 50 lb (22.7 kg) bag yields 0.43 cu ft (0.012 m3); extension of 25 lbs (11.34 kg) aggregate yields 0.60 cu ft (0.017 m3)

- Potential Source: W.R. Meadows, Inc., P.O. Box 388, Hampshire, IL 60140-0338, 800-342-5976
- Web Site: http://www.wrmeadows.com

3.6.5. **General Guidance for Repair Material.**

3.6.5.1. Some materials used to patch spalls are very alkaline; therefore, care should be taken to ensure alkaline patch materials are not placed on pavements containing materials that are prone to ASR. Furthermore, aggregates used to extend patch mixes should be checked to ensure ASR- susceptible materials are not used.

3.6.5.2. It is recommended that full containers be used when preparing a patch. Many extremely or very rapid-setting materials contain several chemicals that are a small portion of the mix but are extremely vital to the proper performance of the patch.

3.6.5.3. It is recommended that more material than required be ready for use to ensure sufficient material is on hand. Owing to the precise nature of the chemistry used in many of these materials, some variability in mix performance can be expected in the field.

3.6.5.4. Whenever possible, purchase materials in sealed buckets instead of bags, and store them in covered locations in a temperature-controlled space with low humidity. These steps will significantly increase the shelf life.

3.6.5.5. The best performing spall repair materials have a low heat of hydration (i.e., they don't get very hot while they are setting and curing), are dimensionally stable (i.e., do not shrink or dilate), obtain high bond strengths (in excess of 1200 psi in one day using American Standard Test Method (ASTM) C882, *Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slab Shear*), and have thermal coefficients similar to the existing concrete. Unfortunately, rapid-setting materials tend to create more heat during setting and curing and can experience a large amount of dilation and shrinkage over the first few months after placement. Extremely, or very, rapid-setting materials also tend to be more sensitive to contaminants present during the mixing and placing process.

3.6.6. **Equipment.** The following equipment is recommended for repairing spalls:

- Caterpillar Model PC206 Cold Planer w/ 24 inch drum, 60 carbide-tipped conical bits designed for use on concrete (or equivalent)
- Caterpillar Model 257B High Flow Skid Steer Loader (or equivalent)
- Non-contact infrared digital thermometer
- Concrete saw with a 16-inch- (406-millimeter) diameter or larger blade
- 30-pound or smaller jack hammer
- Small, single pistol grip, pneumatic chisel
- Mixing drill with paddle (500 rpm minimum, 800 rpm maximum)
- Portable air compressor
- Portable electric generator
- 100 ft electrical extension cord
- Wet/dry vacuum
- Utility knife
- Caulking gun
- Large flat-tip screw driver
- 5-gal bucket lid-removing tool
- Large portable supply of water (i.e., water truck or water buffalo)
- Circular saw with 7.25-inch (184-millimeter) diamond-tipped concrete saw blade
- Two stiff bristle brushes (one for cleaning and one for grout scrub)
- Several empty 5-gal buckets (preferably plastic) for mixing materials (if packaged in bags) and for cleaning equipment
- Gasoline-power pressure washer
- Trowels, floats, screeds, and edgers
- Sprayer for applying curing compound
- Can of red spray paint

3.7. Procedures.

3.7.1. **Remove Debris**. Remove loose debris from damaged area by hand, broom, compressed air, and/or with a wet/dry vacuum.

3.7.2. **Mark Edges.** Mark outer edge of the repair area using red spray paint as shown in **Figure 3.1**.

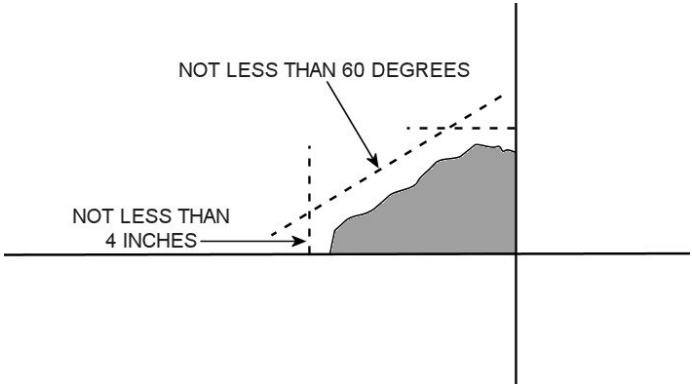
3.7.2.1. The outer edge should be located 2 to 3 inches (50 to 76 millimeters) beyond the damaged area (area of scaling, cracking, or spalling). Use a metal

rod to “sound” the area around visibly damaged area to determine extent of unsound material. In some instances a horizontal crack (delamination) extends beyond visible surface damage.

Figure 3.1. Marking Repair Area.

3.7.2.2. Repair area should be square or rectangular in shape (it may be pentagonal at a slab corner as shown in **Figure 3.2**).

Figure 3.2. Pentagonal Repair at Slab Corner.



3.7.2.3. When a repair spans a crack or joint, the repair must be considered as two repairs—one on each side of the crack or joint.

3.7.2.4. Each dimension of the rectangle must each be greater than or equal to 24 inches (60.96 centimeters) or the width of the cold planer drum, but less than 8 feet (2.44 meters).

3.7.2.5. Repairs greater than the width of the planing drum shall be planed in adjacent rows until the desired width is achieved.

3.7.2.6. When using a saw Vs a cold planer the length and width of the rectangle must each be larger or equal to 6 inches (152 millimeters).

3.7.2.7. The ratio of the longer dimension to the shorter dimension of repair is referred to as aspect ratio.

3.7.2.7.1. The aspect ratio should be less than two.

3.7.2.7.2. If the aspect ratio is larger than two, the repair must be broken into two or more individual repairs. These repairs can be accomplished at the same time, but must be separated at the time the material is placed by using a form or insert (backer board), or it must be separated by saw cutting once the material has cured for at least two hours but not more than three days.

3.7.3. **Cold Planer.** Orient the cold planer to the repair so that the grinding drum is parallel with the longest edge of the repair. Place the cold planer directly above the repair area so that the grinding drum begins cutting at the repair edge furthest from the skid steer, **Figure 3.3** (**Note:** The cold planer is designed to be pulled backward with the skid steer during normal operation, rather than pushed forward). Ensure bits/tips of planer are designed for use on concrete, **Figure 3.4**. Use of a jack hammer alone is not recommended. If a jack hammer must be used, hammer should be 30 pounds or smaller in size. Larger hammers may cause damage to underlying material as shown in **Figure 3.5**, which leads to reduced life expectancy of the repair.

Figure 3.3. Planer Orientation.

Figure 3.4. Cold Planer – 60 Tooth Milling Drum.

Figure 3.5. Damage to Substrate Due to Heavy Impact Loads.

3.7.3.1. Begin planer operation and slowly lower the grinding drum to pavement surface until teeth begin cutting repair area (**Figure 3.6)**.

Figure 3.6. Cold Planer Operation.

3.7.3.2. Operating depth of the planer should be set to 4.5 inches (11.43 centimeters).

3.7.3.3. Operate the hydraulic system of the loader at the high setting (26 gallons per minute at 3,335 psi).

3.7.3.4. Continue to plane until maximum depth is achieved (**Figure 3.7)**.

Figure 3.7. Completed Cold Planer Excavation.

3.7.3.5. Slowly grind away from initial cut until the entire marked area has been excavated to the required depth (**Note:** The cold planer drum leaves a radius in the excavation such that the bottom surface of the spall excavation is not parallel with the pavement surface). A hand-held or wheel-mounted concrete saw may be used to square the radius edges in the excavation and prepare the area for placing repair material.

3.7.3.5.1. Cut radius edges with a concrete saw to extend at least two inches (50 millimeters) below pavement surface or 0.5 inch (13 millimeters) below the bottom of the spall. Extend the saw cuts so as to form a vertical corner. Do not feather the repair on any side.

3.7.3.5.2. Remove remaining material using a small jack hammer (30 pounds or less).

3.7.3.5.3. A small hand pistol grip chisel may be used to clean up the corners and avoid extra spalling of the edges. Pre-cutting concrete ensures material beneath repair is not damaged.

3.7.3.6. Wash the repair area with a high-pressure washer or use water and a scrub brush. When using a polymer, it is best to clean the surface without water by scrubbing the surface with a stiff brush while blowing compressed air over it,

or sandblasting the repair area. **Figure 3.7** shows a photograph of the cleaned excavation.

3.7.4. **Alternative Preparation Method.** A hand-held or wheel-mounted concrete saw may be used to remove unsound material and prepare the area for placing repair material.

3.7.4.1. Cut edges of the repair with a concrete saw to a minimum depth of 2 inches (50 millimeters) or 0.5 inch (13 millimeters) below the bottom of the spall. Extend the cuts to form a vertical corner. Do not feather the repair on any side (**Figure 3.8**).

Figure 3.8. Cutting Edges of Repair Area.

3.7.4.2. Make additional cuts within the bounds of the repair edges using a concrete saw. Make longitudinal cuts and space 1 to 2.5 inches (25 to 64 millimeters) apart (**Figure 3.9**).

Figure 3.9. Longitudinal Interior Cuts.

3.7.4.3. Cuts should extend 2 inches (50 millimeters) below pavement surface or 0.5 inch (13 millimeters) below bottom of the spall.

3.7.4.4. Make sure cuts do not extend beyond edge of repair or across a joint or crack.

3.7.4.5. Once longitudinal cuts are complete, one or two transverse cuts on each end should be made 1.5 inches (38 millimeters) from ends of repair (**Figure 3.10**). Depth of cuts should match that of edge cuts.

Figure 3.10. Transverse Interior Cuts.

3.7.4.6. Remove remaining material using a small jack hammer (30 pounds or less).

3.7.4.7. A small, hand pistol grip chisel may be used to clean up the corners and avoid extra spalling of the edges. Pre-cutting concrete ensures material beneath repair is not damaged.

3.7.4.8. If necessary, bottom of repair may be sloped; however, the slope should be kept as minimal as possible and with no abrupt changes (**Figure 3.11** and **Figure 3.12**).

Figure 3.11. Repair with Abrupt Slope (NOT Recommended).

Figure 3.12. Repair without Abrupt Slope (Recommended).

3.7.4.9. Remove loose debris from repair area by hand, broom, compressed air, and/or with a wet/dry vacuum. Remove any loose material in joint or crack. Compressed air should be filtered to prevent oil and other contaminants from being blown onto the clean surface.

3.7.4.10. If a dowel bar or any rebar is exposed, with more than one-fourth of bar circumference exposed for 3 inches (76 millimeters) or more of length, remove material 0.5 inch (13 millimeters) to either side and below dowel/rebar. This should be done with a concrete saw and a small pneumatic chisel, hammer drill, or jack hammer. Typical design standards place dowel bars at mid-height of a slab; however, they have been found in the top half of the slab at some contingency locations. If encountering a dowel at mid-height, a full-depth repair should be accomplished.

3.7.4.11. Wash repair area with a high-pressure washer or use water and a scrub brush. When using a polymer, such as FlexPatch, it is best to clean the surface

without water by scrubbing surface with a stiff brush while blowing compressed air over it, or sandblasting repair area.

3.7.4.12. Remove any loose material or lodged debris from joint or crack.

3.7.4.13. Place small bead of caulk over joint or crack.

3.7.5. **Pavement Temperature.** If pavement temperature is above 90°F (32°C), pour ice or cool water onto repair area and, if possible, allow it to sit for two to five minutes, or flush cool water over repair area for two minutes (some materials require this at temperatures above 80 °F [27 °C]).

3.7.5.1. Remove excess water with a wet/dry vacuum or compressed air.

3.7.5.2. When using a polymer, such as Pave Patch, SikaQuick, or Futura, all moisture must be removed by blowing the surface with compressed air.

3.7.5.3. For cement-based materials such as Pavemend, CTS Cement Rapid Set DOT Road Repair Mix or Dayton Superior HD-50, leave area SSD.

3.7.6. **Joints or Cracks.** Place a section of backer board, or other soft insert material, over any joint or crack in repair area (**Figure 3.13** and **Figure 3.14**).

Figure 3.13. Compressible Insert Placed Before Placing Repair Material.

Figure 3.14. Compressible Insert Placed within Partially Completed Repair.

3.7.6.1. Thickness of the insert should be slightly wider (0.125 to 0.25 inch [3 to 6 millimeters]) than the joint/crack width. It should be at least 0.75 inch (19 millimeters) thick for expansion joints and at least 0.5 inch (13 millimeters) thick for all other joints and cracks.

3.7.6.2. Insert must extend from top to bottom and from one side to the other of repair area. Any holes or gaps in insert must be filled or sealed. It may be necessary to tape several pieces of backer board together to meet repair geometry.

3.7.7. **Bonding Agent.** Apply surface preparation/bonding agents to reduce amount of water absorbed by the surrounding material.

3.7.7.1. Polymer materials such as Pave Patch do not require a special bonding agent. However, they may (as in the case of Pave Patch) require the user to apply some liquid portion of the product (i.e., prior to adding aggregate) to repair area surfaces with a brush or trowel (**Figure 3.15**).

Figure 3.15. Applying Polymer Liquid to Repair Area Surfaces.

3.7.7.2. Hydraulic cement materials such as Pavemend, CTS Cement Rapid Set DOT Road Repair Mix, and Dayton Superior HD-50, normally do not require a bonding agent if the repair area is in SSD condition when the repair material is placed. At high temperatures (above 90°F [32°C]), and/or where SSD conditions

cannot be maintained before mixing and placing the repair material, a bonding agent such as Dayton Superior's Ad Bond (J-40) (an acrylic latex material) should be applied to the surfaces of the repair area.

3.7.8. **Mixing Materials.** Mix materials in accordance with manufacturers' recommendations (**Figure 3.16**).

Figure 3.16. Mixing Repair Material in Bucket with Mixing Paddles.

3.7.8.1. Due to the rapid-setting nature of these materials, it is recommended the materials be mixed in 5-gal buckets using drills equipped with mixing paddles.

3.7.8.2. For hydraulic cement materials, the bucket and mixing paddle should be wetted prior to mixing. If the materials are too stiff to pour, discard the batch and prepare a new batch adding 5% to 10% more water to the mix.

Note: 0.05 gal [1.89 liters] equals 0.4 pint, 0.8 cup, 6.4 ounces, or 12.8 tablespoons.

3.7.8.3. For polymer materials, all containers, paddles, and trowels should be kept dry. These types of materials require special materials for cleanup (e.g., mineral spirits for Pave Patch).

3.7.8.4. A temperature gun (thermometer) should be used to check water and material temperature before mixing, as well as material temperature during mixing.

3.7.8.5. Mix times will increase at lower ambient air temperatures and will decrease in high temperatures. At temperatures above 95°F (35°C), some recommended materials have been known to flash set.

3.7.8.6. Store mortar at approximately 72°F (22°C) for at least 48 hours before use. Combine with water poured at 72°F (22°C) to extend workability in hot weather and speed set time in cold weather. Alternatively, some materials recommend ice water for mixing in hot temperatures or 90°F (32°C) water for mixing in temperatures below 40°F (4°C); consult manufacturer's recommendations.

3.7.8.7. Some polymers, such as Pave Patch, are very sensitive to moisture and require completely dry surfaces and aggregates (when used).

3.7.8.8. Extreme care must be taken when using locally obtained aggregates to extend materials. In general, use of these aggregates is discouraged. Many repair materials are very alkaline and can prematurely fail when extended with ASR-susceptible aggregates. Some repair materials cannot be extended with limestone aggregates (consult the manufacturer's recommendations). However, the use of aggregates can improve dimensional stability (i.e., reduce shrinkage) and reduce thermal problems during setting and curing. Any aggregates used must be washed before use. Aggregates should be stored in a covered location. They should be dry for use in polymer repairs. Aggregates should be soaked and SSD for use in hydraulic cement repairs. Typically, it is best to use a well-graded aggregate from a crushed material; however, most manufacturers of extremely and very rapid-setting materials recommend use of a uniformly graded rounded aggregate (0.375-inch [10-millimeter] pea gravel) to ensure material can be placed quickly enough. Furthermore, the use of aggregates in these materials is used to control shrinkage and heat production, not necessarily for strength and cement reduction.

3.7.8.9. Some materials are shipped with proprietary aggregates.

3.7.8.10. If locally obtained aggregates must be used, ensure they meet all manufacturers' specifications. Some materials will adversely react with certain aggregates such as limestone.

3.7.8.11. Test a small batch of aggregate/material mix before use on the airfield.

3.7.9. **Material Placement.** Pour/place material in repair (**Figure 3.17**) and ensure material does not enter any joint or crack. Pavemend 15.0 and 5.0 materials are self-consolidating. Other recommended materials require some work to ensure a complete, compact, level repair is obtained. Rod or vibrate material briefly after placing in repair area, then level repair with a screed, float, or trowel. Clean mixing and placement equipment immediately after use. Water

may be used for cleaning when using hydraulic cements; polymers require special materials for cleanup such as mineral spirits for Flexpatch.

Figure 3.17. Filling Repair with Pavemend.

3.7.10. **Curing.** Polymer repair materials do not require any special treatment for curing; however, in cold weather required cure times will increase. Use of a blanket will reduce cure times.

3.7.10.1. Hydraulic cement materials such as CTS Cement DOT Rapid Set Repair Mix, Thoroc, Premium Patch, Dayton Superior HD-50, Versaspeed, and Pavemend require a moisture cure for one hour after the material has initially set and when windy or hot (over 80°F [27°C]), dry conditions prevail. It is recommended to take steps to reduce moisture loss during curing.

3.7.10.2. Once the repair no longer has a surface sheen, place a wet burlap material over repair or mist the repair for one hour.

3.7.10.3. Alternatively, apply a white-colored curing compound that meets ASTM C309, *Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete*, such as ChemMasters Safe-Cure 2000, once the repair no longer has a surface sheen. Apply at least two coats of the compound or apply until the surface appears completely white.

3.7.10.4. When possible, remove the backer board/compressible spacer insert after repair has cured for at least two hours.

3.7.10.5. Reseal joint with backer rod and joint sealant to ensure incompressible material and moisture cannot easily enter the joint or crack.

3.8. Emergency Repair Procedures. When limited time on the airfield, non-availability of materials or equipment, or operational requirements dictate spall

repairs be completed in a manner other than described in **paragraph 3.7**, the following procedures may be used.

3.8.1. Remove loose debris from damaged area by hand, broom, compressed air, and/or with a wet/dry vacuum.

3.8.2. Brush surface vigorously with a stiff brush. Remove all dust /loose debris with a broom, compressed air, and/or with a wet/dry vacuum.

3.8.3. If possible, place a section of backer board, or other soft insert material, over any joint or crack in the repair area.

3.8.4. Mix and place patching material in prepared area until level with (± 0.5 inch [13 millimeters]) of the surface.

3.8.4.1. For temperatures above 90°F (32°C), use Pavemend 15.

3.8.4.2. For temperatures between 40°F and 90°F (4°C to 32°C), use Pavemend 5.0.

3.8.4.3. Alternatively, an asphalt cold patch material such as Instant Road Repair may be used (**Figure 3.18**).

Figure 3.18. Instant Road Repair Patch.

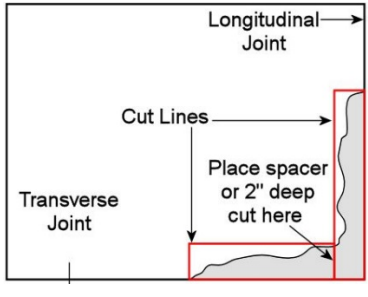
3.8.4.4. Some polymers extremely sensitive (very reactive) to water, such as Concrete Welder, are least preferred materials; however, some of these repairs can be opened to traffic within a few minutes of placement. These materials do not work in presence of water.

3.8.5. At a minimum, monitor emergency repairs daily. Take steps to re-accomplish such repairs in accordance with procedures in **paragraph 3.7** as soon as possible.

3.9. Special Considerations.

3.9.1. If a spall extends along both a transverse joint and longitudinal joint meeting at a corner, the repair must be accomplished as two repairs: one along the transverse joint and one along the longitudinal joint (**Figure 3.19**).

Figure 3.19. Two Repairs when Spall Meets at a Corner of a Slab.



3.9.1.1. If they must be accomplished simultaneously (i.e., in one pour), a spacer must be placed or a 2-inch- (51-millimeter) deep cut must be sawed at the junction of the two repairs (preferably in the longitudinal direction).

3.9.1.2. Saw cuts should be made after final set of the material, usually one to two hours after the pour.

3.9.1.3. The cut or joint should be filled with a backer rod and joint sealant.

3.9.2. Repair sections should be square, rectangular, or pentagonal (for corner spalls) in shape. Many repairs in the field have a complex geometry when seen in the plan view (**Figure 3.20**). When such repair geometries are necessary, the repair must either be accomplished in several phases/pours or crack control joints must be cut into the resulting repair to control the location and condition of cracks (**Figure 3.21**). All joints must be sealed with a sealant. Joints should be aligned in a longitudinal direction whenever possible. Saw cuts must be made no sooner than the final set, which usually occurs one to two hours, and no later than 12 hours, after the material is placed. Delays in making the saw cuts will reduce the life span of the repair.

Figure 3.20. Large Repair with Complex Geometry.

Figure 3.21. Red Lines Indicate Where Saw Cuts Should Have Been Made.

3.9.3. The repair shall not exceed 8 feet (2.4 meters) in its longest dimension. When damaged areas require repairs with dimensions longer than 8 feet (2.4 meters), the repair must either be accomplished in several phases/pours (producing cold joints) or crack control joints must be cut into the resulting repair to control the curling stresses. All sawed control joints must be made to the full depth of the repair. All joints must be sealed with a sealant or preformed elastomeric. Joints should be aligned in the longitudinal direction whenever possible. Saw cuts must be made no sooner than the final set, which usually occurs one to two hours, and no later than 24 hours, after the material is placed. Delays in making the saw cuts will reduce the lifespan of the repair. Controlling the size of the repair will reduce stresses on the bond interface and increase the lifespan of the repair.

3.9.4. Weather conditions during preparation and placement of a repair may decrease life expectancy of the repair. Use the following steps to mitigate weather effects.

3.9.4.1. **Wind.** The biggest effect of wind—aside from blowing debris into the prepared spall—is increased evaporation. This can quickly dry the prepared repair surface adversely affecting the bond, and dry the placed repair material surface leading to shrinkage cracks.

Note: Windy conditions do not affect the performance of polymer materials.

3.9.4.1.1. Use a bonding agent similar to Dayton Superior's Ad Bond (J-40) when an SSD condition on the repair surface cannot be maintained. Alternatively, a grout scrub can also be used as a bonding agent, but it must be applied very rapidly, followed by material placement before the grout sets or dries.

3.9.4.1.2. Moist cure hydraulic cement materials for one hour after the material has no sheen. This can be done by misting the surface or by placing a wet burlap cloth over the repair. Alternatively, a white curing compound, similar to ChemMasters Safe-Cure 2000, can be applied. Apply the curing compound until the entire repair surface appears completely white (at least two coats).

3.9.4.2. **Rain.** Rain can affect the bond by ponding water in the repair area. It can also adversely affect the material during mixing, placement, and curing by affecting the water/cement ratio or by chemically reacting with the polymers. Use a portable rain fly, similar to an easy-up, to cover the repair area and/or use a box van for mixing the materials. Some materials, such as Concrete Welder, will foam up when exposed to the slightest amount of water and are not recommended for use when raining.

3.9.4.3. **Heat.** Heat may affect the bond developed between the repair materials and the existing slab. It can cause flash setting of the repair materials and shrinkage cracking.

3.9.4.3.1. Cool the pavement by placing ice water over the area, by running cold water over the repair area, and/or by blowing compressed air on the repair area.

3.9.4.3.2. If SSD conditions cannot be maintained use a bonding agent with hydraulic cement materials (not for a polymer material).

3.9.4.3.3. Precondition the materials (cement and water) and tools by storing them in a cool place, 72°F (22°C) or cooler, for at least 48 hours before use. When transported to a job site, the materials should be kept in a cooled vehicle cab or in a Styrofoam cooler or insulated box.

3.9.4.3.4. Use materials designed for high temperatures, such as Thoroc 10- 60, Thoroc 10-61, Versaspeed LS, Pavemend 15 or FlexPatch. Some manufacturers sell admixtures that can be combined with their repair products to increase the effective temperature range. CTS offers admixtures that can be used with their DOT repair mix.

3.9.4.3.5. Moist cure hydraulic cement materials (not polymer materials such as FlexPatch) for one hour after the material has set (i.e., no sheen). This can be done by misting the surface or by placing a wet burlap cloth over the repair. Alternatively, a white curing compound, similar to ChemMasters Safe-Cure 2000, can be applied. Apply the curing compound until the entire repair surface appears completely white (at least two coats).

3.9.4.4. **Cold.** Cold temperatures can affect the bond between repair materials and the existing slab. It can cause the material reactions to halt, resulting in the material failing to set or cure.

3.9.4.4.1. Heat the pavement by running hot water or steam over the pavement for several minutes (until the surface is warm to the touch). Alternatively, aerospace ground equipment heaters can be used.

3.9.4.4.2. Precondition the materials (cement and water) and tools by storing them in a warm place, 72°F (22°C) or warmer (Dayton Superior and Premium Patch recommend 90°F [32°C] for HD-50), for at least 48 hours before use. When transported to a job site, the materials should be kept in a warm vehicle cab or in a Styrofoam cooler or insulated box.

3.9.4.4.3. Use materials designed for low temperatures, such as Dayton Superior HD-50, Premium Patch, Versaspeed, Pavemend TR, or Pavemend 5.0. Pavemend 5.0 may be used as a base layer which may then be topped with Pavemend 15 as a surface coat.

3.9.4.4.4. Cover the repair with an insulating blanket or plastic for one to two hours after placement.

3.10. Phasing Repairs. If time required to complete the repair in accordance with this chapter (i.e., a minimum of three hours) is longer than can/will be provided at one time on the airfield, the repair can be accomplished in phases (steps). Phasing the repair will shift the critical resource from time on the airfield to the availability of personnel, equipment, and materials. Several phased repair options are presented below.

3.10.1. Areas of distressed concrete are identified but major spalls do not yet exist, or spalls exist in areas not subject to direct tire loads.

Step 1: Saw cut borders of the spall area and remove loose debris from the repair. It may be possible to make additional cuts within these borders, spaced 2 inches (51 millimeters) apart in the longitudinal direction (direction of traffic), to assist with the removal of material within the borders. Refrain from this step if concrete becomes loose as a result of this additional saw cutting.

Step 2: Remove (jack hammer) the unsound concrete.

Step 3: Place a compressible joint spacer insert.

Step 4: Fill the spall with repair material.

Step 5: If possible, remove the joint spacer and reseal the joint. If joint spacer cannot be removed, use router to remove top 2-inches of spacer and reseal the joint.

3.10.2. Spall must be immediately filled. Additional areas around the spall may be unsound, but are not spalled.

Step 1: Remove loose debris from the spall. Caulk or otherwise protect the joint from repair material entering the joint or crack. If possible, place a compressible joint spacer insert over any joint. Fill the spall.

Note: This type of spall repair will rapidly deteriorate and the next phases must remove and replace this original repair.

Step 2: Saw cut the borders of the spall area and clean loose debris.

Step 3: It may be possible to make additional cuts within these borders, spaced 2 inches (51 millimeters) apart in the longitudinal direction (direction of traffic), to assist with the removal of material within the borders. This can be done in the repair material also, but is difficult to do in some polymer repairs. Refrain from this step if the concrete becomes loose as a result of this additional saw cutting. This may be done in conjunction with Step 1.

Step 4: Remove (jack hammer) the unsound concrete, including the original repair, clean loose debris (if possible, place a compressible joint spacer insert over any joints) and fill the spall.

Step 5: If possible, remove the joint spacer and reseal the joint. If joint spacer cannot be removed, use router to remove top 2-inches of spacer and reseal the joint.

3.10.3. Spall must be filled, but there is not enough time to perform all necessary saw cuts in the initial phase/step.

Step 1: Remove (jack hammer) the unsound concrete directly below the spall and a few inches on all sides. Remove all debris (if possible, place a compressible joint spacer insert) and fill the spall. This may lead to feathered edges and may leave some unsound material remaining outside of the original spall area—this will be addressed in later steps.

Step 2: Cut borders of entire spall area and clean loose debris.

Step 3: Make additional cuts within these borders, spaced 2 inches (51 millimeters) apart in the longitudinal direction, to assist with the removal of material within the borders. This may be done in conjunction with Step 2.

Step 4: Saw cut the spall material 1 to 2 inches (25 to 51 millimeters) within the feathered edge on each side of the spall. Remove (jack hammer) the unsound concrete (if possible, place a compressible joint spacer insert) and fill the spall.

> **Note:** Cut new spall repair in the longitudinal direction along one or two sides of the repair. This will prevent diagonal cracks from forming in the repair. Alternatively, Step 4 may be accomplished in three separate steps, ensuring each time that a rectangular section is poured so as to minimize stress intensities at interior corners and preclude cracking.

Step 5: If possible, remove the joint spacer and reseal the joint. If joint spacer cannot be removed, use router to remove top 2-inches of spacer and reseal the joint.

Chapter 4

FLEXIBLE PAVEMENT MAINTENANCE AND REPAIR

4.1. Purpose. The purpose of maintenance and repair (M&R) of asphalt pavements is to extend the useful life of the pavement, maintain a smooth surface, and prevent water from entering the underlying soil. Limited manpower and resources have increased the importance of M&R to the life of a pavement. To keep a pavement in the best possible condition, it is important to use an effective pavement management and inspection system. As pavements are repaired, it is extremely important to analyze and repair the "true cause" of the pavement distress and not just repair the distress. The intended function of pavements depends on proper and timely M&R.

4.2. Scope. Use UFC 3-260-03, *Airfield Pavement Evaluation*, UFC 3-270-01, *Asphalt Maintenance and Repair*, and UFC 3-270-02, *Asphalt Crack Repair*, for guidance on pavement evaluation, maintenance and repair procedures.

Chapter 5
REPAIR OF CEMENT-STABILIZED SOIL (CSS) SURFACES

5.1. Purpose. This chapter outlines approaches for repairing failed CSS surfaces on airfields. Procedures for removing and replacing Portland cement-stabilized materials as well as performing in-place repairs are presented.

5.2. Background. The U.S. Army Engineer Research and Development Center (ERDC) was tasked to develop a method for repairing Portland cement-stabilized surfaces. Test sections were constructed according to the criteria outlined in UFC 3-250-11, *Soil Stabilization for Pavements*, for cement-stabilized silty sand (SM) soil and different repair methods were performed. The repair methods tested were: 1) saw cut, remove, and replace with original soil mixed with cement (small patch size only); and 2) milling and in-place remixing with cement and water. Repair sizes were full depth (6 inches) for two 8-foot by 8-foot square areas for one test lane (Lane 1) and one 18-foot by 40-foot area for another test lane (Lane 2). Lane 1 did not receive traffic prior to the repair while Lane 2 was trafficked until failure prior to the repair being performed. Traffic was applied using a C-17 six-wheel load cart.

5.3. Soil Stabilization. Soil stabilization is generally defined as making major improvements to the engineering properties of soils by amending the natural soil with an additive. These additives may include other soils or materials such as Portland cement, lime, fly ash, asphalt cement, polymers, and fibers. Traditionally, additives such as bitumen, cement, and lime have achieved widespread use. Bitumen is typically used as a soil surface treatment to limit dust and loss of fines. Cement is used to provide strength to soil. Lime is often used in clay soils to control plasticity. The long-term performance of pavements constructed using CSS is influenced by the characteristics of the soil, the type and quantity of stabilization additive, construction practices, pavement system design, loading frequency and magnitude, and the local climate/environment.

5.3.1. CSS is often used as a base layer for pavements since it improves the strength of the soil. However, when used as a surface layer, it may suffer from durability problems. The durability problems arise from inherent susceptibility of the natural soil and the relatively lower amounts of cement used for soil stabilization combined with less-than-ideal moisture and curing conditions in most cases. The durability of cement-stabilized materials is addressed in UFC 3-250-11 through ASTM D559-03, *Standard Test Methods for Wetting and*

Drying Compacted Soil-Cement Mixtures, and ASTM D560-03, *Standard Test Methods for Freezing and Thawing Compacted Soil-Cement Mixtures* (depending on project climate), by establishing criteria for weight loss after simulated weather cycling. Additional information may be found in Army FM 5-410, *Military Soils Engineering*, Chapter 9, *Soil Stabilization for Roads and Airfields*.

5.3.2. Several cement-stabilized military airfields have been constructed in the continental United States: Holland Assault Landing Zone (ALZ) at Fort Bragg, North Carolina, All American ALZ at Little Rock AFB, Arkansas, and Fullerton Landing Zone and Self Landing Zone at Fort Polk, Louisiana. Holland ALZ was removed from service due to FOD issues and All American ALZ also suffered severe FOD issues due to CSS surface degradation. The CSS airfields at Fort Polk are reported to be performing well.

5.3.3. The problems at Holland ALZ appeared to be primarily related to construction techniques. Considerable cracking and spalling were evident at longitudinal cold joints where adjacent lanes from the stabilizer machine abutted. There is evidence that some lanes may have been allowed to cure for a significant period before constructing the adjoining lane. This prevented adequate compaction and bond at the joint and possibly degraded the cured material due to the compactor bridging from the cured side into the uncured material. In many locations, it appeared that a thin layer of CSS was placed to achieve final grade. The thin layer failed to adequately bond to the underlying material, resulting in large sheets of CSS delaminating and becoming a serious FOD issue. No evidence of an emulsion coating was observed. An emulsion coating (such as asphalt or polymer) serves two functions. First, applied immediately after mixing and compaction, it serves to hold moisture within the pavement, allowing it to react with the cement. Second, it serves as a barrier to external moisture, minimizing CSS softening and freeze-thaw damage.

5.3.4. The problems at All American ALZ were deemed to be both construction and material related. Problems resulting from placing thin layers of CSS were also observed at this site, similar to those observed at Holland ALZ. In addition, durability testing was not conducted during design, which likely led to reduced design cement content and an inadequate mix design. It was also noted in discussions with base personnel that the source of the borrow soil was changed in the middle of construction without verifying the mixture design's adequacy. It was determined that moisture contents may not have been properly controlled

during construction. Degradation of the pavement also appeared to be the result of moisture intrusion and freeze-thaw damage. This may have been exacerbated by not maintaining a moisture barrier (such as asphalt or polymer emulsion). Construction records indicated that an asphalt emulsion was applied after construction. However, it was not clear if the emulsion was applied immediately after completion of each portion of the surface or was applied to the completed runway. The moisture barrier should have been applied to each completed portion of the pavement and a final coat applied to the entire surface when the project was completed. The moisture barrier should also have been periodically reapplied based on surface wear from traffic and/or degradation due to weathering.

5.3.5. Properly designed and constructed CSS airfields, such as those at Fort Polk, are performing well. However, proper maintenance—such as reapplying emulsion coatings (asphalt or polymer) to prevent water intrusion (especially in freeze-thaw areas) and spot-repair of failed areas is necessary to prevent CSS degradation.

5.4. Repair Procedures.

5.4.1. Remove and Replace.

5.4.1.1. The remove-and-replace method is analogous to a full-depth repair of a concrete pavement. It may be used to repair small areas (localized damage of less than an 8-foot by 8-foot area) or large areas; however, this method is probably feasible only for repairs of less than 2,000 square feet if a reclaimer/stabilizer is not available. A concrete saw may be used to cut the sides of the repair area and a jackhammer or backhoe can be used to remove the failed material. For larger areas, it may be more feasible to use a reclaimer/stabilizer device or a front-end loader mounted miller (fitted with carbide cutting teeth). If milling is used, the sloped ends of the milled area created by the milling drum will need to be sawed vertically to avoid feathering the edge of the repair. The exposed base course will also need to be smoothed and repaired if any damage is evident after removing the failed CSS. Typically, the depth of repairs should not exceed 6 to 7 inches for compacted soil (8 to 9 inches for loose fill).

5.4.1.2. For smaller patch areas, the material should be prepared outside of the patch recess and then placed. The amount of soil to be used can be estimated based on the patch dimensions, depth, and maximum density at the optimum moisture content (OMC). Excess soil should be mixed and placed to allow for

surface trimming of the patch after compaction. Prepare the soil to be used in the repair by drying, if necessary, or by adding water to obtain the proper moisture content. A front-end loader can be used to fold the soil repeatedly while wetting. Once the appropriate uniform moisture content has been obtained, the cement should be added and mixing continued until a uniform mixture is obtained. Once mixed, the cement will begin to cure with the moisture in the soil so work as quickly as possible. Immediately place the soil-cement mixture into the excavation and spread uniformly with a substantial overfill of 3 to 4 inches. To obtain a fully compacted 6-inch soil layer will require approximately 8 inches of loose, uncompacted soil. After compaction, the patch area should be immediately trimmed to match the grade of the adjoining pavement and covered or sprayed with an emulsion to seal the surface to prevent excess moisture loss. If using Type I cement, a minimum of seven days of curing should be allowed for temperatures above 40 °F (4 °C). For Type III cement (high early strength), a minimum of 24 hours of cure should be allowed for temperatures above 40 °F (4 °C). The surface should be protected from freezing temperatures during the curing period. At temperatures below 40 °F (4 °C), Portland cement is not recommended.

5.4.2. Mix In Place (MIP).

5.4.2.1. The MIP method would typically be used for repairs where a large area of pavement needs repair and mixing soil cement outside the repair area is not practical. This method is feasible only for repairs of greater than 2,000 square feet. A reclaimer/stabilizer machine is recommended for the MIP process, although a milling drum mounted on a front-end loader may be used. The reclaimer/stabilizer machine may also be used to mill the damaged CSS for removal or reuse. The area to be repaired should be milled at a speed of less than 30 feet per minute to allow for efficient cutting of the damaged CSS. Care must be taken to properly set the depth of the reclaimer/stabilizer to prevent base course damage. The milled material should be discarded and replaced with the same or similar soil unless time and material constraints dictate otherwise.

5.4.2.2. After milling, the sloped edges created by lowering and raising the milling drum at the beginning and end of the milling process will need to be cut vertically to avoid feathered edges on the repair. If reusing the millings, it may be necessary to add some fresh soil to the millings to increase the volume of material. After compaction, it will be necessary to trim the repair area to grade, which requires some overfill of the repair area. Ideally, the milled material

should be sampled and tested to determine the moisture-density relationship (ASTM D1557-09, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort [56,000 ft-lbf/ft^3 {2,700 kN-m/m3}]) that will define the optimum moisture content for compaction. When testing is not practical, such as in a contingency environment, then the OMC of the millings, new soil, and cement must be estimated based on field tests and engineering judgment.

5.4.3. Calculations.

5.4.3.1. Calculations are required to determine the amount of cement and water to add for a given repair area and depth. The calculations are based on the maximum dry density of the material (based on Standard or Modified Proctor), soil volume, optimum moisture content of the soil, cement content, and moisture content prior to construction. If using cement bags, determine the spacing of the cement bags over the repair area to achieve the target stabilizer content. If a reclaimer/stabilizer machine outfitted with a spray-bar inside the cowling is being used for the MIP procedure then water pump rates must be determined based on ground speed to achieve the target moisture content. The cement bag spacing within the reclaimer/stabilizer mixing lane must also be determined.

5.4.3.2. Stabilizer Calculations.

A = area, square feet

D = depth of cut, feet

OMC = optimum moisture content, %

MSM = measured soil moisture content, %

MDD_{OMC} = maximum dry density at optimum moisture of the unmodified soil, lbs/ft3

P_{Cement} = percentage of cement by dry weight of soil, %

W_{Soil} = weight of soil to be stabilized, lbs

W_{Cement} = weight of cement to be added to soil, lbs

bag spacing = number of cement bags/area, bags/ft^2

V_{Water} = volume of water needed to reach OMC, gals

The weight of cement, W_{Cement}, required for the mixture is calculated from the volume of soil, the maximum dry density, and the percentage of cement to be used based on UFC 3-250-11. The MDD_{OMC} for the soil-cement mixture should

be determined according to ASTM D1557-09 and ASTM D558-11, *Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures*. If the MDD_{OMC} is not known for the mix but only for the unmodified soil, a rule of thumb is that for every 5% of cement added, increase by 1% the amount of water needed to reach OMC. For example, if the MDD_{OMC} is 9% of the unmodified soil, for a 7% cement addition, the MDD_{OMC} of the modified soil would be estimated at 10%. If 11% cement was being added, the estimated MDDOMC of the modified soil would be 11%. This increase in the OMC results from the increased fines present in the cement and the need for extra water to hydrate the cement. The cement bag spacing is then determined by dividing W_{Cement} by the weight of cement bags divided by the area (typically either square feet or square yards). The volume of water necessary to reach the OMC for the soil-cement mix is determined from the weight of soil, W_{Soil}, and the OMC.

$$W_{Soil} = A \times D \times MDD_{OMC}$$

$$W_{CEMENT} = W_{Soil} \times P_{Cement}$$

$$\text{Number of Bags} = \frac{W_{Cement}}{\text{Bag Weight}}$$

$$\text{Bag Spacing} = \frac{\text{Number of Bags}}{A}$$

$$V_{Water} = \frac{(W_{Soil} + W_{Cement}) \times (OMC\text{-}MSM)}{8.33}$$

5.4.3.2.1. Remove and Replace.

5.4.3.2.1.1. As an example of the remove-and-replace method, 7% cement is being used to make a 10-foot-wide by 10-foot-long by 6-inch-deep repair with a SM soil having MDD_{OMC} = 130 lbs/ft^3. The OMC of the unmodified soil is 9% and the MSM = 4%. Using the equations above:

W_{Soil} = 10 x 10 x 0.5 x 130 = 6500 lbs

W_{Cement} = 6500 x 7% = 455 lbs

number of bags = 455/94 = 4.8, so round up to 5

bag spacing = 5/(10x10) = 1 bag per 20 sq. ft.

V_{Water} = [(6500+455) x (10-4)]/8.33 = 50 gals water

5.4.3.2.1.2. The weight of soil is 6500 pounds, resulting in a cement weight of 455 pounds. For 94-pound bags of cement (typical in the United States), 4.84 bags are needed. Always round up to the nearest whole number so five bags of cement (bag spacing = 1 bag per 20 square feet) would be needed to repair the area. For 7% added cement, the OMC for the soil-cement mix would be 10% (OMC of the soil = 9% + 1% added for extra water needed for 5% to 10% cement dosage) and using the MSM, leads to V_{Water} = 50 gals to reach a 10% OMC target. The water should be evenly mixed with the soil before mixing the cement. After the cement is well mixed, the material should immediately be evenly placed in the repair recess with a 3- to 4-inch overfill and well compacted.

5.4.3.2.2. MIP.

5.4.3.2.2.1. For the MIP method the calculations are the same. However, the cement needs to be spread in the mixing lane of the reclaimer/stabilizer machine. The target moisture content may be reached by surface addition of water to the area or by spray-bar, if equipped. Surface water addition is the simplest approach as this avoids the complications of using the spray-bar method. When using the spray-bar approach, a nurse truck with water tank is required, and the pump rate (typically in gals/minute) must be controlled according to the total gals of water required over the area, the speed of the machine, and the width of the cutter head. Overlap of adjacent lanes must be minimized to avoid overwatering the overlap area and lane spacing must be coordinated to match the size of the repair area.

$$\text{Bag Spacing/Lane} = \frac{A}{CHW \times \text{Number of Bags}}$$

$$\text{Pump Rate} = \frac{V_{Water} \times CHW \times \text{Machine Speed}}{A}$$

A = area, square feet

CHW = cutter head width, feet/lane

PR = pump rate needed to reach optimum moisture, gals/minute

bag spacing/lane = bag spacing in mixing lane, feet

machine speed = feet/minute

5.4.3.2.2.2. As an example, a 100-foot by 100-foot area needs to be repaired using the MIP method. The same soil and cement conditions as in the previous

example will be used. According to the previous equations, W_{Soil} = 650,000 pounds and W_{Cement} = 45,500 pounds. For 94-pound bags of cement (typical in the United States), 484 bags are needed. The bag spacing would be the same as the previous example: one bag per 20 square feet. For the MIP method, it is best to spread these in the mixing lane. The cutter head width of 6 feet is used to yield a bag spacing/lane of 3.44 feet. Thus, a bag of cement would be placed about every 3.5 feet in a 6-foot-wide mixing lane. The cutter head width yields the number of machine lanes of 16.7, which is rounded up to 17. The V_{Water} = 5,010 gals to reach a 10% OMC target. Assuming a machine speed of 30 feet/minute, a pump rate of approximately 90 gals/minute is needed to reach OMC.

5.4.4. Compaction. For proper compaction and to achieve proper grade, the repair recess must be overfilled. This process is similar to a cold joint compaction method for asphalt pavement repair. The filled material should be placed or arranged to overlap the repair area a few inches and then raked back inside the edge to create a raised area of new repair material around the perimeter of the repair (**Figure 5.1**). A steel wheel roller in static mode should be used to initially compact or pinch the edges and corners. The raised edge should remain above the surrounding grade at all times during compaction. When operating the compactor inside the patch area, care should be exercised to compact as closely as possible to the edges and in the corners of the patch recess without getting the compactor drum or plate outside the patch area. This is especially critical if using vibration or a heavy drum compactor, as this may damage the surrounding pavement. Vibration should be used to compact the material to density. After compaction, the patch area should be trimmed with a grader to match the grade of the adjoining pavement. Static operation of a steel wheel roller may be used to remove roller marks or a rubber tire roller may be used to finish the surface. The patch area should then be sprayed with an emulsion to seal the surface to prevent excess moisture loss.

5.5. Repair Location. The location of the repair may dictate the size of the repair needed. If the damaged area is outside the aircraft wheel path in the runway, a small patch may be appropriate. However, patches located within the wheel paths shall extend across the full width of the gear on both sides of the centerline such that the patch condition encountered by the aircraft gear is the same (**Figure 5.2**).

Figure 5.1. Replacement, Preparation & Compaction of Soil Cement.

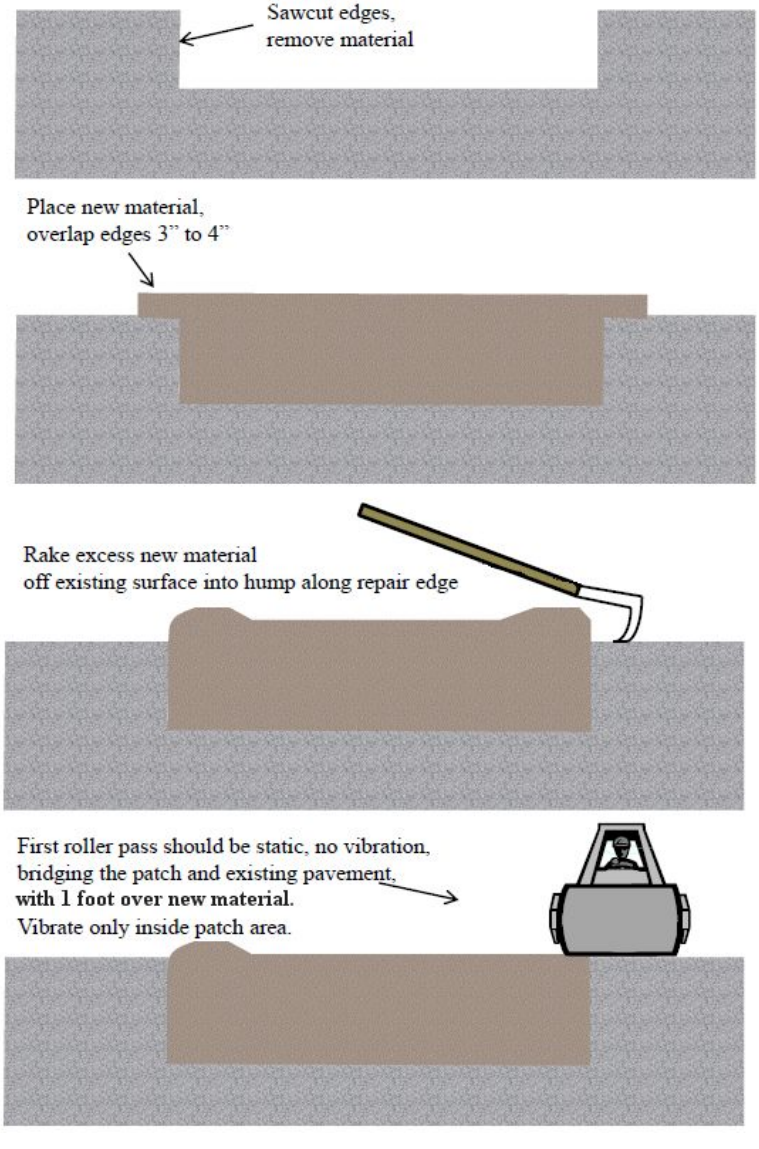
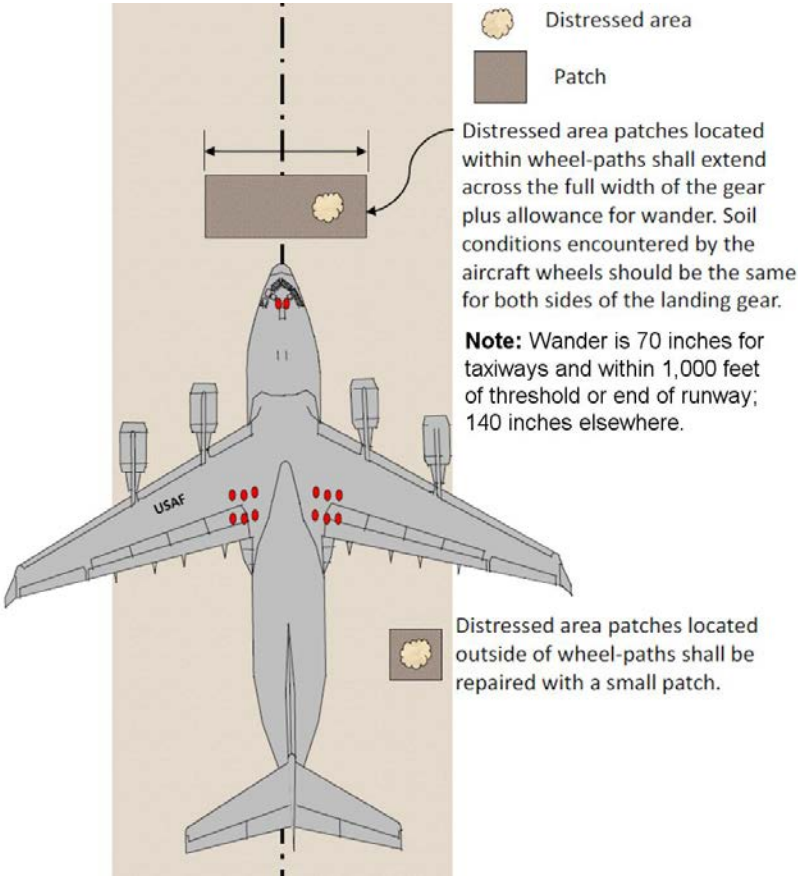


Figure 5.2. Wheel Paths and Location of Repairs.



5.6. Additional Considerations. Further research may be needed to validate these repair methods under full-scale testing conditions for different CSS pavement thicknesses, repair sizes, types of soils, and cement contents. Environmental factors such as wet-dry and freeze-thaw conditions exacerbate CSS degradation, especially if strict construction specifications and routine maintenance are not followed. A research study may also be warranted to identify surface treatments that prevent moisture intrusion, retain frictional characteristics, provide a wearing course, and act as curing membranes.

Chapter 6

CHEMICAL DUST CONTROL FOR AIRFIELDS

6.1. Purpose. This chapter provides guidance for the mitigation of dust for contingency roads, base camps, helipads, and airfields. It also includes detailed guidance for selecting and applying chemical dust palliatives in contingency environments. The implementation of dust mitigation technology is necessary to reduce FOD potential, improve the safety of military operations, and reduce operational hazards to military personnel.

6.2. Background. The U.S. military was plagued by fugitive dust during Operations Enduring Freedom and Iraqi Freedom. Airborne dust generated during air and ground operations had a significant impact on missions: ground vehicles experienced safety hazards during convoy activities and personnel were exposed to potential health hazards from fine particulate matter. In addition, the widespread accumulation of dust during ground vehicle operations and in base camps adversely impacted the ability of military personnel to effectively conduct combat operations.

6.2.1. Rotary-wing aircraft often experienced “brown out” conditions, in which the density of airborne dust was such that the pilots lost sight of the ground, resulting in hazardous operating conditions. Aircraft and personnel were lost due to accidents resulting from “brown out” conditions. Fixed-wing aircraft operations in contingency environments generated significant dust from operating on semi-prepared surfaces and unusually narrow taxiways and runways. The generated dust resulted in increased aircraft maintenance, airfield maintenance (particularly sweeping operations), and reduced operations tempo while waiting for the dissipation of dust clouds generated during aircraft landings and departures.

6.2.2. The U.S. Army ERDC was tasked by AFCEC to develop dust-control guidance to address these concerns. ERDC recently concluded research and development of chemical dust palliatives for the U.S. Marine Corps Systems Command for mitigating dust for two distinct applications: one for expeditionary use on forward area arming and refueling points and one for sustainment use on roads and other large area applications. The technology developed under the Marine Corps program was leveraged and applied to fixed-wing aircraft operations, including field tests at two semi-prepared runway test

sites sustaining C-17 aircraft operations. The results of these experiments were used to develop this publication.

6.3. Summary of Recommended Product Applications.

6.3.1. **General Application Guidance.** This chapter is a quick reference tool for rapidly selecting a type of dust palliative, the target palliative application rate, and method of applying the product for a variety of dust-abatement missions. The recommended use of this chapter is summarized in the following steps:

6.3.1.1. Use **Table 6.1** to select the recommended type of product.

6.3.1.2. Review **paragraph 6.3.2**. "Detailed Dust Palliative Descriptions."

6.3.1.3. Select product from recommended product category (**Tables 6.2** thru **6.4**).

6.3.1.4. Review **paragraph 6.3.3**, "General Application Information."

6.3.1.5. Review **paragraph 6.3.4**, "Detailed Application Guidance."

Table 6.1. Recommended Product Applications.

Application	Primary Solution				Secondary Solution(s)			
	Product Category	Application Rate	Dilution Ratio	Application Type	Product Category	Application Rate	Dilution Ratio	Application Type
Fixed-Wing Airfields	Synthetic Fluid	0.4 gsy	N/A	Topical	Polymer Emulsion	1.2 gsy	3:1	Admix*
Roads	Polymer Emulsion	0.8 gsy	3:1	Admix**	Synthetic Fluid	0.6 gsy	N/A	Topical
Helipads	Synthetic Fluid	0.4 gsy	N/A	Topical	Polymer Emulsion	1.2 gsy	3:1	Topical
Base Camps	Synthetic Fluid	0.4 gsy	N/A	Topical	Polymer Emulsion	0.6 gsy	3:1	Topical
					Polysac-charide	0.6 gsy	3:1	Topical

*Depth of mixing should be a minimum of 4 inches (102 millimeters).
**Depth of mixing should be a minimum of 3 inches (76 millimeters).

6.3.1.6. **Table 6.1** provides a summary table for selecting a type or category of dust palliative recommended for a particular application. The table provides

general guidance concerning the recommended application rate or quantity of each product, as well as information on whether the product should be diluted with water before use. **Table 6.1** also indicates whether the material should be applied topically or admixed into the soil to achieve the desired dust control results. If site conditions or the mission scenario preclude the use of the primary solution, **Table 6.1** also includes secondary solution recommendations.

6.3.2. **Detailed Dust Palliative Description.** This section describes the different categories of recommended chemical dust palliatives. Selecting the correct type of dust palliative is critical to ensure the method of dust abatement is compatible with the mission.

6.3.2.1. Polymer Emulsions. Polymer emulsions used for dust control are generally vinyl acetate or acrylic-based copolymers suspended in water by surfactants (**Table 6.2**). They typically consist of 40 percent to 50 percent solid particles by weight of emulsion. Once they are applied, the polymer particles begin to coalesce as the water evaporates from the system, leaving a soil-polymer matrix that prevents small dust particles from escaping the surface. The polymers used for dust control typically have excellent tensile and flexural strength, adhesion to soil particles, and resistance to water. These materials are often limited by a short shelf life (less than 2 years). Some vendors dilute polymer emulsion products, so it is recommended that random samples of the bulk product be taken to ensure that the bulk product includes at least 40 percent solids according to ASTM D 2834. Polymer emulsions should not be mixed with gray water or salt water for dilution. If applied topically to helipads, take care to ensure sufficient application rates and penetration depths to avoid the formation of thin crusts (less than 1 inch), creating the potential for FOD.

6.3.2.2. Polysaccharides. Polysaccharides are solutions or suspensions of sugars, starches, and surfactants in water (**Table 6.3**). They have excellent shelf life, but the solids may settle from the solution when the product is not stored per the manufacturer’s recommendations. Polysaccharides may be diluted with water, depending on the intended use. Polysaccharides provide dust abatement by encapsulating soil grains and providing a binding network in the ground. They are biodegradable and may leach from the soil with exposure to precipitation.

Table 6.2. Polymer Emulsions.

Product Description	Effective Uses	Limitations	Shipping
Vinyl acetate or acrylic polymers suspended in water by surfactants. Water evaporates when placed on soil and leaves a bonded soil-polymer matrix. Prevents dust by binding soil grains.	Helipads Roads Base Camps Airfields	May require mixing with soil for roads and airfields. Potential for FOD damage on helipads, especially when light topical applications are used or this crusts (< 1 in.) are produced.	275-gal containers (2,500 lb)

Product	Vendor	Web Site Address	Telephone Number
Soil-Sement	Midwest Industrial Supply, Inc.	www.midwestind.com	1-866-662-3878
Soiltac	Soilworks, LLC	www.soilworks.com	1-800-545-5420
Envirotac II	Enviromental Products & Applications, Inc.	www.envirotac.com	1-888-674-9174

Table 6.3. Poly Saccharides.

Product Description	Vendor Information	Effective Uses	Limitations	Shipping
Surtac: Mixture of sugar and starches designed to bind soil grains. Product is water soluble, biodegradable, and capable of dilution with water.	Soilworks, LLC www.soilworks.com 1-800-545-5420	Helipads Base Camps	Limited effective lifespan. Lower strength than polymer emulsions. May settle fromsolution during storage.	275-gal containers (2,500 lb)

6.3.2.3. Synthetic Fluids. Synthetic organic fluids have an indefinite shelf life and are applied to a soil “as received.” These fluids (**Table 6.4**) are not miscible with water and are therefore unable to be diluted. They consist of isoalkanes that do not dry or cure with time. The reworkable binder is ready for immediate use upon application and maintains effectiveness over extended periods of time. Follow-on applications have a cumulative effect. Despite lower application rates for a given usage (i.e., airfields, roads, helipads, or base camps), since synthetic

organic fluids are not diluted for application they can be two to three times as costly to use as polymer emulsions and polysaccharides.

Table 6.4. Synthetic Fluids.

Product Description	Vendor Information	Effective Uses	Limitations	Shipping
Envirokleen and Durasoil: Blend of isoalkanes that form a reworkable binder in soil. Will not mix with water. Effective for long-term use.	Envirokleen Midwest Industrial Supply, Inc. www.midwestind.com 1-866-662-3878 Durasoil Soilworks, LLC www.soilworks.com 1-800-545-5420	Helipads Roads Base Camps Airfields	More expensive than most other products.	275-gal containers (2,000 lb)

6.3.3. **General Application Information.** This section briefly describes the primary considerations and methods for applying the recommended dust palliatives.

6.3.3.1. Soil Type. The soil type has an effect on the performance of dust palliatives. Finer grained soils (silts and clays) present a larger problem with dust generation and are more difficult to control. The higher specific surface of the soil will require greater quantities of the product for treatment. Penetration may also be hindered by the small pore sizes between soil grains. Multiple light application rates may be required to effectively treat fine-grained soils and to prevent ponding or surface runoff. Coarse-grained soils (sands and gravels) typically have higher infiltration rates that minimize ponding or runoff. The soil should be classified according to ASTM D 2487.

6.3.3.2. Intended Use. Choosing a dust palliative will ultimately be governed by the existing need for dust control. Some products work better for helipads, while others are more effective on roads or airfields. Each chemical has benefits and limitations which should be considered before selecting a product. **Table 6.1** lists some of the recommended product categories for different dust-control needs.

6.3.3.3. Application Rates. Application rates should be chosen according to the soil type, the intended use of the treated area, and the necessary duration of use.

Dust palliatives should be applied at the rates given in **Table 6.1**. Synthetic fluids may be applied at lower rates for most projects because they contain 100 percent active ingredients. Polymeric materials may require application rates greater than 1.0 gallon per square yard (gsy) in areas of heavy traffic. For example, using polymer emulsions on helipads will require an application rate of approximately 1.2 gsy to produce thicker surface crusts to reduce FOD potential. Refer to **Table 6.1** for guidance on selecting application rates. Note that higher application rates may be required if the polymer emulsions/polysaccharides are pre-diluted by the vendor as evidenced by less than 40 percent solids according to ASTM D 2834.

6.3.3.4. Dilution Ratios. Some products may require dilution with water. These are typically emulsified products (polymers and polysaccharides). Diluting an emulsion will reduce the viscosity and improve penetration. In general, 3 parts water should be added for each part product. Note that the recommended dilution ratio may need to be reduced if the palliatives have been pre-diluted by the vendor to less than 40 percent solids according to ASTM D 2834. Synthetic fluids are intended for use “as received” and should be applied in their concentrated form.

6.3.3.5. Topical Method. Topical applications are the most commonly used technique for dust control. Spraying the surface of the soil with a dust palliative will solve most dust problems. Alternative methods should be used when the area to be treated is structurally deficient for the anticipated traffic or when greater durability is needed. Topical applications are accomplished by spraying the dust palliative onto the natural or prepared soil surface. It is imperative to maintain the greatest level of uniformity while dispersing the liquid. Application quantities are determined by estimating the area of ground surface to be treated and multiplying that area by the suggested application rate. Manufacturers’ literature indicate that topical applications are typically effective for 6 to 24 months, dependent on soil type, compaction, penetration depth, climate, and traffic type and volume. Reapplication is generally performed at 20 percent to 30 percent of the initial application rate.

6.3.3.6. Admixture Method. Admix methods are designed to incorporate dust palliatives deeper into the soil and provide longer lasting dust abatement. These methods are usually necessary when heavy, repetitive loading will be applied to the soil. Roads and airfields (runways, taxiways, or parking aprons) generally require admix applications to achieve the desired results. Admix depths should

be at least 3 inches (76 millimeters) for roads and at least 4 inches (102 millimeters) for airfields. Recommend the following procedure to incorporate dust palliative into the soil:

Step 1. Grade the soil, if necessary, using a motor grader (**Figure 6.1**).

Figure 6.1. Grading Soil Surface before Treatment.

Step 2. Spray half of total palliative application rate onto the soil surface (**Figure 6.2**).

Figure 6.2. Applying with HydroSeeder & Mixing with Rotary Mixer.

Step 3. Blend into the top 3 inches to 4 inches (76 millimeters to 102 millimeters) of soil using a rotary mixer (**Figure 6.2**).

Step 4. Compact using steel-wheeled vibratory roller (**Figure 6.3**).

Figure 6.3. Compacting Soil after Mixing.

Step 5. Spray remaining product onto the compacted surface (**Figure 6.4**).

Figure 6.4. Applying Final Spray to Soil Surface after Compaction.

This method will provide optimal performance of most palliatives. Alternative construction methods may not provide sufficient durability.

6.3.3.7. Distribution Equipment. A variety of distribution equipment can be used to apply the palliatives. **Table 6.5** includes some equipment used by the ERDC.

Table 6.5. Distribution Equipment and Vendor Information.

Equipment Type	Model*	Vendor	Web Site Address	Telephone
HydroSeeder	T-90 T-120	Finn Corporation	www.finncorp.com	1-800-543-7166
Water Distributor	613CWD	Caterpillar	www.cat.com	1-309-675-1000
*Listed materials were evaluated by ERDC researchers. Other models which may meet project needs are also available. It is recommended to consult ERDC researchers (1-601-634-2467) before renting or purchasing any equipment.				

6.3.4. **Detailed Application Guidance.** This section provides detailed guidance for treating helipads; roads; large, open areas; base camps; and fixed-wing airfield facilities. Undiluted chemicals used in these processes pose a potential skin, eye and respiratory irritation hazard. Therefore, during mixing, personnel should avoid skin contact with these products by using—at a minimum—nitrile gloves (or other gloves approved by the site bioenvironmental engineer) and chemical goggles. Aprons and/or face shields may be necessary if a significant splash hazard exists. Mixing operations should be reviewed by the bioenvironmental engineer to determine if adequate ventilation exists. If the products are mixed outside in a well ventilated area, respiratory protection should not be required. The primary environmental concern with organic nonpetroleum dust and solvent-based suppressants is how they impact the groundwater quality, freshwater aquatic environment, and plant community. Do not apply these products in excess or directly to any water bodies, wetlands, or where excess product runoff could discharge to a water body (e.g., stream, lake, pond, wetlands). Take all necessary precautions to keep dust palliative materials out of water drainages and roadway ditches leading to streams.

6.3.4.1. Dust Abatement on Unsurfaced Helipads. Equipment requirements may be modified depending upon availability and mission requirements; however, the general types of equipment and process should be similar.

6.3.4.1.1. Supplies. Necessary supplies include the following:

- Truck to haul the chemical totes, pumps, etc., and to tow the distribution equipment, if necessary.
- HydroSeeder or other spray distribution system compatible with the selected chemical.

- Two to four 275-gal totes for dust palliative (synthetic fluid – primary solution).
- One trash pump and sufficient hoses with quick-connect ends to transfer the material from the totes to the distributor if the distributor does not include a pump.

6.3.4.1.2. General Procedures. General application procedures are as follows:

Step 1. Survey and establish the area to be treated.

Step 2. Place synthetic fluid into a HydroSeeder/distributor (**Figure 6.5**).

Figure 6.5. Filling Hydroseeder from Material Tote.

Note 1: Approximately 450 gals will be required for a 100-foot by 100-foot (30-meter by 30-meter) helipad for smaller rotary-wing aircraft.

Note 2: Approximately 900 gals will be required for a 150-foot by 150-foot (46-meter by 46-meter) helipad for larger rotary-wing aircraft.

Note 3: Greater quantities will be required for treating with a polymer emulsion (secondary solution). Follow dilution/application guidance in **Table 6.1**.

Note 4: If a polymer emulsion is used as the secondary solution, the material must be diluted 3:1 with water and agitated for a minimum of five minutes before application.

Step 3. Position the HydroSeeder/distributor on the edge of the helipad.

Step 4. Use the tower gun and a long-distance nozzle to spray half of the product on half of the helipad (**Figure 6.6**).

Step 5. Move to the opposite side of the helipad and spray the remaining product.

Figure 6.6. Topical Material Application from HydroSeeder Tower Gun.

Step 6. If the distributor does not have standoff spray capability, it may be necessary to traverse the helipad to ensure spray overlap. (**Note**: If the helipad ruts significantly under the distributor, an attempt to smooth the ruts should be made and the ruts retreated by a hand wand to keep the ruts from acting as erosion focal points during aircraft operations.)

Helicopters may land immediately on areas treated with synthetic fluids; however, for best results wait one day before trafficking (**Figure 6.7**). If a polymer emulsion is used as the alternative solution, the material must be allowed to cure for 24 hours before allowing traffic on the helipad.

Figure 6.7. UH-1 Helicopter Operating on Treated Helipad.

6.3.4.2. Dust Abatement on Unsurfaced Roads. Equipment requirements may be modified depending upon availability and mission requirements; however, the general types of equipment and the process should be similar.

6.3.4.2.1. Supplies. Necessary supplies include the following:

- Motor grader for initial grading, if necessary.
- Truck and/or HMMWV to haul chemical totes, pumps, etc., and to tow the distribution equipment, if necessary.
- HydroSeeder or other chemical distributor compatible with the product(s).
- Polymer emulsion and water (primary solution). **Note:** Quantities must be calculated based upon the recommended product application rate and the length and width of the road.
- Rotary mixer for admixing.
- Steel-wheeled vibratory compactor.

6.3.4.2.2. General Procedures. The general application procedures are as follows:

Step 1. Grade the road to establish general grade requirements and correct distresses.

Step 2. Determine the length of road that can be treated per tank of product (HydroSeeder/distributor tank capacity) as follows:

Length (yard [yd])=[Tank Capacity (gal)]/[Application Rate (gsy)]x[Road Width (yd)]

Step 3. Place 675 gals of water into HydroSeeder/distributor (minimum 900-gal capacity). For smaller distribution equipment, recalculate quantities to match the recommended dilution ratio.

Step 4. Add 225 gals of polymer emulsion.

Step 5. Mix for five minutes using mechanical agitation.

Step 6. Apply product to the road surface using a distribution bar or wide fan nozzle on the tower gun.

Step 7. Immediately till the road surface with a rotary mixer to a depth of 3 inches (76 millimeters).

Step 8. Compact the soil until the desired density is achieved.

Step 9. Spray a light application (~0.2 gsy) of the product over the compacted road surface.

Step 10. Repeat steps 1 through 9 for all subsequent road lengths to be treated.

6.3.4.2.3. If a synthetic fluid (secondary solution) is used, it is applied in a topical application following the general approach described for dust abatement on unsurfaced helipads.

6.3.4.3. Dust Abatement in Base Camps and other Non-Traffic Areas. The application guidance for these areas is less robust and more cost effective since the surface is subjected to reduced loading requirements. Thus, this guidance should not be used for areas directly exposed to vehicle traffic. Equipment requirements may be modified depending upon availability and mission requirements; however, the general types of equipment and process should be similar.

6.3.4.3.1. Supplies. Necessary supplies include the following:

- Truck and/or HMMWV to haul the chemical totes, pumps, etc., and to tow the distribution equipment, if necessary.
- HydroSeeder or other chemical distributor compatible with the product(s).
- Synthetic fluid. **Note:** Quantities must be calculated based upon the recommended product application rate and the length and width of the area to be treated.

6.3.4.3.2. General Procedures. The general application procedures are as follows:

Step 1. Determine the area that can be treated per tank of product (HydroSeeder/distributor tank capacity) as follows:

Area (square yard [sq yd])=[Tank Capacity (gal)] / [Application Rate (gsy)]

Step 2. Fill the distribution equipment with the synthetic fluid. Do not dilute.

Step 3. Apply product to the soil surface using a distribution bar, wide fan nozzle on the tower gun, or a hand wand/hose.

Step 4. Repeat steps 1 through 3 as required to treat the desired area.

6.3.4.4. Dust Abatement around Fixed-Wing Airfields. For paved airfields, chemical dust palliatives may be used on any unpaved area around the perimeter of the pavement, including unpaved shoulders and graded areas. Due to safety concerns associated with surface friction requirements, dust palliatives are not recommended on any primary operating surface of unsurfaced airfields. The exception is when a polymer emulsion is used as a soil stabilization agent and effectively admixed into the soil at depths greater than 4 inches (102 mm) and at higher application rates, typical of soil stabilization. Additionally, since the shoulders of unsurfaced airfields are designed to support occasional aircraft loading, it is also recommended that the products not be used on shoulders of unsurfaced airfields. Thus, for unsurfaced airfields, the use of chemical dust palliatives is limited to the graded areas. Due to potential FOD concerns, it is highly recommended that synthetic fluids be used for this application. If the alternative polymer emulsion solution is used, the material MUST be admixed into the soil to minimize FOD potential. Polymer emulsions or other stabilization additives cannot be topically applied around fixed-wing airfields due to the potential to form thin crusts capable of generating FOD. Equipment requirements may be modified depending upon availability and mission requirements; however, the general types of equipment and the process should be similar.

6.3.4.4.1. Supplies. Necessary supplies include the following:

- Truck and/or HMMWV to haul the chemical totes, pumps, etc., and to tow the distribution equipment, if necessary.
- HydroSeeder or other chemical distributor compatible with the products.
- Synthetic fluid. Quantities must be calculated based upon the recommended application rate and the length and width of the area to be treated.

6.3.4.4.2. General Procedures. The general application procedures are as follows:

Step 1. Determine the area of airfield that can be treated per tank of product (HydroSeeder/distributor tank capacity) as follows:

Area (sq yd) = [Tank Capacity (gal)] / [Application Rate (gsy)]

Step 2. Fill the distribution equipment with synthetic fluid. Do not dilute.

Step 3. Apply to soil surface using a distribution bar or wide fan nozzle on the tower gun.

Step 4. Repeat steps 1 through 3 as required to treat the desired area.

6.3.4.4.3. Application Areas for Fixed-Wing Facilities. A major consideration in the treatment of areas around fixed facilities is the size of the area requiring treatment. The width of treatment along the perimeter is generally reasonable; however, the length of treatment for airfields can range from 1 to 3 miles per side of the runway—the resulting treatment area can accumulate quickly. Analyses of the propeller/jet wakes for the C-130 and C-17 aircraft were performed to develop recommendations for the width of the area to be treated. The minimum treatment width for effective treatment is based upon the wingspan of the aircraft and the highest intensity exhaust plume, while the optimum treatment width is based upon the distance required to reduce the exhaust plume to a maximum velocity of 50 feet per second (35 miles per hour). As general guidance, the treatment width along each side of the runway and around any turnarounds or aprons should be:

- C-130 minimum treatment width: 27 feet (8 meters)
- C-130 optimum treatment width: 50 feet (15 meters)
- C-17 minimum treatment width: 50 feet (15 meters)
- C-17 optimum treatment width: 100 feet (30 meters)

For unsurfaced fixed-wing facilities, the treatment should begin at the edge of the shoulder and be applied outward into the graded area and transition area. For paved fixed-wing facilities, the treatment should begin at the edge of the paved surface and extend outward for the recommended width.

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DCS/Logistics, Engineering & Force Protection

Attachment 1

GLOSSARY OF REFERENCES & SUPPORTING INFORMATION

References

AFI 10-210, *Prime Base Engineer Emergency Force (BEEF) Program*, 21 January 2015

AFPAM 10-219, Volume 4, *Airfield Damage Repair Operations*, 28 May 2008

Air Force Doctrine Annex 3-34, *Engineer Operations* 30 December 2014

AFMAN 33-363, *Management of Records*, 1 March 2008

Air Force Transportation Network Activity Management Plan (AMP) Airfield Pavements AMP

AFI 32-1041, *Airfield Pavement Evaluation Program*, 10 September 2013

AFI 91-203, *Air Force Consolidated Occupational Safety Instruction*, 15 June 2012

UFC 3-250-06, *Repair of Rigid Pavements Using Epoxy Resin Grouts, Mortars and Concretes*, 16 January 2004

UFC 3-250-08FA, *Standard Practice for Sealing Joints and Cracks in Rigid and Flexible Pavements*, 16 January 2004

UFC 3-250-11, *Soil Stabilization for Pavements*, 16 January 2004

UFC 3-260-03, *Airfield Pavement Evaluation*, 15 April 2001

UFC 3-260-16FA, *Design: Airfield Pavement Condition Survey Procedures*, 16 January 2004

UFC 3-270-01, *Asphalt Maintenance and Repair*, 15 March 2001

UFC 3-270-02, *Asphalt Crack Repair*, 15 March 2001

UFC 3-270-03, *Concrete Crack and Partial Depth Spall Repair*, 15 March 2001

UFC 3-270-04, *Concrete Repair*, 15 March 2001

UFC 3-270-07, *O&M: Airfield Damage Repair*, 12 August 2002

Adopted Forms

AF Form 847, *Recommendation for Change of Publication*

Abbreviations and Acronyms

AFCEC—Air Force Civil Engineer Center
AFI—Air Force Instruction
AFMAN—Air Force Manual
AFPAM—Air Force Pamphlet
AFRC—Air Force Reserve Command
AFRIMS—Air Force Records Information Management System
AFRL—Air Force Research Lab
ALZ—Assault Landing Zone
AMP—Activity Management Plan
ANG—Air National Guard
ASR—akali-silica reaction
ASTM—American Standard Test Method
BEAR—Basic Expeditionary Airfield Resources
BEEF—Base Engineer Emergency Force
°C—degrees Celsius
CSS—Cement Stabilized Soil
CTL—Compact Track Loader
cu. ft.—cubic foot
ERDC—Engineer Research Development and Research Center
°F—degrees Fahrenheit
FOC—full operational capability
FOD—foreign object debris
FOL—forward operating location
ft—foot
ft^3—cubic foot
gal—gallon
gsy—gallons per square yard
IAW—in accordance with
IOC—initial operational capability
KPI—Key Performance Indicator

kW—kilowatt
lbs—pounds
LoS—Levels of Service
M&R—maintenance and repair
MIP—mix in place
MISCAP—Mission Capability
MSDS—Material Safety Data Sheet
NSN—National Stock Number
OMC—optimum moisture content
OPR—Office of Primary Responsibility
PACES—Parametric Cost Engineering System
PAVER—Pavement Maintenance Management System
PCC—Portland Cement Concrete
PCI—Pavement Condition Index
PDP—Power Distribution Panel
PM—preventative maintenance
PMP—Preventive Maintenance Program
psi—pounds per square inch
RDS—Records Disposition Schedule
RH—RED HORSE
RTCH—rough terrain container handler
SM—silty sand
sq. ft.—square foot
SSD—saturated surface dry
SuPR—Sustainment Pavement Repair
TTP—tactics, techniques and procedures
UFC—Unified Facilities Criteria
UTC—Unit Type Code
VSTOL—Very Short Take-Off and Landing
yd—yard

Terms

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. (DODD 3000.10)

Critical Pavement Condition Index (PCI)—The PCI value of a section at which the rate of deterioration significantly increases and return on investment of PM decreases. Critical PCI (or breakdown point) will depend on the pavement type, pavement use, and traffic level, and is unique for each base. Until the PAVER software is configured to calculate the critical PCI, the policy PCI of 70 will be the default critical PCI for primary pavements and 55 for secondary and tertiary pavements. In the future, PAVER will develop critical PCIs for runways, taxiways, aprons, overruns, shoulders, asphalt concrete, and PCC pavements.

Global Preventive Maintenance (PM)—Global PM is used to retard or slow pavement deterioration. Generally, global PM is effective at the beginning of pavement life and/or when climate-caused distresses have not started or, in some cases, the severity is low or medium. Global PM, like localized PM, may be performed in response to the appearance or progression of distress, but is more commonly performed on a recurring schedule (i.e., at set time intervals) without regard for the distresses present.

Localized Preventive Maintenance (PM)—Localized PM consists of maintenance actions performed on pavement at the location of individual distresses to slow down the rate of pavement deterioration. It differs from global PM in that it typically is not applied to pavement outside of the location of the distress, whereas global PM is applied to areas of the pavement that may not be distressed.

Pavement Condition Index (PCI)—PCI is a numerical indicator between 0 and 100 that reflects the surface condition of the pavement.

PAVER—pavements management software used by DOD, government, and private industry

Policy PCI—A project should be programmed before the pavement reaches these conditions:

- Sections with a PCI greater than or equal to 71 generally require minor M&R
- Sections with a PCI of 56 to 70 generally require major and/or minor M&R
- Sections with a PCI of 41 to 55 generally require major and minor M&R or reconstruction
- Sections with a PCI of 26 to 40 generally require major repair or reconstruction
- Sections with a PCI less than or equal to 25 generally require reconstruction

Preventive Maintenance (PM)—PM is a program of activities that preserves the investment in pavements, reduces the rate of degradation due to specific distresses, extends pavement life, enhances pavement performance, and reduces mission impact. PM includes localized PM and global PM. Both are performed on pavements that are above the critical PCI and are intended to maintain good pavements in good condition at minimal cost.

Preventive Maintenance Plan (PMP)—PMP is a plan for sustainment funds, i.e., a document that informs base leadership:

- When maintenance is needed
- What maintenance activities are to be performed
- How the work is to be accomplished
- What is the cost for the work and what is the risk if the work is not accomplished

As a minimum, the PMP should include a prioritized list of projects by contract and in-house with location, quantity, estimated cost, and the risk associated with not performing the work.

Primary Pavements—Primary pavements are mission-essential pavements such as runways, parallel taxiways, main parking aprons, arm-disarm pads, alert aircraft pavements, and overruns (when used as a taxiway or for takeoff). In general, only pavements used by aircraft on a daily basis or frequently used transient taxiways and parking areas are considered primary pavements.

Rate of Pavement Deterioration—This is the rate at which a specific pavement at a specific location deteriorates over time. This rate is dependent on climatic conditions, pavement use, and traffic level.

Tertiary Pavements—Tertiary pavements include pavements used by towed or light aircraft, such as maintenance hangar access aprons, aero club parking, wash racks, and overruns (when not used as a taxiway or for takeoff or to test aircraft arresting gear). Paved shoulders are classified as tertiary. In general, any pavement that does not support aircraft taxiing under their own power or is used only intermittently is considered a tertiary pavement.

Attachment 2

4FWSP MISSION CAPABILTIY STATEMENT

Provides initial WRM equipment/vehicle capability for minor airfield pavement repairs. UTC requires specialized equipment and materials to support Prime BEEF, RED HORSE and/or other civil engineer units operating in austere locations. This deployable standardized kit contains multi-use equipment and certified materials to maintain and repair both asphaltic and/or Portland cement pavements with semi-permanent materials to include limited joint sealing capabilities. UTC consists of five 8’ x 20’ shipping containers which include: (1) 279 compact loader (w/atchs), (1) CB14 dual steel wheeled roller compactor, (1) drum concrete mixer; (1)Husqvarna walk behind saw; (1) heated asphalt mixer; (1) air compressor; walk behind router; limited quantities of rapid setting flowable fill backfill and concrete capping material, pelletized asphalt and joint sealant; various mobile maintenance repair kits (lube, oil, filter, gaskets) and mechanics tools. UTC require qualified vehicle mechanic support. Supports Open the Airbase, Operate the Airbase, and Recover the Airbase AETF Force Modules.

Attachment 3

CONTAINER DRAWINGS AND INVENTORY LISTS

Figure A3.1. Container 1.

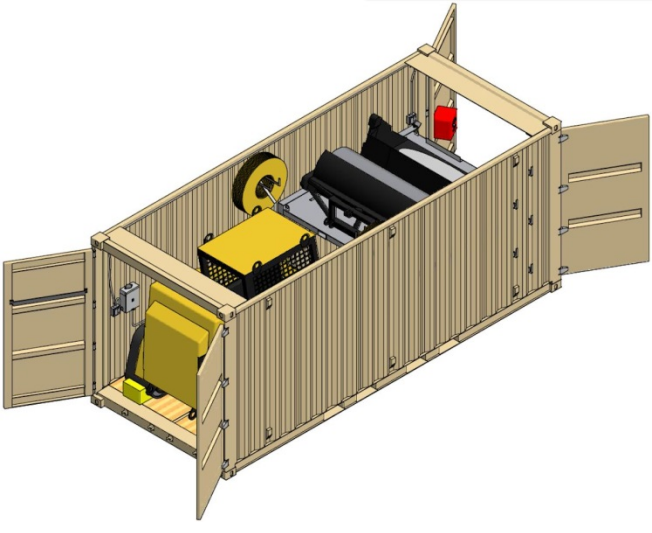

Figure A3.2. Container 1 - Top View

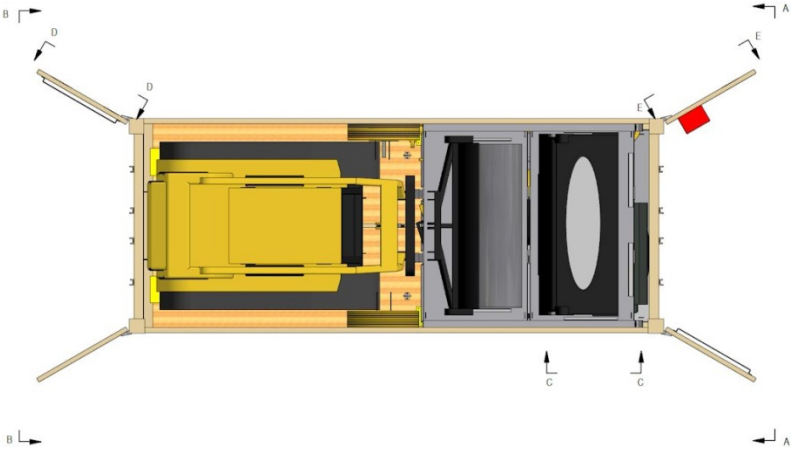

Figure A3.3. Container 1 - End View.

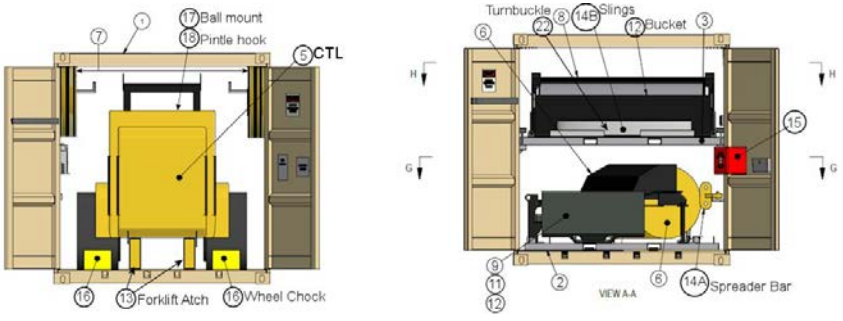

Figure A3.4. Container 1 – Top Views, Pallets.

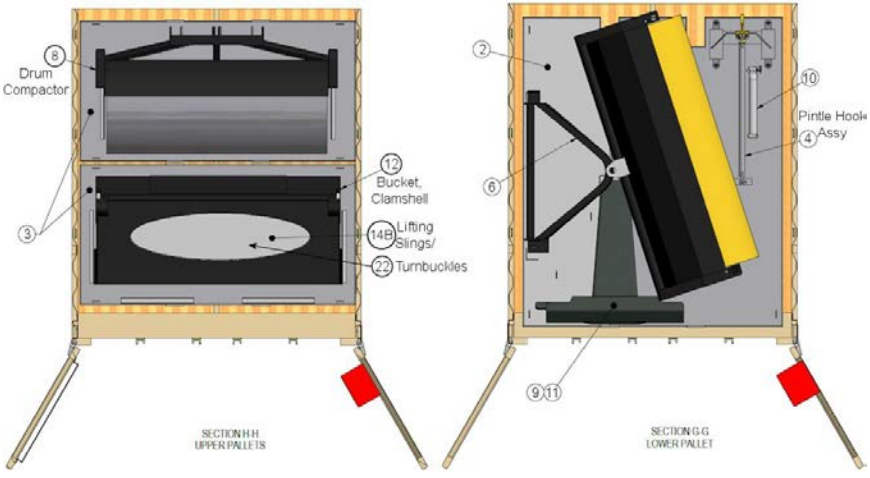

Table A3.1. Container 1 Inventory (subject to change).

PARTS LIST			
ITEM	**NOMENCLATURE**	**QTY**	**NOTES**
1	Intermodal Shipping Container	1	20-foot
2	Pallet (angle broom / hydraulic hammer)	1	
3	Pallet (bucket / compactor)	2	
4	Pintle hook assembly	1	
5	Compact Track Loader w/hose assembly, connecting lines	1	Cat P/N 378-6714
6	Broom, Angle attachment	1	Cat P/N 241-8236
7	Poly brush kit (angle broom, spare brushes)	2	Cat P/N 166-0322
8	Compactor, vibratory drum	1	Cat P/N 231-8601
9	Hammer H65D S, Pin on	1	Cat P/N 249-3161
10	Chisel tool (for hammer)	1	Cat P/N 254-1455
11	Moil tool (for hammer)	1	Cat P/N 254-1456
12	Bucket, clamshell	1	Cat P/N 279-5402
13	Fork attachment, 48” pallet w/carriage	1	Cat P/N 353-1697
14	Spreader bar lifting beam kit* (14A & 14B)	1	Heco P/N AK24A00-00A-PA
15	Kit, emergency medical, lg w/2 hook and loop straps, 1” wide (Velcro P/N 90105)	1	Swift P/N 346200
16	Wheel chock	2	MC1909
17	Ball Mount Set 2” Ball	1	CRB B26SI
18	Pintle Hook, 5-ton	1	BBC RM59
19	Strap, ratchet	19	NSN 1670-00-725-1437
20	Chain, 20-foot w/hook	4	P/N TC5162070
21	Binder, Ratchet Chain 5/16-inch	4	P/N CB150
22	Turnbuckle, Jaw Eye 1.5”x24”	4	389501NSL0029
*Item 14 kit components located in 2 locations. See Figures A3.3 and A3.4.			

Figure A3.5. Container 2.

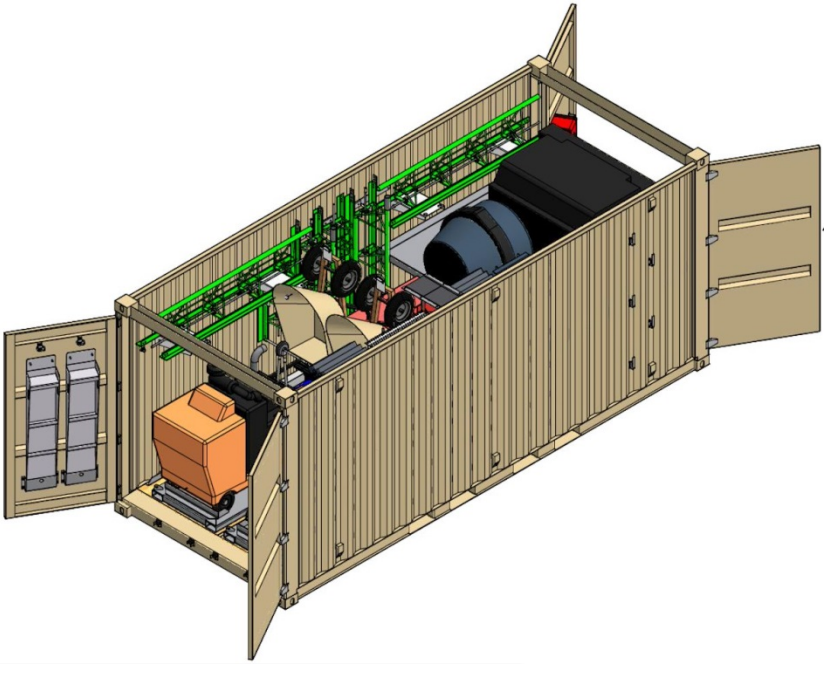

Figure A3.6. Container 2 – Top View.

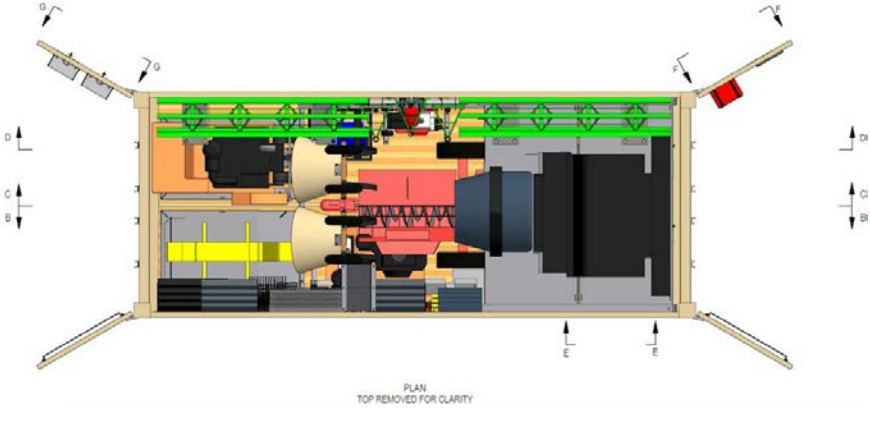

Figure A3.7. Container 2 – Left Bulkhead.

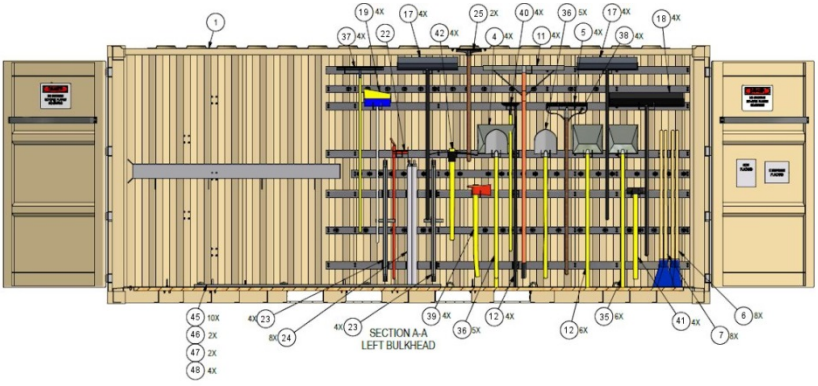

Figure A3.8. Container 2 – Center Looking Left.

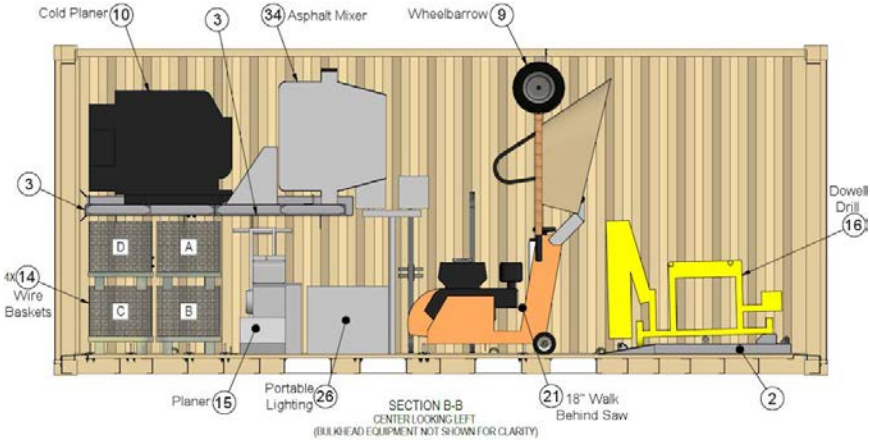

Figure A3.9. Container 2 – Center Looking Right.

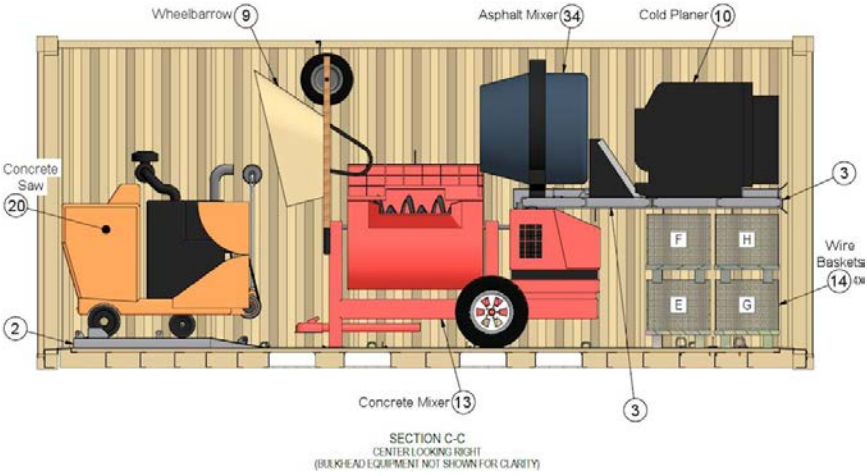

Figure A3.10. Container 2 – Right Side Bulkhead.

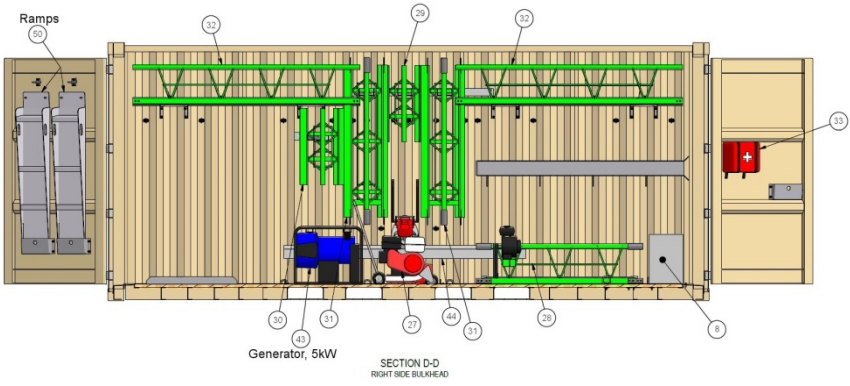

Table A3.2. Container 2 Inventory (subject to change).

ITEM	NOMENCLATURE	QTY	NOTES
1	Intermodal Shipping Container	1	20-foot
2	Pallet, equipment	2	For dowel drill / 42” walk behind concrete saw
3	Pallet, equipment	2	For cold planer attachment / asphalt mixer
4	Scoop, asphalt	4	Marshalltown 801009
5	Rake, asphalt	4	Ames 1880500
6	Scraper, 4”	8	Ames 293255
7	Scraper, 7”	8	Ames 683455
8	5/16” x 100’ chain	1	Dail’s Commercial 184536 (in 5 gal bucket)
9	Wheelbarrow, 2-wheel	2	Brentwood ACWB-19482
10	CTL attachment, cold planer	1	Caterpillar 2467315
11	Rake, lute	4	Marshalltown 24435
12	Bar, pinch	4	Council Tool 170CO
13	Mixer, concrete	1	Crown Construction Equip. S12SH-DY10
14	Wire basket (A thru H)	8	Nashville Wire WM-CJ2032161/21/2-11DSZ
15	Planer	1	EDCO CPM-8-9H
16	Drill, Dowel	1	E-Z Drill 210B-SRA
17	Broom, push	8	Cequent & Nupla 303
18	Broom, course concrete	4	Kraft & Nupla CC156 & 60” handle
19	Broom, hand	4	Cequent 476
20	Saw, concrete, walk behind 42”	1	Husqvarna 965885412 FS6600D
21	Saw, walk behind 18”	1	MK Diamond 1613H
22	Puller, stake	1	Jet #S-P
23	Float, bull	8	Kraft Tool CC803-01
24	Handle, float extension	8	Kraft Tool CC336
25	Tamper, dirt	2	Kraft Tool CC921
26	Lighting, portable	1	Lentry 200XT
27	Router, crack cleaner	1	Little Wonder 6236
28	Screed, 5’ vibratory truss w/motor	1	Multiquip WSHE50KIT11H

ITEM	NOMENCLATURE	QTY	NOTES
29	Screed, LH 2.5” vibratory truss	1	Multiquip WSHESPW(L)
30	Screed, RH 2.5” vibratory truss	1	Multiquip WSHESPW(R)
31	Screed, 5’ vibratory truss	2	Multiquip WSHE50
32	Screed, 7-1/2” vibratory truss	2	Multiquip WSHE75
33	Kit, emergency medical, lg w/2 hook and loop straps, 1” wide (Velcro P/N 90105)	1	Swift P/N 346200
34	Rotary drum asphalt mixer	1	NiTech Asphalt Mixer
35	Shovel, flat head	12	Nupla 72-071
36	Shovel, round head	10	Nupla 74-016
37	Placer, concrete	4	Nupla 36-316
38	Rake, bow	4	Nupla 69-616
39	Axe, pick head	4	Nupla 31-687
40	Hoe, mortar mixing	4	Nupla 69-366
41	Hammer, sledge 12 lb	4	Nupla 27-212
42	Mattock, pick	4	Nupla 24-151
43	Generator, gas, 6 kW	1	Tsurumi TPG3-6000HDX
44	Wet Screed w 8ft blade	1	MBW 500H/17808 Blade
45	Wire, electric – 10ft	1	GrayBar THHN-6-STR-BLK
46	Ground rod	2	Erico 815880
47	Clamp	2	Erico CP58
48	Mechanical lug	4	Burndy KA6U
49	Chain, 20 ft with hooks, 1/4-in	5	CR-279576
50	Ramp	2	
51	Binder, Ratchet Chain, 1/4”	5	P/N CB 135
52	Strap, ratchet, 20 ft	44	Kinedyne NSN 1670-00-725-1437
53	Skid, slide-in	2	For dowel drill & 48” saw
54	Skid, slide-in	2	For asphalt mixer & planer

Table A3.3. Container 2 – Wire Basket Contents.

NOMENCLATURE	QTY	NOTES
Wire Basket A		
Strap, ratchet, 20 ft	12	NSN 1670-00-725-1437
30” pry bar	4	NSN 5120-00-293-0665
Mixing paddle, cake beater	6	NSN 3895-00-234-3098

NOMENCLATURE	QTY	NOTES
Vibratory shaft, 7’ long	1	Multiquip FS7; part of BP25H
Vibratory head 15.25” long	1	Multiquip 1400HD; part of BP25H
Dual shaft hand mixer with (2) paddles	2	Collomix, XO 55 DUO
3/4” Hexafix Dr, 5-1/2” dia mixing paddle	2	Collomix, MKD140HF
Quickie scrub brush	1	NSN 7920-00-282-2470
Single shaft hand mixer with (1) paddle	1	Collomix, XO6
Wire Basket B		
Steel concrete form stakes, 24” w/holes	20	Dails Comm. 3424CFS
Wire tie, steel reinforced 400’	1	LH Dottie TY-164 (515RW)
1-1/4” x 18” Epoxy Dowel	100	Whitlock Bros DO3253
Metal dowel chairs 5” w/plate	82	Whitlock Bros 73228
Wire Basket C		
Strap, ratchet, 20 ft	10	NSN 1670-00-725-1437
Strapping and sealing kit	1	3540-00-565-6244
1-1/4” Dowel cap	250	Whitlock Bros 60025
Metal dowel chairs 5” w/plate	82	Whitlock Bros 73228
Wire Basket D		
Kraft adjustable tilt for float	8	NSN 5120-01-274-9917
12” Mag float	4	Kraft Tool CF012
16” Mag float	4	NSN 5120-00-106-2690
18” Mag float	6	Kraft Tool CF018
16” Concrete trowel	4	Kraft Tool CF221
12” Concrete trowel	4	Kraft Tool CF212
6X2 3/4 Brass concrete edger	6	NSN 5120-01-473-9955
6X4-1/2 Brass concrete joiner	6	NSN 5120-00-640-6511

NOMENCLATURE	QTY	NOTES
Wire Basket E		
Tow chains, 20’ X 5/16”	2	Dails Comm. 513578
Replacement teeth 50 pack	10	Cat 149-5763
Tow straps 20’	4	Dails Comm. 2922
Wire Basket F		
Water hose 5/8” X 100ft	4	NSN 4720-01-447-8757
Water hose 5/8” X 25ft	4	Dails Comm. 8695-25
Wire Basket G		
Forney MIG welder	1	NSN 5130-01-522-1379
Welding helmet	1	NSN 4240-00-540-0623
Large welding gloves	2	NSN 8415-01-568-0008
0.030 MIG wire roll, 2 lb	4	Dails Comm. 30055
Extension cord 100’	5	Coleman 25890002
0.032 Spacer saw walk-behind 18” GP	2	Husqvarna, 541202367
0.064 Spacer saw walk-behind 18” GP	2	Husqvarna, 541202368
1-1/4” Grout retaining rings	100	Whitlock Bros, 60074
20 ft Jumper cables	1	Grote 84-9278
Wire Basket H		
14” GP 5/8 Routing blade (for 18” saw)	2	Husqvarna, 542751005
End handle kit set of 2	1	NSN 5340-01-624-3409
Screed dolly	2	Multiquip 36243, part of NSN 3895-01-461-7069
Hand crank option	1	Multiquip SHW
25 ft Extension cord	4	NSN 6150-00-485-6149
1-ft Adaptor	4	Cable Exchange, CAX-L5-20-L5-30-125V-1

Figure A3.11. Container 3.

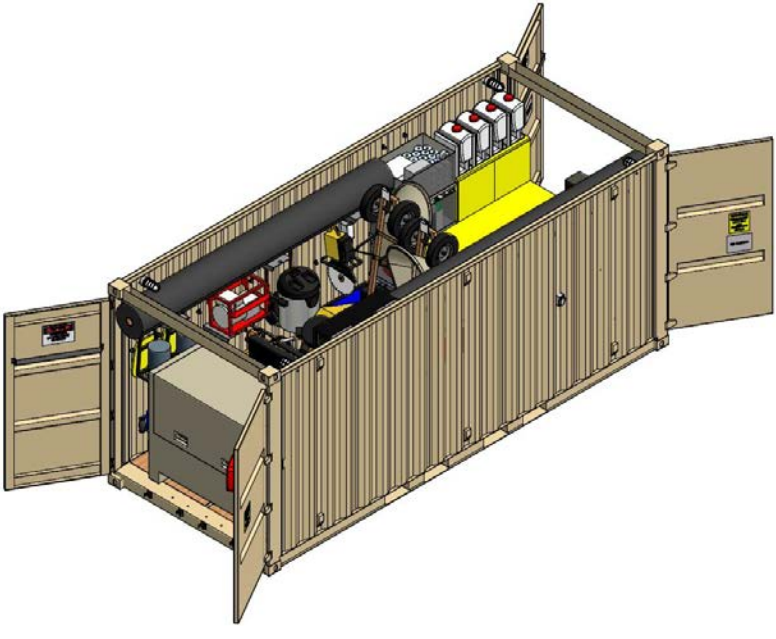

Figure A3.12. Container 3 – Top View.

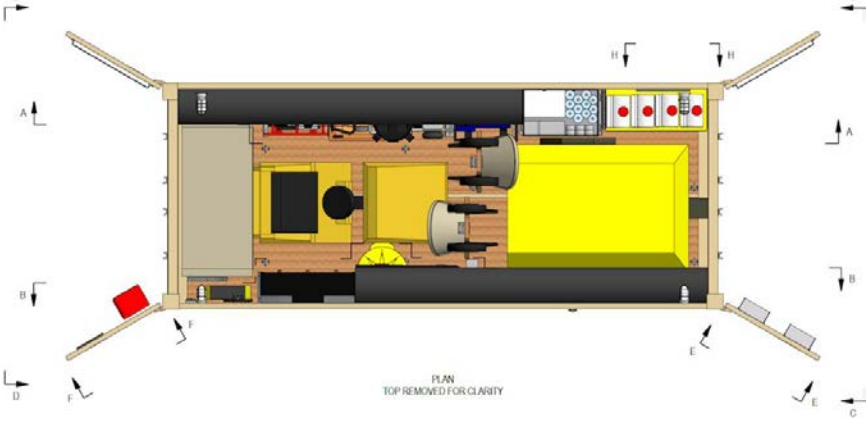

Figure A3.13. Container 3 – End View.

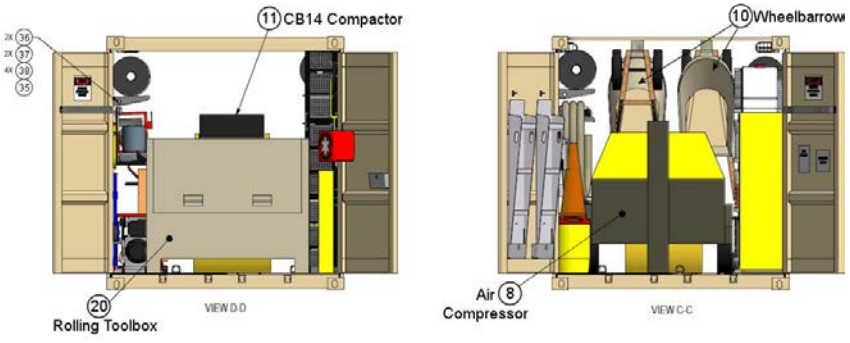

Figure A3.14. Container 3 – Right Bulkhead.

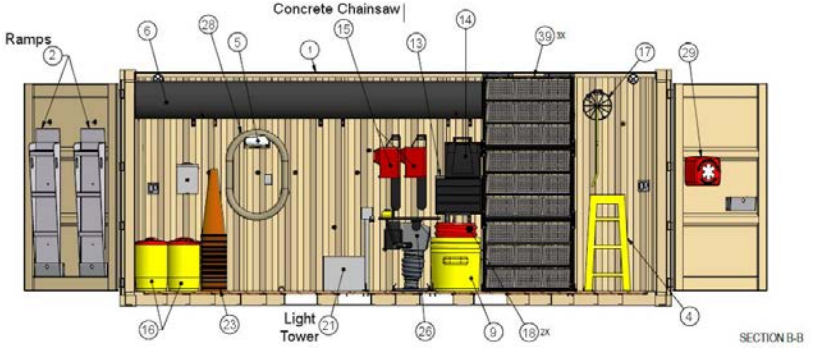

Figure A3.15. Container 3 – Left Bulkhead.

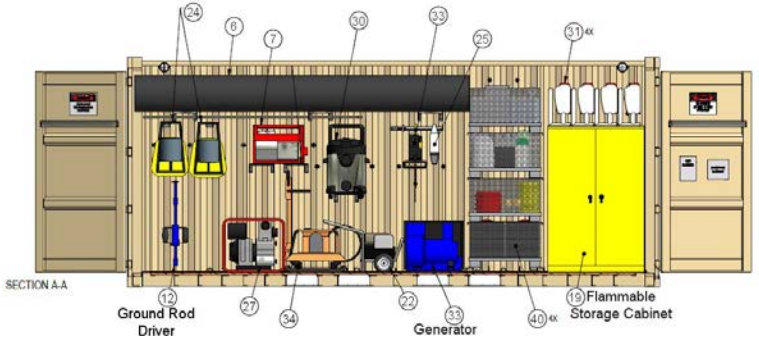

Table A3.4. Container 3 Inventory.

ITEM	NOMENCLATURE	QTY	NOTES
1	20’ x 8’-6” Container	1	
2	Ramp	2	
3	Strap, ratchet 20 ft	37	NSN 1670-00-725-1437
4	3 ft fiberglass step ladder	1	Werner 7303S, type IAA
5	Discharge hose, 3”x 50’	1	Abbott Rubber 1130-3000-50-CE
6	Geotex Roll	2	Non-Woven Geotextile, 12.5’x360’
7	55 gal drum pump sprayer	1	Allen Eng 7560XL (029424)
8	Air compressor	1	Atals Copco XAS 185 JD7
9	Spill kit; 20 gal lab pack	1	Brady SKO-20 (oil only)
10	Wheelbarrow, 2 wheel	2	Brentwood ACWB-19482
11	CB14 Compactor	1	Caterpillar 323-8279
12	Ground rod driver	1	Condux 18000010 (5.8-in, 25 lb)
13	Hardware box	1	Hillman, nails, screws, nuts
14	Backpack blower	1	Husqvarna 350BT
15	Concrete chain saw	2	ICS Blount 680GC
16	5 gal water cooler	2	Igloo 11863
17	Measuring wheel	1	Johnson 1801-0300
18	3/4-inch x 50-foot air hose	2	HBD Industries 11456258
19	Flammable storage cab.	1	Justrite 894520 (see Table A3.6)
20	Rolling toolbox	1	Knaack 1000 (see Table A3.7)
21	Retractable light tower	1	Lentry 200XT
22	Power washer	1	Mi-T-M JP-2403-OMAB, 2400 psi
23	18” Safety orange cones	20	MSA Safety Works 10073409
24	backpack vibrator motor	2	Multiquip Inc. BP25H (gasoline)
25	Hand concrete vibrator	1	Multiquip MGX13810
26	Rammer	1	Multiquip MTX80SD
27	Trash pump	1	Multiquip QP3TZ
28	Suction hose 3” D x 25 ft	1	Multiquip HAQ325
29	Emergency medical kit	1	Swift 346200 (large)
30	Wet/dry vac, 16 gal	1	SHOP VAC 9553600 (6.5 peak hp)
31	Backpack sprayer	4	Solo-Horton 473D-ECS
32	K1260 16” hand held saw	1	Husqavarna 966003501
33	Generator, 6 kW	1	Tsurumi TPG4-6000HDX
34	Plate compactor	1	Chicago Pneumatic MV100A
35	Wire cut reel 10ft	1	Graybar THHN-6-STR-BLK
36	Ground rod	2	Erico 815880

ITEM	NOMENCLATURE	QTY	NOTES
37	Acorn Clamp	2	Erico CP58
38	Mechanical lug	4	Burndy KA6U
39	Basket locker (2 locking bars w/push pins)	1	See Table A3.5
40	Wire basket	4	See Table A3.8 for contents
41	Binder, Ratchet Chain,	3	CB135 (1/4-inch)
42	Binder, Ratchet Chain,	4	CB150 (5/16-inch)
43	Chain, Tie Down	3	CR-279576 (1/4-inch w/hooks)
44	Chain, Tie Down	4	TC5162070 (5/16-inch w/hooks)

Table A3.5. Container 3 – Basket Locker Contents.

NOMENCLATURE	QTY	NOTES
Basket Locker 1A		
Sawzall blade, 5 PK	1	Milwaukee 48-00-5706
Belt for CP8-9H	1	Edco 81007
Filter for CP8-9H	2	Honda 17210-ZE3-505
Spark plug for CP8-9H	2	NGK BPR6ES
Pull rope for CP8-9H	1	Honda 28462-ZE2-W11
Glow sticks	20	Life Gear LG151
Basket Locker 1B		
Spark plug for K1260 saw	1	Husqvarna 503235109
Air filter kit for K1260 saw	1	Husqvarna 510244103
Belt for K1260 saw	1	Husqvarna 544976301
Basket Locker 1C		
Angle brackets	2	Husqvarna 5421993-65
Air filter	1	Husqvarna 5421911-16
Belt	2	Husqvarna 5052832-01
Fuel filter	1	Multiquip 959300770
Spark plug	1	Multiquip 650140580
Air filter	1	Multiquip 66010080
Pre-filter element	1	Multiquip 366010070

NOMENCLATURE	QTY	NOTES
Basket Locker 2A		
Small water sump pump	1	MTA SIMER 2305-04
Water flow kit	1	Pentair WFK2
Basket Locker 2B		
Filter AS water sep, 2 PK	1	Cat 233-9856
Filter AS Engine Oil, 6 PK	1	Cat 267-2528
Basket Locker 2C		
Service kit for MV100A	1	Chicago Pneumatic 338210000001
Starter rope for compactor	1	Chicago Pneumatic 4700239374
Fuel filter #1 for compactor	4	Honda 16955-ZE1-010
Fuel filter #2 for compactor	4	Honda 17672-ZE2-W01
Basket Locker 3A		
Air compressor maintenance kit	1	Atlas Copco 609530
Air wand for compressor	1	Legacy Manf. AG632-BG-GRA
Basket Locker 3B		
Container Light	20	GE 75A/RS/STGPQ/1620
Basket Locker 3C		
Light bulbs, 650W for light tower	4	Lentry FCM-HIRQ-650T3
Spark plug for light tower	2	Lentry 98056-54777
Air filter 1 for light tower	5	Lentry 17211-Z07-000
Air filter 2 for light tower	5	Lentry 17218-Z07-000
Starter rope for light tower	2	Lentry 28462-Z07-004
Fuel filter 1	5	Lentry 16952-ZA8-800
Fuel filter 2	5	Lentry 17670-Z07-R30
Basket Locker 4A		
Spark plug	1	MK Diamond 543 047 852
Belt 633 PK 12 (160772 premium)	1	MK Diamond 543 044 964
Filter, washer	1	MK Diamond 542 045 640
Water tank strap assembly	1	MK Diamond 158094

NOMENCLATURE	QTY	NOTES
Basket Locker 4B		
5/8” hose repair kit	4	Westward 4KG68
Flow meter	2	Great Plains 113255-4
Water hose nozzle trigger	2	Gilmour 572TFR
Water cut-off valve – 3/4”	2	Apollo Valve 7010401
Basket Locker 4C		
Efficiency (hydraulic) filter 6 pk	1	Cat 1G-8878
Basket Locker 5A		
Blade shaft belt 18”	1	Husqvarna 542166629
Blade shaft belt 20”	1	Husqvarna 542166629
Back wheel	1	Husqvarna 542198842
Engine Pulley	1	Husqvarna 166366
Basket Locker 5B		
Blade collar outer flange 4-1/2”	1	Husqvarna 163172
Blade collar outer flange 5”	1	Husqvarna 166307
Drive pin 18-30 mm	1	Husqvarna 505531901
Drive pin 36-42 mm	1	Husqvarna 53900010
Blade shaft bolt LH	1	Husqvarna 542163488
Blade shaft bolt RH	1	Husqvarna 542163487
Blade shaft wrench	1	Husqvarna 539300133
Engine oil filter	1	Husqvarna 542199460
Hydraulic oil filter	1	Husqvarna 542166449
Fuel filter	1	Husqvarna 5421199461
Knob	1	Husqvarna 542166038
5 amp fuse	3	Husqvarna 542166857
30 amp fuse	3	Husqvarna 542198815
Key, ignition (set of 2)	2	Husqvarna 166854
Blade collar outer flange 6”	1	Husqvarna 542163272
Basket Locker 5C		
Blade shaft belt 26”	1	Husqvarna 542166629
Blade shaft belt 36”	1	Husqvarna 542166629

NOMENCLATURE	QTY	NOTES
Blade shaft belt 30”	1	Husqvarna 542166362
Blade shaft belt 42”	1	Husqvarna 542199764
Blade collar outer flange 7”	1	Husqvarna 5421199378
Front wheel	1	Husqvarna 191770
Basket Locker 6A		
Chain saw blade 12”	8	ICS Blount 71400
Basket Locker 6B		
Spark plug for chain saw	2	ICS Blount 73199
Decompression valve for chain saw	2	ICS Blount 71642
Rim sprocket for chain saw	2	ICS Blount 70949
Chain saw tensioner	2	ICS Blount 73935
Clutch cup for chain saw	2	ICS Blount 71520
Cover clamp nut for chain saw	4	ICS Blount 73958
Starter rope for chain saw	1	ICS Blount 73904
Fuel filter for chain saw	6	ICS Blount 73459
Air filter gasket for chain saw	3	ICS Blount 71756
Prefilter for chain saw	6	ICS Blount 73336
Air filter for chain saw	6	ICS Blount 71752
Clutch needle bearing for chain saw	3	ICS Blount 73979
Basket Locker 6C		
Impeller assy for trash pump	1	Multiquip 2367040033ASSY
Fuel filter kit for trash pump	3	Multiquip 1635210
Key for switch 14644 (trash pump)	2	Multiquip 50404900
Cable throttle assy for trash pump	1	Multiquip 510229
Basket Locker 7A		
Advance efficiency filter, 6 pk	1	Cat 144-6691
Basket Locker 7B		
Mixer maint. kit for 12SH-DY10	1	Crown Const. 609530-A
Basket Locker 7C		
Air filter for Screed Demon	1	Honda 17211Z0Z000
Spark plug for Screed Demon	1	NGK CMR5H

NOMENCLATURE	QTY	NOTES
Fuel filter for Screed Demon	1	Honda 16035ZM3802
Thermometer	4	Greenlee Textron TG-1000
Basket Locker 8A		
Filter for pressure washer	1	Honda 17210-2E1-517
Pull rope for pressure washer	1	Honda 28462-ZH8-003
Spark plug for pressure washer	1	Honda 98079-55846
Pump saver fluid, 6 oz	1	MI-T-M AW-4070-0004
O-rings, 3/8, for pressure washer	1	MI-T-M AW-0025-0123
O-rings, 1/4, for pressure washer	1	MI-T-M AW-0025-0122
Pressure washer nozzle set	1	MI-T-M AW-4003-0000
Basket Locker 8B		
Spark plug	1	Multiquip 9807955846
A/C element	2	Multiquip 17210ZE2515
Governor spring	2	Multiquip 16561ZE2000
Screed spare belt	2	Multiquip 2422B41
Air filter combo 17210-ZE3-505	1	Honda 100-012
NGK spark plug BPR6ES	1	Honda 130-823
Basket Locker 8C		
Air cleaner element	1	Multiquip 17211ZM7000
Spark plug	1	Multiquip 9805655777
Light bulb	1	Cat 378-6901
Basket Locker 9A		
Harness	1	Cat 398-3530
Filter element AS, 4 pk	1	Cat 139-4834
Filter element air, 4 pk	1	Cat 234-9828
V-belt (alt, water pump) 4 pk	1	Cat 183-3942
Filter AS engine oil, 2 pk	1	Cat 220-1523
Replacement spray nozzle (3)	6	Cat 812948 (for CB14)
Spare keys for CB14	1	Cat 8H5306 & 5P8500
Basket Locker 9B		
Saw blade, circular, 7-1/4” kit	1	Freud D0724A

NOMENCLATURE	QTY	NOTES
Paint brush	6	Wooster FS119-4
Basket Locker 9C		
THE-M16 Manual epoxy dispenser	1	Hilti 428532
Note: *The baskets are held in place during shipment with two 1/8" x 2" x 7.5' aluminum locking bars with locking pins wired to the bars.*		

Table A3.6. Container 3 – Flammable Locker Contents.

NOMENCLATURE	QTY	NOTES
E-Z Drill Oil	1	Dails Commercial 180VEG100
XAS185JD7 Compressor air filter	1	Atlas Copco 1310033926
XAS185JD7 Compressor air filter	1	Atlas Copco 1310030160
Jack hammer oil	1	Dails Commercial 250ml
Burner head, 7 pc, torch kit	2	UL125FB
Filter element AS-Air (4-PK)	3	Caterpillar 110-6326
Measuring cup	2	Grainger 2YU29
THE-50 Epoxy dowel (16oz/473ml)	4	Hilti 3451468
Air filter	1	Husqvarna 5421911-16
Chain saw bar 12"	8	ICS Blount 71395
Fuel can, 3 gal	2	Just Rite 7225120
Fuel can, 5 gal	2	Just Rite 7250130
Propane tank, empty	2	Manchester RF1LB
Diesel fuel can 5 gal	2	Midwest 8600-5 GAL
Gas Fuel can, 5 gal	4	Midwest 5600-5 Gal
Funnels	4	Miller MFG CO 100021
Grease gun	2	Alemit 1056-LE4
Barrel pump	1	Legacy L3000
Heavy duty adhesive	2	Liquid Nails LNP-901
Flex Spout 16"	4	

Table A3.7. Container 3 – Rolling Tool Box Contents.

Nomenclature	Qty	Vendor
1-3/8" Bit	6	E-Z Drill B801
Pipe wrench 1/4" – 3"; 24 LG	1	Armstrong 73-024
Pipe wrench 1/4" – 2"; 14" LG	1	Armstrong 73-014
Pipe wrench 1/8" – 1-1/2"; 10" LG	1	Armstrong 73-010
Pneumatic chisel	1	Chicago Pneumatic CP4123
Tex150 PE Jack, Hammer, 30 lb	1	Atlas Copco 8461022335

Nomenclature	Qty	Vendor
Tex90S jack, Hammer, 90 lb	1	Atlas Copco 8461022822
Moil, chipping hammer (CP0012)	2	Chicago Pneumatic 3083412010
Chisel, chipping hammer (CP0012)	4	Chicago Pneumatic 3083412100
Chisel, 30 lb Hammer (TEX150PE)	4	Chicago Pneumatic 3083330900
Chisel (TEX90S)	4	Chicago Pneumatic 3083326800
Air compressor, 2 gal, 150 psi max	1	Dewalt D55141
GuardAir 24” safety air gun	2	GuardAir LZR600024AA
Wood folding ruler	2	Cooper Tools X46F
General Tool Kit	1	Snap On
Self-leveling rotary laser level	1	David White 48-3110GR-2
Hand drill, corded	2	Dewalt DWD215G
18V Cordless XRP 6-Tool Kit	1	Dewalt DWD655X
Pneumatic Hose O-ring	4	Dixon AWR4
45 PC Drill & Drive Set	1	Montana Brand MB-065944
Hammer Drill	1	Hilti 3468366
(19”) Pointed Chisel	4	Hilti 282265
(19”) Flat self-sharpening chisel	4	Hilti 282269
(19”) Wide self-sharpening chisel	4	Hilti 282275
TE-Y Chisel Clay spade	4	Hilti 382278
Putty knives	5	Hyde 2000
Metal snips, 3 pc	1	Irwin M1RM2RM3R
Chalk line	1	Irwin 2031319DS
Level 2 ft	1	Sands SLHD24
Level 4 ft	1	Sands SLHD48
Measuring tape, 100ft	2	Klein Tools Inc 946-100
Screwdriver set	1	Klein Tools Inc 85076
Ballpeen hammer, 12 oz	1	Klein Tools Inc 803-12
Heavy duty hammer, 16 oz	1	Klein Tools Inc 808-16
Doubleface hammer, 36 oz	1	Klein Tools Inc 809-36
Adjustable wrench, 15”	1	Klein Tools Inc 506-15
Adjustable wrench, 8”	1	Klein Tools Inc 507-8
Adjustable wrench 6”	1	Klein Tools Inc 507-6
Bolt cutter	1	Klein Tools Inc 63130
String	4	Marshalltown 16581
Sawzall, reciprocating saw w/case	1	Milwaukee Elec Tool 6509-31
Circular saw, corded	1	Milwaukee Elec Tool 6390-20
1/4” X 50’ air hose	1	Coilhose S14-50B

Nomenclature	Qty	Vendor
Caulking gun	4	Newborn 112D Caulking Gun
Large caulk gun	4	Newborn 125
Line level	7	Johnson 555
Battery jumppack	1	Schumaker PSJ-2212
Metric wrench set	1	Williams MWS-18A
19” All-purpose toolbox, black	2	Stack-On SHB19
1/2” X 300ft Measuring tape	1	Lufkin FE300D
30 ft Measuring Tape	6	Stanley 33-730
Utility knife	6	Stanley 10-099
3/16” – 200 ft Pull rope	1	Stens 146-955
Bucket opener	5	Allway PPO 11350 6

Table A3.8. Container 3 – Wire Basket Contents.

Nomenclature	Qty	Notes
WIRE BASKET W1 CONTENTS		
Duct tape	19	LH Dottie DT260
Trash bags, 42 gal	4	Berry Plastic CCB720
Paper towels	12	Kimberly Clark 75180
Rags	1	LH Dottie RGZ25
WIRE BASKET W2 CONTENTS		
Knee pads	5	Kraft WL083
Disposable gloves	1	Showa Best 7005L
Foam ear, 100 pr	2	MSA10059484
Safety glasses	12	MSA 817697
Safety glasses	24	MSA 10006315
Hard hat	12	MSA 818066
Face shield	4	MSA 10103487
Ear Muffs	4	MSA 10033236
Work gloves	24	Midwest Gloves 608
Duct tape	5	LH Dottie DT260
WIRE BASKET W3 CONTENTS		
Safety wire	1	Dixon WB3
100ft Extension Cord	5	Coleman 25890002
3/4” x 50’ Air Hose	4	HBD Ind 11456258
LED Solar Beacon	8	Lab Safety 143824
Stiff Bristle Brush	4	Rubbermaid X171-0654109

Nomenclature	Qty	Notes
WIRE BASKET W4 CONTENTS		
Filter element AS-Air (4-pk)	1	Caterpillar 110-6326
3/4” x 50’ Air Hose	2	HBD Ind 11456258
Size 13 Muck Boot	8	Onguard 866061333

Figure A3.16. Container 4.

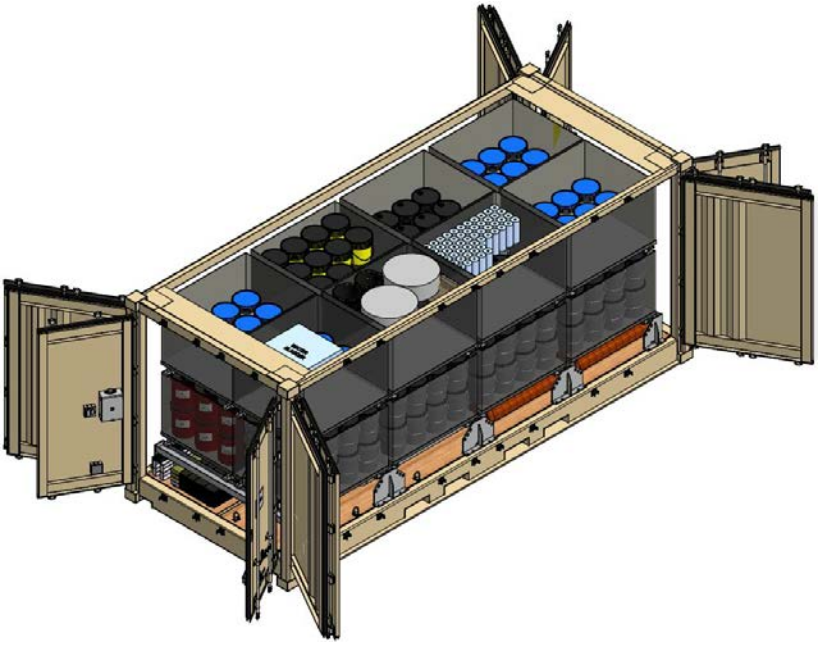

Figure A3.17. Container 4 – Elevation View.

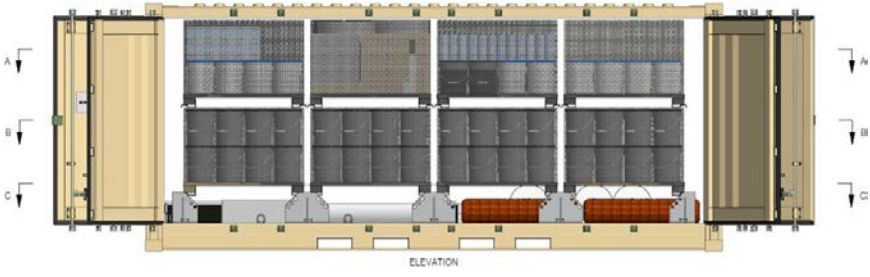

Figure A3.18. Container 4 – Overhead View, Top Level.

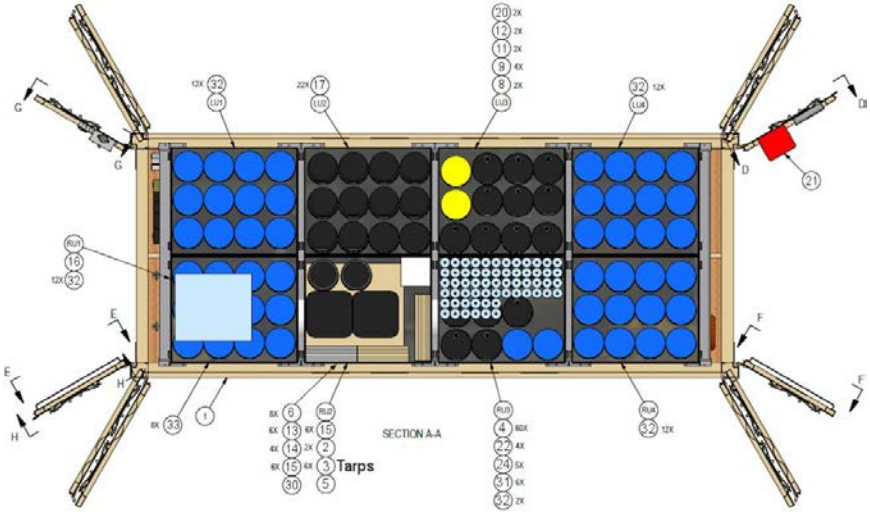

Figure A3.19. Container 4 – Overhead View, Middle Level.

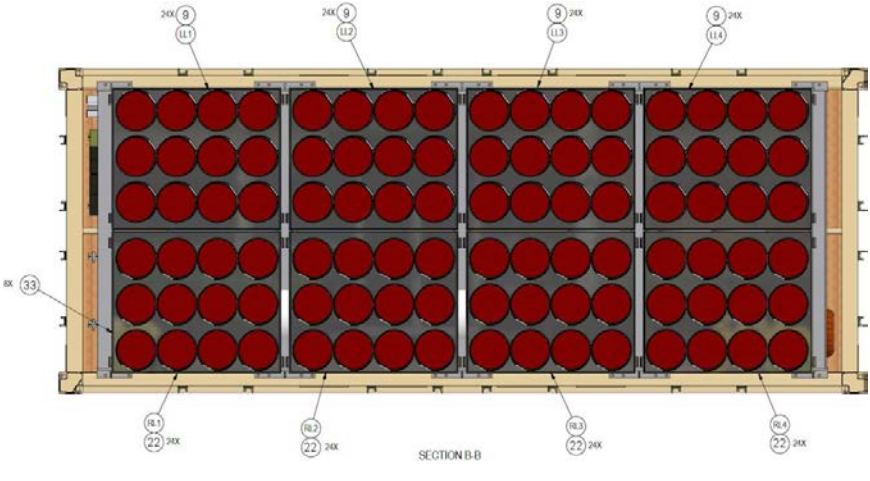

Figure A3.20. Overhead View, Bottom Level.

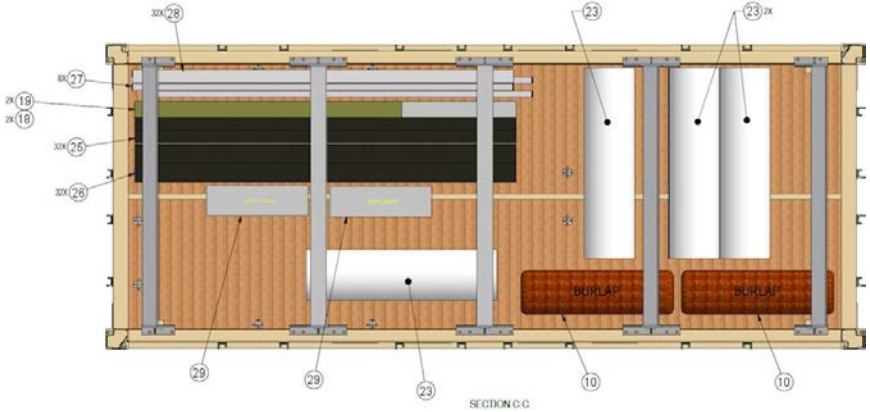

Table A3.9. Container 4 Inventory.

ITEM	NOMENCLATURE	QTY	NOTES
1	Container, full access	1	
2	3/4” closed cell backer rod, 100’ roll	2	CR Laurence EF34C
3	10’x20’ Heavy duty silver/ black poly tarp	6	Tarp Supply Inc SB1020
4	Paper towel roll	60	Kimberly Clark 75180
5	Rags	1	L H Dottie Co RGZ25
6	Pail, utility, 5 gal	8	Leaktite B5GSKD
7	Strap, ratchet, 20 ft	44	NSN 1670-00-725-1437
8	Release agent (asphalt) 5 gal	2	Dails Comm 5RA or EQ Black Magic
9	Repair material (spall) 5 gal	100	CTS rapid set concrete mix
10	Burlap roll	2	Dayton Burlap
11	Citric acid, bucket 5 gal	2	Dails Comm CA5G
12	Curing compound 5 gal	2	Whitlock Bros
13	Blade, saw 24” (walk behind)	6	Carter Waters 542758945
14	Blade, saw 36” (walk behind)	4	Carter Waters 542758956
15	Blade, saw 18”	12	Carter Waters 542751097

ITEM	NOMENCLATURE	QTY	NOTES
16	Bladder, water 250 gal	1	Interstate products RC-GB-WB250-WAP
17	Cold patch, repair 5 gal	22	Dails Comm 5CP
18	Screed straight edge	2	Kraft Tool Special M [2X5-10’]
19	Screed straight edge	2	Kraft Tool Special M [2X5-7’]
20	Release agent (concrete) 5 gal	2	Whitlock Bros LR-5
21	First aid kit	1	Dails Comm 346200
22	Asphalt (5 gal)	100	Nitech 50 FG-NDGB
23	Steel, reinforcing roll	4	Whitlock Bros 5150RW
24	Tac Kote 5 gal	5	Dails Comm 5TC
25	Expansion board, 4”x1/2”x10’	32	Whitlock Bros EJ-4
26	Expansion board, 6”x1/2”x10’	32	Whitlock Bros EJ-6
27	Form, concrete 4”X10’ lg	8	Whitlock Bros M1304
28	Joint repair caps 10ft	32	Whitlock Bros WS-941
29	Screening, plastic roll	2	Whitlock Bros 620C
30	Wire, steel reinforcement tie (roll)	1	Dails Comm TW-WA16X6MARMCB5
31	Concrete expansion joint sealant	6	Whitlock Bros SIKAFLEX 1C SL
32	Flowable fill 5-gal	50	Buzzi-unicem utility fill 750 one-stop
33	Basket, 50”Wx42”Dx36”H	16	

A3.21. Container 5.

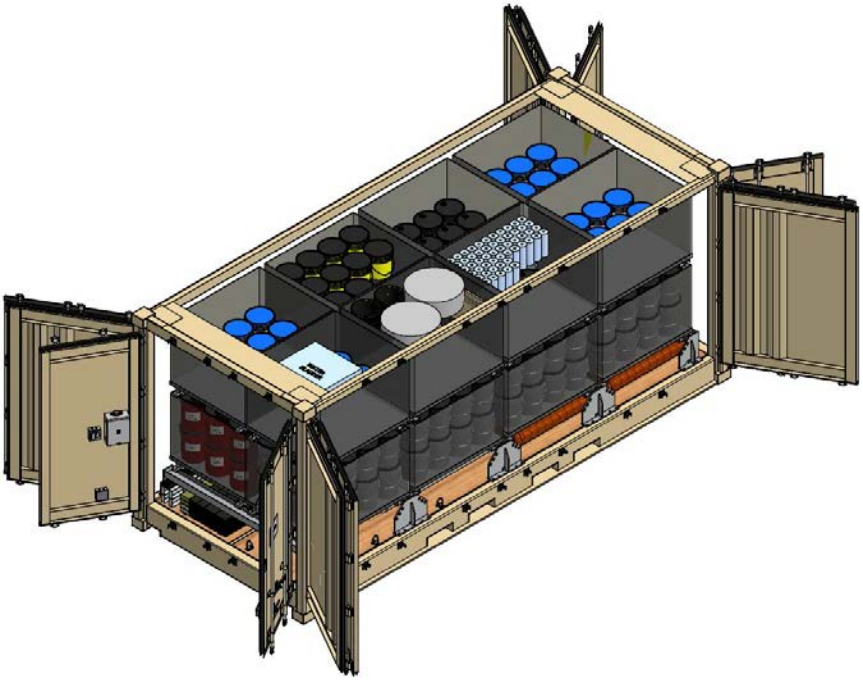

Figure A3.22. Container 5 – Elevation View.

Figure A3.23. Container 5 – Overhead View, Top Level.

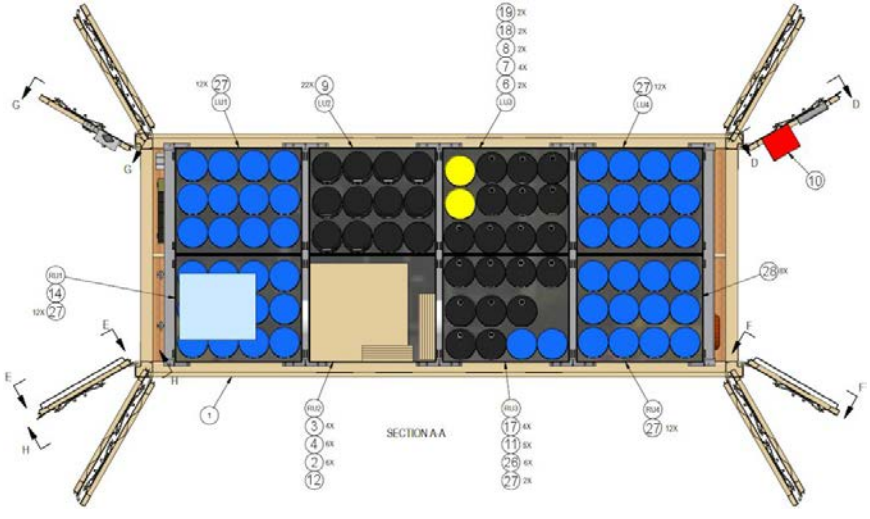

Figure A3.24. Container 5 – Overhead View, Middle Level.

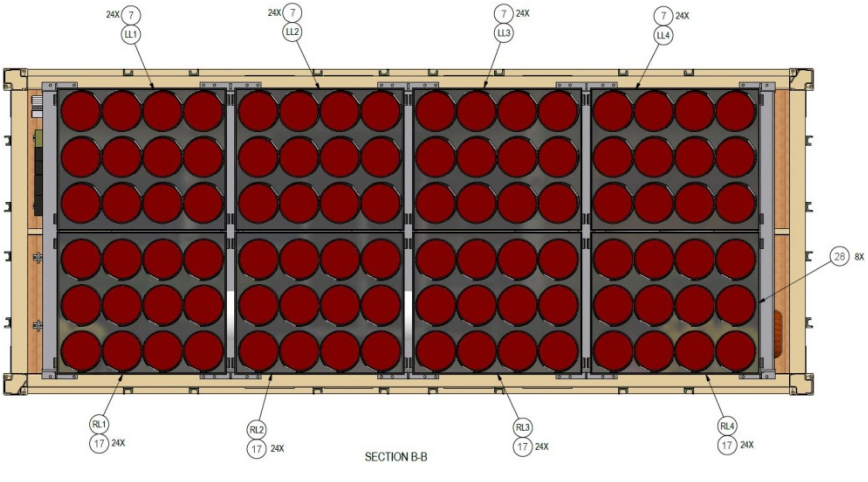

Figure A3.25. Container 5 – Overhead View, Bottom Level.

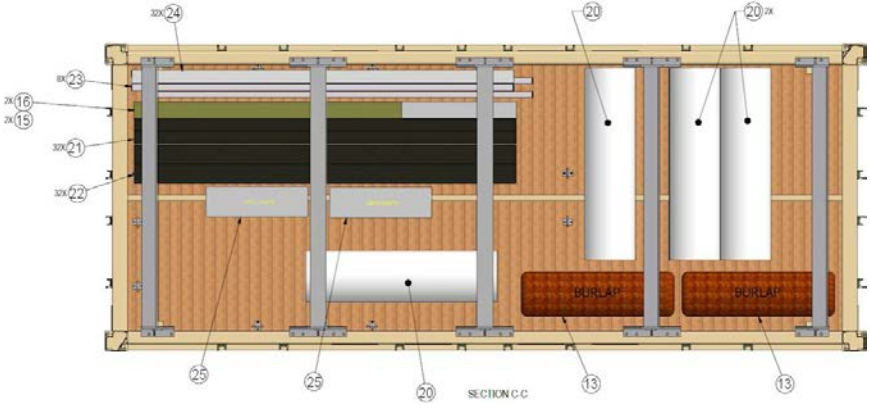

Table A3.10. Container 5 Inventory.

ITEM	NOMENCLATURE	QTY	NOTES
1	Container, full access	1	
2	Blade, saw 24” (walk behind)	6	Carter Waters 542758945
3	Blade, saw 36” (walk behind)	4	Carter Waters 542758956
4	Blade, saw 18”	6	Carter Waters 542751097
5	Strap, ratchet, 20 ft	44	NSN 1670-00-725-1437
6	Release agent (asphalt) 5 gal	2	Dails Commercial 5RA or EQ Black Magic
7	Repair material (spall) 5 gal	100	CTS rapid set concrete mix
8	Citric acid, bucket 5 gal	2	Dails Commercial CA5G
9	Cold patch, repair 5 gal	22	Dails Commercial 5CP
10	First aid kit	1	Dails Commercial 346200
11	Tac Kote 5 gal	5	Dails Commercial 5TC
12	Wire, steel reinforcement tie (roll)	1	Dails Commercial TW-WA16X6MARMCB5
13	Burlap roll	2	Dayton Burlap
14	Bladder, water 250 gal	1	Interstate products RC-GB-WB250-WAP
15	Screed straight edge	2	Kraft Tool Special M [2X5-10’]
16	Screed straight edge	2	Kraft Tool Special M [2X5-7’]

17	Asphalt (5 gal)	100	Nitech 50 FG-NDGB
18	Curing compound 5 gal	2	Whitlock Bros
19	Release agent (concrete) 5 gal	2	Whitlock Bros LR-5
20	Steel, reinforcing roll	4	Whitlock Bros 5150RW
21	4”x1/2”x10’ Expansion board	32	Whitlock Bros EJ-4
22	6”x1/2”x10’ Expansion board	32	Whitlock Bros EJ-6
23	Form, concrete 4”X10’ lg	8	Whitlock Bros M1304
24	Joint repair caps 10ft	32	Whitlock Bros WS-941
25	Screening, plastic roll	2	Whitlock Bros 620C
26	Concrete expansion joint sealant	6	Whitlock Bros SIKAFLEX 1C SL
27	Flowable fill 5-gal	50	Buzzi-unicem utility fill 750 one-stop
28	Basket, 50”W x 42” D x 36” H	16	

Table A3.11. Container Rearrangement Actions.

Step	Nomenclature/(Item #)	Cont.	Action
1	CTL w/forklift attch. (12/13)	1	Back out of cont. 1 and use for lifting/moving items
2	Rolling tool box (43)	3	Move to cont. 1, CTL position
3	Roller (34)	3	Move to covered storage
4	Upper pallet (10/25/49)	2	Move to covered storage
5	Wire baskets (29-8 ea)	2	Move to cont. 1 against walls, in front of toolbox
6	Floor pallet, conc. saw (7/35)	2	Move to covered storage
7	Floor pallet, dowel drill (7/31)	2	Move to covered storage
8	Bucket attachment (21)	1	Remove from pallet & move to covered storage
9	Lifting slings (23B)	1	Strap to upper pallet (item 5)
10	Upper pallet w/slings (5)	1	Replace in original location
11	Spreader bar (23A)	1	Replace in original location
12	Air compressor (31)	3	Move to covered storage, use pintle-hook assy. if req.
13	Wheelbarrows (24)	2	Move to covered storage
14	Wheelbarrows (33)	3	Move to covered storage
15	Concrete mixer (28)	2	Move to covered storage, use pintle-hook assy. if req.