AIR FORCE TACTICS, TECHNIQUES, AND PROCEDURES 3-32.22

12 FEBRUARY 2024

WATER AND FUEL EXPEDIENT REPAIR SYSTEM

DEPARTMENT OF THE AIR FORCE

This page intentionally left blank.

BY ORDER OF THE SECRETARY OF THE AIR FORCE

AIR FORCE TACTICS, TECHNIQUES, AND PROCEDURES 3-32.22

12 FEBRUARY 2024

Tactical Doctrine

WATER AND FUEL EXPEDIENT REPAIR SYSTEM

OPR: AF/A4CX Certified by: AF/A4C

Pages: 213

This publication supports Air Force Instruction (AFI) 10-209, *RED HORSE Program*, AFI 10-210, *Prime Base Engineer Emergency Force (BEEF) Program*, AFPAM 10-219, Volume 4, *Airfield Damage Repair Operations*, and Air Force Doctrine Publication (AFDP) 3-34, *Engineer Operations*. It provides Tactics, Techniques, and Procedures for expeditious water and fuel systems repair and recovery after attack, natural disaster, or catastrophic failure using the Water and Fuel Expedient Repair System (WaFERS) Unit Type Codes (UTCs). Refer recommended changes and questions about this publication to the Office of Primary Responsibility using Department of the Air Force (DAF) Form 847, *Recommendation for Change of Publication*; route DAF Form 847 from the field through the appropriate functional chain of command and Major Command publications/forms managers. Ensure all records generated as a result of processes prescribed in this publication adhere to Air Force Instruction 33-322, Records Management and Information Governance Program, and are disposed in accordance with the Air Force Records Disposition Schedule, which is located in the Air Force Records Information Management System. The use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this publication does not imply endorsement by the DAF.

APPLICATION: This publication applies to the Regular Air Force, the Air Force Reserve, and the Air National Guard Civil Engineer personnel performing water and fuel infrastructure repair and recovery actions after an attack, natural disaster, or catastrophic failure. This publication does not apply to the United States Space Force. The Tactics, Techniques, and Procedures 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 publication describes expeditious water and fuel system repair and recovery actions after an attack, natural disaster or catastrophic failure. Specifically, this publication describes WaFERS capabilities to include consolidated tools and equipment, pipeline repair and bypass, layflat hose, line patch, tank patch, fuel and water pumping, and fuel filtering.

Chapter 1

INTRODUCTION

1.1. Overview. The Water and Fuel Expedient Repair System (WaFERS) is a modular and scalable set of capability-based Unit Type Codes (UTCs) configured to enable expedient repair or recovery of mission essential water and fuel distribution systems and associated infrastructure.

1.1.1. Following a conventional airfield attack where the water or fuel infrastructure becomes damaged or inoperative, the resumption of fuel supply to support flying operations is a top priority. Engineer forces must be prepared to locate and assess water or fuel system damage and unexploded explosive ordnance (UXO) hazards, mitigate UXO that threaten WaFERS personnel and/or flying operations, and repair the infrastructure sufficiently to resume flying operations within timelines specified by Joint Force Commanders.

1.1.2. The scope of WaFERS requirements during airfield recovery will vary proportionally to the intensity of the attack. It could range from minor pipe puncture repairs to bypassing an entire pump house and manifold system to get fuel to a hydrant loop system or intermediate transfer tanks. It is this latter possibility AF engineers must be prepared to perform swiftly, adeptly and efficiently. In addition, high operational tempos mandate more durable and sustainable repairs to minimize system downtime that may negatively affect sortie rates.

1.1.3. WaFERS are War Reserve Materiel (WRM) UTCs. The system provides the tools, equipment and consumables to repair a variety of anticipated damage to water and fuel systems. Vehicles will normally be postured at installations for use with the required WaFERS capability. Vehicles may be WRM assets or assigned to the Civil Engineer (CE) Unit as joint-use assets for normal day-to-day shop use.

1.1.4. The manufacture’s operations manuals provide required maintenance instructions for the power equipment, specialized tools and general hand

tools. This publication will reference these manuals in lieu of duplicating instructions within this publication. Use instructions and procedures within the manuals for scheduled inspections, operational checks, preventive maintenance and repair to sustain assets while stored in WRM and for unit level maintenance when in use.

1.1.5. The WaFERS UTCs are packaged and stored in Tricon containers. These containers are suitable for transport by ship, rail, truck, or airlift. All intermodal containers will be managed in accordance with Defense Transportation Regulation 4500.9-R, Part VI. The intermodal container management chapters of this regulation have specific requirements that govern coding, marking, inspection, re-inspection, maintenance, repair, movement reporting, tracking and inventory.

1.2. Capability Descriptions. The system encompasses capabilities required to repair and recover water or fuel infrastructure at U.S. or allied airfields. Depending upon the damage, use a single UTC, or a combination of two or more, to restore water or fuel system operations. The modularity and scalability of WaFERS allows UTC selection based on the installation's unique infrastructure and allows flexible repair and recovery capability. Input and output connection points for all components are standard DOD configuration allowing use of quick-connect type fittings and couplers to the maximum extent possible. Capabilities include, but are not limited to, pipe repair or bypass, valve/manifold repair or bypass, hydrant capping, tank patching, fuel and water pumping, and fuel filtering. The system consists of capabilities as summarized below.

1.2.1. Consolidated Tools and Equipment (4FWCT). This UTC consolidates, organizes and provides easy accessibility of consumables, general hand tools, special-use tools and power equipment to support expedient repair and recovery of water or fuel distribution and storage systems. The assets within this UTC support, and prevents duplication within, the remaining WaFERS UTCs to accomplish repairs.

1.2.2. Repair and Bypass (4FWRB). This UTC offers several capabilities to include repairing small and large leaks and punctures in a pipeline, fitting or

valve; inline repair; valve replacement; and hydrant capping. The term bypass refers to rerouting the flow through a hose or pipe in order to bypass a damaged system or to go around an area due to hazards, traffic patterns/paths, or congestion. When this UTC is combined with other WaFERS UTCs (such as the pump and filter UTCs), the capability is greatly enhanced.

1.2.3. Layflat Hose (4FWLH). Use the Layflat Hose UTC to replace significant sections of damaged pipe above grade quickly, or to bypass damaged/inoperable infrastructure, such as a pump house. Use this UTC up to the American National Standards Institute (ANSI) 150 class pressures.

1.2.4. Tank Patch (4FWTP). This UTC has the capability to repair a leak from a penetrating hole, puncture or small tear in the wall of a bulk-fuel storage tank. This capability has several methods of repair to include wooden plugs driven into the leaking hole with a hammer and the umbrella patch used on larger penetrations. Depending upon the chosen method, repairs are capable on damages between a small pinhole up to large repairs of 23 inches in diameter.

1.2.5. Water and Fuel Pump (4FWFP). The Water and Fuel Pump UTC consists of a trailer mounted diesel engine driven pump capable of pumping liquid from approximately 50 feet below grade with discharge flow of 600-gallons per minute (GPM) and an outlet pressure of 150-pounds per square inch (PSI). This pump is capable of series (higher pressure) and parallel (additional flow rate) configurations. Approved pump engine fuels are JP-5, JP-8, Jet-A, kerosene and diesel fuel, potentially scavenged from the pumped flow to fuel the engine. A dedicated hydraulic power unit enables hydraulic tooling and extracting fuel from cut and cover fuel tanks with the down-hole turbine pump. This capability works in combination with the Fuel Filter UTC. When combined with the Layflat Hose UTC, use in series or parallel to meet flow or pressure demands of a hydrant loop or other fuel configurations.

1.2.6. Fuel Filter (4FWFF). This UTC consists of a trailer mounted filter system with two 600-GPM filter separators. The capability has numerous hose connection adapters to facilitate connection to Fuels Operational Readiness

Capability Equipment or other systems providing lateral support. Assets include inlet strainers, eductor system to vacate one filter for quick filter change, spare filters and a grounding reel with rod.

Note: The following tools, vehicles and equipment (assumed available within the in-garrison unit) are NOT provided with WaFERS, but may be required for repairs:

- Vapor toxicity meter
- Backhoe/Excavator
- Truck, ½ Ton, w/pintle hook
- Individual personal protective equipment (PPE) such as hardhat, gloves, safety-toed boots, safety glasses, hearing protection, etc.

1.3. Damage Scenarios and WaFERS Employment. Based on threat, there are approximately 16 types of water and fuel infrastructure damage likely to occur during attack within WaFERS capabilities to repair. **Table 1.1** provides a summary of these scenarios and related WaFERS repair capabilities. The scenarios do not attempt to capture small details, but represent an assessment based solely on the specific threat. Because of the modular and scalable capability of WaFERS, technicians may select several options, depending on the situation, to optimize repairs.

1.4. UXO Mitigation. Expedient repair and recovery of water or fuel systems may require an Explosive Ordnance Disposal capability to effectively identify and assess hazards associated with UXO prior to repairing damaged infrastructure. Explosive Ordnance Disposal Technicians support WaFERS by assessing the UXO, then remove, render safe, or detonate UXO affecting the recovery process.

1.5. Manpower and Equipment. Each Water and Fuel Systems Maintenance Team will typically be comprised of three personnel capable of accomplishing all types of repairs within the scope of WaFERS. Source personnel from CE personnel UTCs employed at home station (fight-in-place), augmented by UTCs from other locations, or UTCs tasked through the Joint Operation Planning and Execution System at contingency bases.

WARNING: Once components have been used to process fuel, they cannot be used to process water.

Table 1.1. Damage Scenarios and Related WaFERS Repair Capabilities.

Damage Scenarios Based on Threat	Repair Options	WaFERS Capabilities					
		4FWCT	4FWRB	4FWLH	4FWTP	4FWFP	4FWFF
		Common Tools & Equipment	Pipeline Repair & Bypass	Layflat Hose (long runs)	Tank Patch	Water & Fuel Pump	Fuel Filter
Major Valve Damage	Replace or Bypass	✓	✓	●			
Major Fitting Damage	Replace or Bypass	✓	✓	●			
Major Damage to Buried Pipe	Inline Repair (Hard Pipe) or Bypass	✓	✓	●			
Major Damage to Exposed Pipe	Inline Repair (L.F. Hose) or Bypass	✓	✓	●			
Severed Pipe	Inline Repair or Cap	✓	✓				
Punctured Pipe Valve or Fitting	Patch with Plug, Clamp, or Epoxy	✓					

Punc-tured Tank Small Hole <5”	Patch with Plug (Hole up to 5”)	✓			✓		
Punc-tured Tank Large Hole <23”	Umbrella Patch (>5” and <23”)	✓			✓		
Fuel in Above Ground Tank	Re-cover/Re-move w/600 GPM Pump	✓	✓	●	✓	✓	●
Fuel in Below Ground Tank	Recover w/Booster Pump & 600 GPM Pump	✓	✓	●		✓	●
Fuel in Pipeline	Recover or Extract (Filter, Store)	✓		●		✓	●
Fuel Spill in Berm	Re-cover/Ex-tract, (Fil-ter, Store)	✓		●		✓	●
Contam-inated Fuel	Re-cover/Ex-tract, Filter, (Store)	✓				✓	✓

Damaged Hydrant	Cap Only	✓	✓				
Destroyed Pantographs	Cap Only	✓	✓				
Pumps Damaged (Beyond Repair)	Bypass with Fittings & Hose	✓	✓	✓		✓	●
Damaged Filter	Bypass w/fittings, Hose, Filter	✓	✓				✓

Legend: ✓ : Primary Options (take only what is needed)
● : Secondary Options
Note: Scenarios not all-inclusive; serve to highlight probable results from known effects.

Chapter 2

CONSOLIDATED TOOLS AND EQUIPMENT UTC (4FWCT)

2.1. Overview. This chapter provides safety, operation and installation procedures of the various special-use tools and power equipment included in this UTC. The consolidated general hand tools, special-use tools and power equipment are organized to make them easily accessible and allow technicians to select only what is needed for a repair. The Consolidated Tools and Equipment UTC supports the other WaFERS UTCs.

2.2. Contents. The following paragraphs describe the main UTC contents. **Attachment 2** provides a complete inventory of the UTC.

2.2.1. Common Hand Tools. The general hand tools include various wrenches, screwdrivers, sockets, hammers and other tools used for typical mechanic work.

2.2.2. Special-Use Tools. The special-use tools include the cutter-groover, guillotine saw, mini-guillotine saw, alignment bar, ventilators and brick lights.

2.2.3. Power Equipment. The power equipment consists of a hydraulic power unit, generator and air compressor needed to power some of the special-use tools.

2.3. Tool Operating Procedures. Special-use tools in this UTC require operators to use PPE and have knowledge of additional supplemental tools to operate the special-use tools safely and properly. The manufacturer's operating manual should be always used and adhered to when using this equipment.

2.3.1. Pneumatic Reciprocating Saw. The reciprocating saw cuts steel, wood, building materials, fiberglass and many other materials (**Figure 2.1**). The tool is commonly found in the oil and gas industry and fire and rescue services. Its application to WaFERS is to cut small pipelines, typically 4-inches and

smaller, remove jagged hole penetrations in metal, and cut any other metal that may require cutting. The air compressor within the UTC provides the air to operate the saw.

Figure 2.1. Reciprocating Saw.

2.3.1.1. General Safety. Wear eye protection, hearing protection, safety-toe boots and work gloves while performing cutting operations.

2.3.1.2. Operating Procedures.

Step 1. Ensure the pipe, or part, to cut is secure to prevent back and forth movement or saw kickback. Support the loose end to prevent it from causing injury when it falls or springs.

Step 2. Start the air compressor using procedures in the operator's manual.

Step 3. Lubricate the saw's internal moving parts by squirting a few drops of the accompanying oil into the air hose fitting before connecting the air hose.

Step 4. Connect the hose from the air compressor to the air caddy **(Figure 2.2)**, and then connect a hose from the air caddy to the saw.

Ensure the air caddy oil reservoir is at the proper level before operation.

Figure 2.2. Air Caddy.

Step 5. Cut pipe or part with the saw. While cutting, cool the cutting blade with lubricating oil from the UTC or soapy water to prolong life of the blade and allow for smoother cutting operation.

Note: If the blade becomes jammed or wedged, let go of the squeeze grip, or depress the red emergency stop knob on top of the handgrip, and carefully free the blade before continuing.

2.3.2. Bristle Sander. The pneumatic bristle sander tool roughs up surfaces and removes coatings where adhesives or epoxy materials will be used (**Figure 2.3**). The key to making the tool effective is the bent bristles pass over the stationary roller accelerator bar causing the bristles to spring back into place stabbing the surface with the end of each wire bristle.

Figure 2.3. Bristle Sander.

2.3.2.1. General Safety. Always wear eye protection, hearing protection, safety toed boots, work gloves and a particle mask while using this tool.

Warning: This tool can produce sparks. If fuel vapors are present while using this tool, remove the vapors with the ventilator provided in the UTC or an explosion and/or fire could result. Monitor lower explosion limit (LEL) levels during the operation. Ensure the UTC's included fire extinguisher is readily available during operations.

2.3.2.2. Operating Procedures.

Step 1. Secure the pipe, or part to be prepared, to prevent movement.

Step 2. Start the air compressor using procedures in the operator's manual.

Note: Adjust air compressor's pressure regulator, or the in-line pressure regulator, to prevent exceeding 90 psi.

Step 3. Connect hose from the air compressor to the air caddy (**Figure 2.2**).

Step 4. Lubricate tool's internal components by squirting a few drops of accompanying oil into the air hose fitting, and then connect the hose from the air caddy to the tool.

Step 5. Hold the tool body firmly and the vertical handle at the same time.

Step 6. Hold the accelerator bar close to the surface to sand.

Step 7. Use the air safety lever to operate.

2.3.3. Work Area Lighting. The LED-explosion proof area light provides work area lighting (**Figure 2.4**). Power the light by plugging the cord into any 3-prong 120 VAC electrical outlet or by plugging into a generator, included with the UTC, 120 VAC electrical outlet.

2.3.3.1. General Safety. Do not connect to a power source in a hazardous location. Only the light housing and cable to the connection box are explosion proof. Place the connection box outside the hazardous location before connecting the power cord.

Figure 2.4. Work Area Lighting.

2.3.3.2. Operation.

Step 1. Plug the electrical cord into the brick light.

Step 2. Plug the opposite end of the cord into a nearby electrical outlet, or an outlet on the generator included with this UTC.

Step 3. Position the light in a suitable location. If necessary, use the A-frame mount or magnetic knuckle mount as shown in **Figure 2.5**.

Figure 2.5. Mounting Options.

2.3.4. Manual Impact Wrenches. These wrenches (**Figure 2.6**) loosen or tighten bolts on equipment such as the grooved-style clamps.

Figure 2.6. Manual Impact Wrenches.

2.3.4.1. General Safety. Wear eye protection and work gloves while operating the manual impact wrench.

2.3.4.2. Operating Procedures.

Step 1. Affix an appropriately sized socket to the ratchet head.

Step 2. Tighten the fastener until hearing an audible impact noise.

2.3.5. Guillotine Saw. The portable guillotine saw (**Figure 2.7**) can cold cut 6-inch through 14-inch pipe of all materials, as well as solid stock such as bars and rails. The saw provides cold cutting of pipe in preparation of either installation of couplings or machining a straight cut. The mini-guillotine Saw can cut 2-inch to 6-inch material. The primary use of this saw is to cut hydrant outlets but can be used anywhere required.

Figure 2.7. Guillotine and Mini-Guillotine Saws.

Portable Guillotine Saw Mini Guillotine Saw

2.3.5.1. General Safety. Wear eye protection, hearing protection and safety-toe boots while operating this tool. DO NOT WEAR GLOVES WHILE OPERATING THE SAW. Wear gloves before and after cutting operations to protect hands. Remove or secure loose-fitting clothing and

jewelry to prevent catching them in moving parts. The portable guillotine saw weighs approximately 300 pounds; utilize material handling equipment when moving and/or positioning the saw.

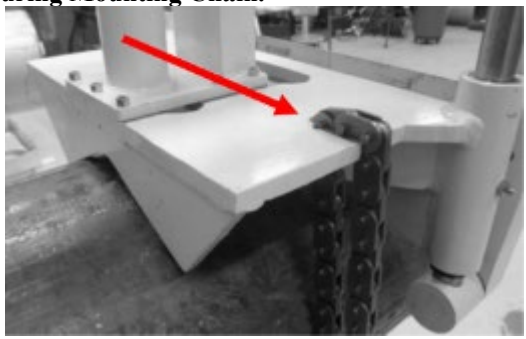
2.3.5.2. Mounting the saw. Mount the saw without the blade installed to avoid damaging the blade.

Step 1. Turn the feed handle to retract the bow to its full upward travel.

Step 2. Set the saw securely on the pipe at the cutting location. Place the saw on the supported side of the cutting location.

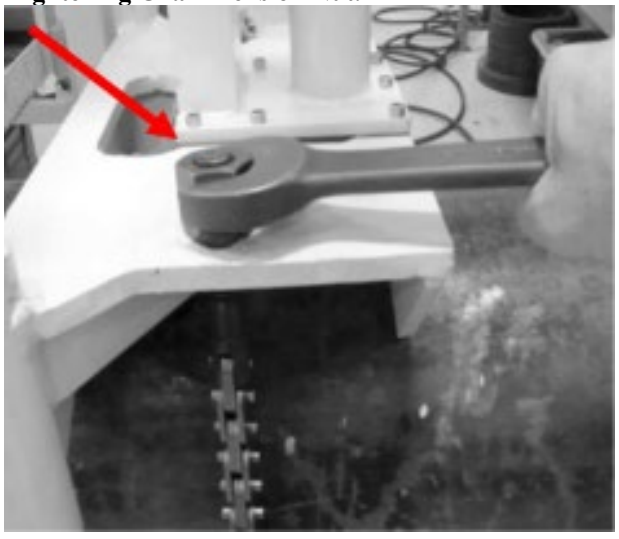
Step 3. Wrap the mounting chain around the pipe. Pull it snug and insert the last link you can get into the slot in the saddle as seen in the **Figure 2.8**.

Figure 2.8. Securing Mounting Chain.



Step 4. Make sure chain tension nut is properly oriented (rounded part on bottom) and then tighten the chain tension nut securely to hold the saw in place as seen in **Figure 2.9**. Ensure the saddle is in firm contact with the pipe surface.

Figure 2.9. Tightening Chain Tension Nut.



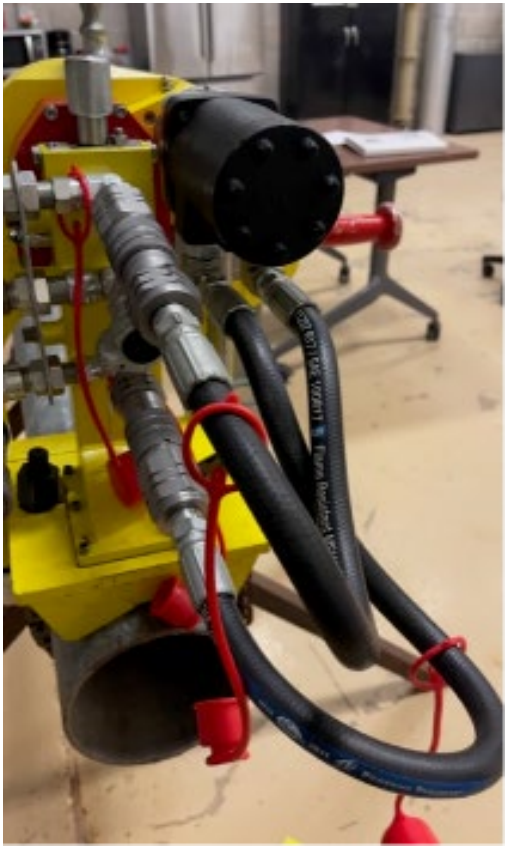
2.3.5.3. Installing the Drive Motor. Determine which drive motor in the UTC is most suitable for the particular job, pneumatic or hydraulic; both attach to the saw's drive adapter in the same manner. Both drive motor power sources, air compressor and hydraulic power unit, come with this UTC.

Step 1. Put motor in place and secure it by tightening the drive adapter screw (**Figure 2.10**).

Figure 2.10. Tightening the Drive Adapter Screw.

Step 2. If using the hydraulic drive motor, attach the hoses to the connectors on the manifold (**Figure 2.11**). Attach the hoses from the Hydraulic Power Unit to the pressure input and return connectors. If using the air drive motor, attach the air motor hose to the air quick connector on the manifold. Attach the air source line to the air input Chicago-style connector.

Figure 2.11. Hydraulic Motor Installed on Saw.



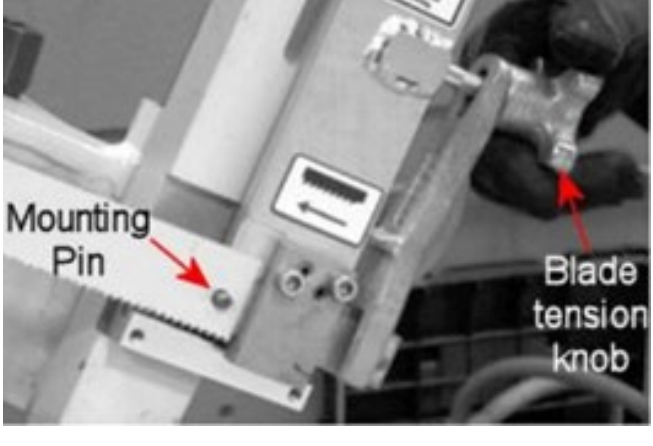
2.3.5.4. Blade Installation. Install blade with teeth facing to the left when looking at the front of the saw (see labels on the saw bow). Completely raise the saw bow before installing the blade.

Step 1. Put left end of blade onto the blade-mounting pin and tighten the blade lock over the end of the blade (**Figure 2.12**).

Step 2. Loosen blade tension knob and mount the other end of blade on the pin. Turn the knob to tension the blade (**Figure 2.13**). Tighten the knob securely by hand.

Figure 2.12. Tightening the Blade Lock.

Figure 2.13. Opposite End of Blade Mounted on Pin.

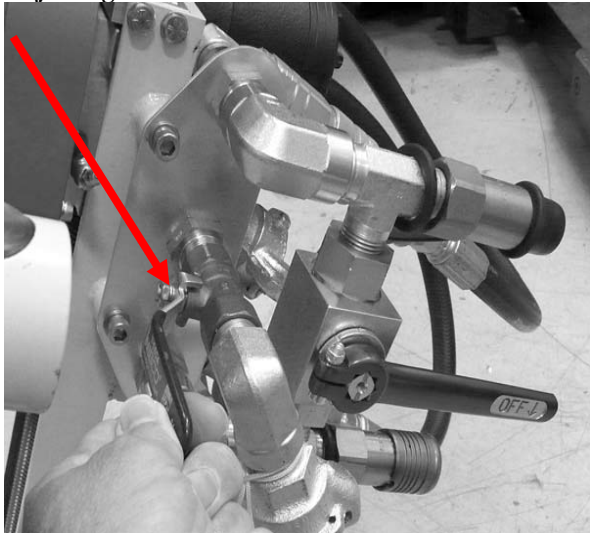


2.3.5.5. Perform the Cut.

Step 1. Engage the power source (air or hydraulic).

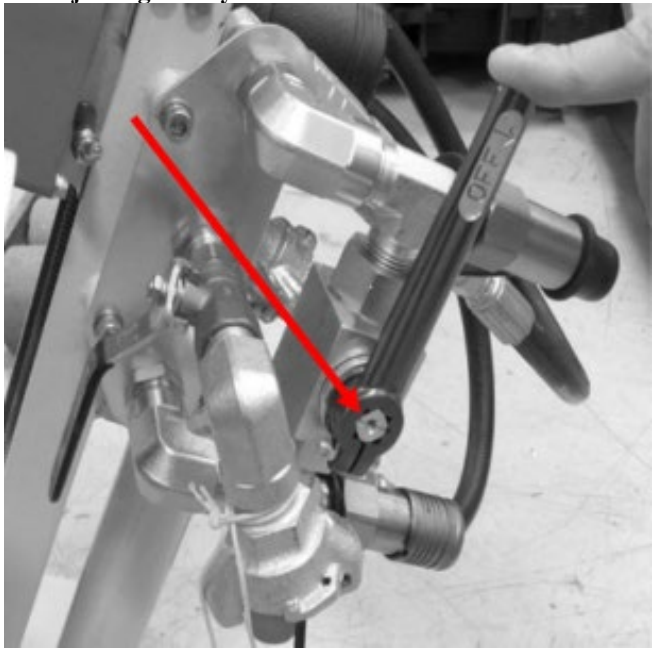
Step 2. Use control lever on the saw manifold to turn saw motion on and off and adjust the saw motion speed as needed. If using the pneumatic motor, turn the air motor control lever to the ON position to control the saw motion (**Figure 2.14**).

Figure 2.14. Adjusting the Air Motor Control Lever.



If using the hydraulic motor, turn the hydraulic motor control lever to the ON position to control the saw motion (**Figure 2.15**).

Figure 2.15. Adjusting the Hydraulic Motor Control Lever.



Step 3. Slowly turn the feed handle on top of the saw to feed the blade into the pipe.

Note: Feed the blade slowly through the crown of the pipe, where the cut begins and ends. Increase the speed of the cut towards the center of the pipe if desired. Adjust speed to achieve the smoothest cutting. While cutting, cool cutting blade with lubricating oil, provided with the UTC, or soapy water to prolong life of the blade and allow for a smoother and cooler cutting operation.

Step 4. Support the unsecured end of the pipe when approaching end of the cut to prevent the blade from being pinched or injury to personnel.

Step 5. When the cut is complete, position the motor control lever to the OFF position and fully raise the bow to the top of the saw.

Step 6. Disengage and disconnect the power source from the saw.

Caution: The hydraulic motor hose connections will be hot after continuous use. Use gloves when disconnecting hoses and removing the motor.

Step 7. Loosen the mounting chain and remove the saw.

2.3.6. Fuel Extraction Kit. The fuel extraction kit can tap an existing intact piping system in order to drain or extract the fuel to allow necessary repairs to the pipeline. The kit contains a tapping machine with pneumatic driver, service saddles ranging in sizes from 6-inch to 12-inch, and a 2-inch corporation valve and suction tube assembly. **Figure 2.16** provides an example of the tapping machine.

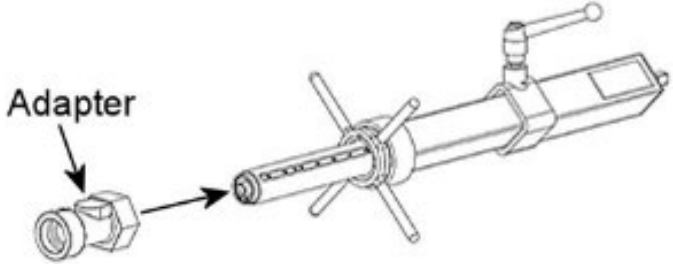
2.3.6.1 General Safety. Always wear required personal protection equipment.

Figure 2.16. Fuel Extraction Kit.

2.3.6.2. Assembly.

Step 1. Thread the hex shaped end of the adapter onto the lead tube until it is snug, this assures the O-Ring in the adapter will seal against the lead tube (**Figure 2.17**).

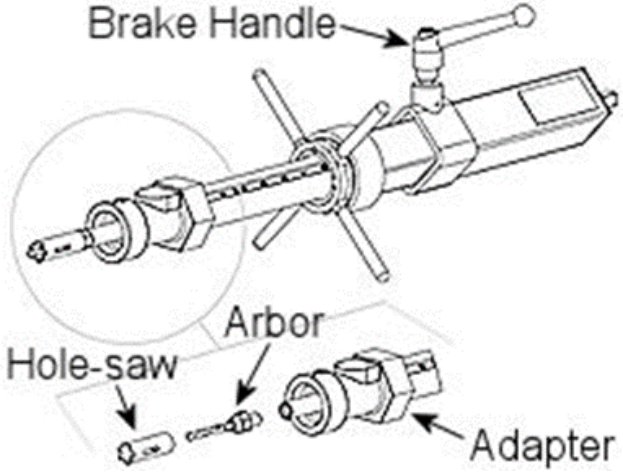
Figure 2.17. Adapter to be Threaded on the Lead Tube.



Step 2. Loosen the brake handle and collapse the square tubes to exposes the end of the shaft. Attach the hole-saw and arbor to the shaft (**Figure 2.18**). Hold the square end of the shaft with a crescent wrench and thread the cutting tool onto the shaft. DO NOT use a pipe wrench on the shaft.

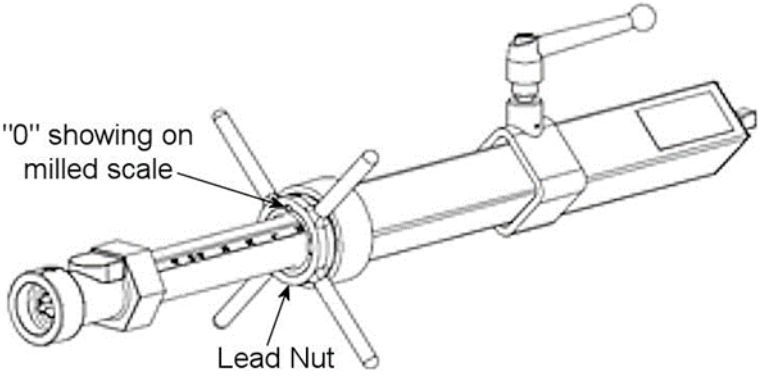
Note: Check hole-saw to ensure saw is sharp and not filled with plugs (coupons) from previous cuts. Replace hole-saw if required.

Figure 2.18. Exposing the Adapter Shaft to Attach the Hole-saw and Arbor.



Step 3. Retract the shaft and cutting tool back into the adapter by extending the square tubes to its full travel (approximately 6.5 inches). Thread the lead nut in reverse to show the number “0” on the milled scale in the lead tube (**Figure 2.19**).

Figure 2.19. Lead Nut on Tapping Machine.



Step 4. Attach the service saddle and valve to the pipe (**Figure 2.20**) and then pour a generous amount of water/coolant into the saddle.

Step 5: Attach the corporation stop and ensure it is in the fully open position.

Figure 2.20. Service Saddle and Valve Attached to Pipe.

2.3.6.3. Mounting the Tapping Machine.

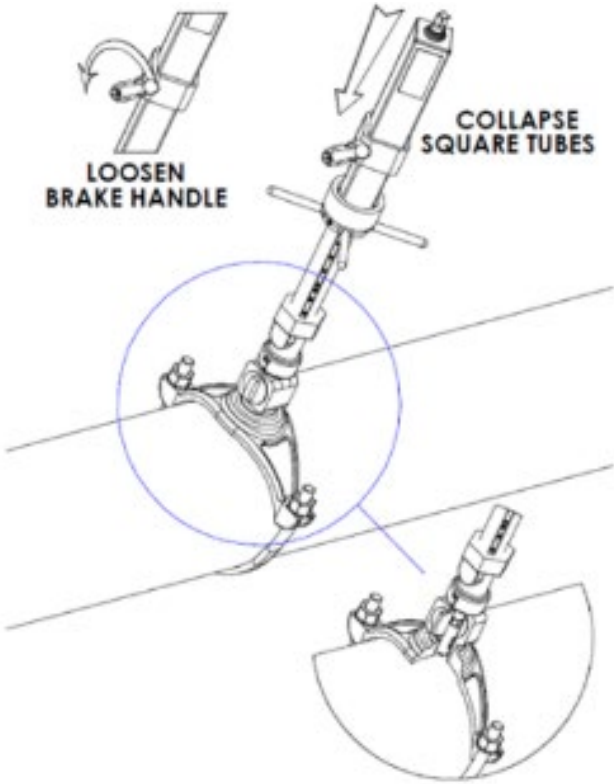
Step 1. Thread the machine and adapter onto the 2-inch valve until tight (**Figure 2.21**). Use a pipe wrench on the adapter to tighten the machine and adapter onto the 2-inch valve; it may leak if left loose.

Step 2. Loosen the brake handle and slowly collapse the two square tubes, advancing the cutting tool until it contacts the pipe wall (**Figure 2.22**). Avoid heavy contact with the pipe, as this may damage the pilot drill.

Figure 2.21. Positioning Tapping Machine to Thread onto the 2-Inch Valve.

Note: Pour a liberal amount of water or coolant into the corporation valve (a limited amount of water/coolant is included with the UTC).

Figure 2.22. Contacting the Pipe with the Pilot Drill.



Step 3. Tighten the brake with the brake handle (**Figure 2.23**). Mount a ratchet wrench, or the pneumatic drive, on the square end of the shaft.

Note: Always turn the ratchet wrench in clockwise direction when looking toward the pipe. Reversing direction of the shaft's rotation will damage the cutting tool.

Figure 2.23. Tightening Brake with Brake Handle.

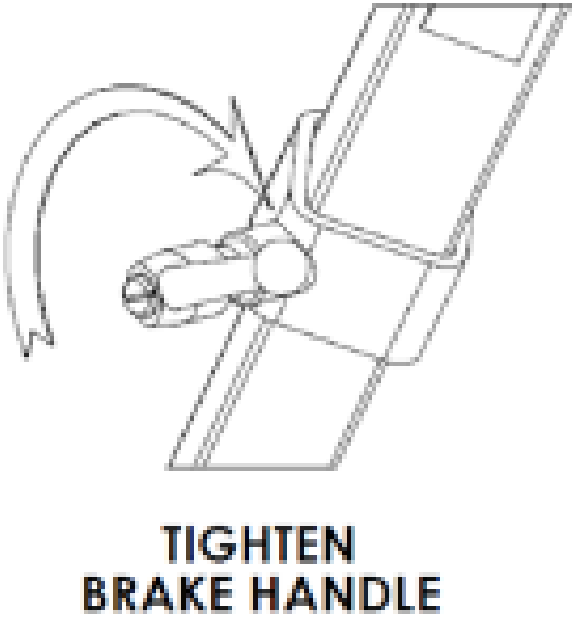


Figure 2.24. Pneumatic Driver.

2.3.6.4. Pneumatic Driver Operating Instruction.

Step 1. Start air compressor, provided with this UTC, using procedures in the operator's manual.

Note: Use compressor's pressure regulator, or the in-line pressure regulator, to prevent air pressure from exceeding 90 psi.

Step 2. Connect hose from the air compressor to the air caddy (**Figure 2.2**).

Step 3. Place a few drops of oil, provided with the UTC, into the air hose fitting to lubricate the power head's internal components.

Step 4. Attach the pneumatic power head square tube over the tapping machine and engage the square drive.

Step 3. Ensure power head air valve is in the OFF position and connect the air hose from the air caddy to the power head.

Step 4. Slowly open the power head's air valve until the cutting bit begins cutting into the pipe.

Note: If the air motor fails to rotate when air is applied, manually rotate the air motor shaft to ensure the shaft turns freely. If the power head fails, cut the fuel extractor hole manually using the ratchet handle over the drive socket.

Step 5. Slowly turn the feed handle clockwise (avoid binding the blade) until it reaches the locking nuts (**Figure 2.25**).

Note: Feed about 1/8th of a turn on the feed nut for every two revolutions of the hole-saw. Do not overfeed the hole-saw.

Figure 2.25. Tapping Machine Handle Feed.

Step 6. Close air valve and disconnect hose. Remove power head from fuel extractor assembly and set aside. Keep power head out of the dirt.

Step 7. Retract the cutting bit to the fully raised position by turning the feed handle counterclockwise.

Step 8. Unlock and move cutting bit up through the corporation stop assembly. Close valve temporarily.

Note: If valve will not close, attempt to retract the machine fully. The shaft of the drilling machine may still be interfering.

Step 9. Remove the tapping machine from the 2-inch valve and set it aside.

Step 10. Install suction tube assembly (**Figure 2.26**) into the corporation stop assembly and hand-tighten until snug using the tightening handles provided.

Note: The service saddle and 2-inch valve can be reused for additional tapping operations by repairing the hole with a suitable repair device (clamp, plug, wrap) from the Repair and Bypass UTC.

Figure 2.26. Suction Tube Assembly

2.3.7. Pipe Prep Tool. Use this tool to remove pipe coatings and to prepare pipe surfaces for composite wrap installation (**Figure 2.27**).

Figure 2.27. Pipe Prep Tool.

2.3.7.1. General Safety. Wear eye protection, hearing protection, safety-toe boots, work gloves and a particle mask while using this tool. Remove jewelry and avoid loose clothing to prevent catching by moving parts and potentially causing injury.

2.3.7.2. Operating Procedures.

Step 1. Ensure the pipe, or part to be prepared, is secure to prevent movement.

Step 2. Start the air compressor, provided with this UTC, using operator's manual procedures.

Note: Using the pressure regulator on the air compressor, or the in-line pressure regulator, to prevent exceeding 90 psi.

Step 3. Lubricate the tool's air drive by squirting a few drops of oil, provided with this UTC, into the air fitting.

Step 4. Connect the hose from the air compressor to the air caddy, then the air caddy to the tool.

Step 5. Turn on the air motor and ensure that only the rear roller of the tool is in contact with the surface.

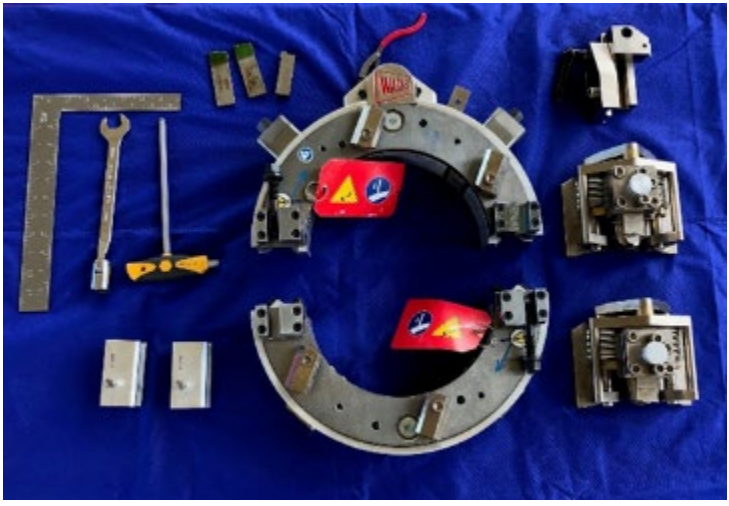
Step 6. Slide the outer sleeve down the lever and depress the lever towards the body. Begin moving the machine slowly over the work surface.

Note: The machine is capable of backwards and forwards movement. Each pass should be overlapped to ensure the finish is uniform.

Step 7. To stop, release the lever on the air motor.

2.3.8. Cutter/Groover Machine. The cutter/groover machine (**Figure 2.28**) is a portable pipe cutting and grooving system developed for on-site operation. Use the cutter/groover to cut pipe between 6 inches and 14 inches in diameter and add a groove to the cut pipe.

Figure 2.28. Disassembled Cutter/Groover Machine.



2.3.8.1. General Safety. Always wear eye protection, hearing protection and safety-toe boots while using this tool. DO NOT WEAR GLOVES WHILE OPERATING THE SAW. Wear gloves before and after cutter/groover operations to protect hands. Remove jewelry and avoid loose clothing to prevent catching by moving parts and potentially causing injury.

2.3.8.2. Operating Procedures

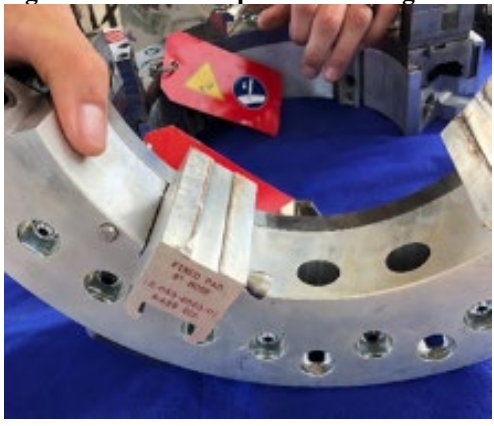
Step 1. Select the required aluminum clamp pads from the list in **Table 2.1**.

Table 2.1. Work Piece Pipe Sizes and Clamp Pads.

Pipe Size	Modular Design Split Frame (MDSF)	Clamp Pads
6”	408 (12-053-4000-08)	12-053-0053-01
8”	612 (12-053-4000-12	12-053-0053-02
10”		12-053-0053-03
12”	1016 (12-053-4000-16)	12-053-0053-04
14”		12-053-0053-05

Step 2. From the bottom side of the cutter/groover, slide pads into the grooved slots on the ring (**Figure 2.29**).

Figure 2.29. Sliding Aluminum Clamp Pad into Ring.



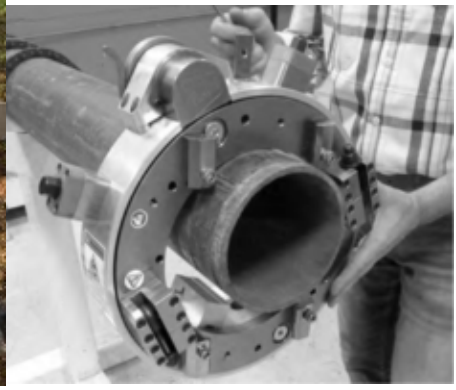
Step 3. Pull the locking pin up to slide the pad all the way on and let the pad and pin snap into place (**Figure 2.30**).

Figure 2.30. Pulling Locking Pin Upward.

2.3.8.3. Mount the Machine.

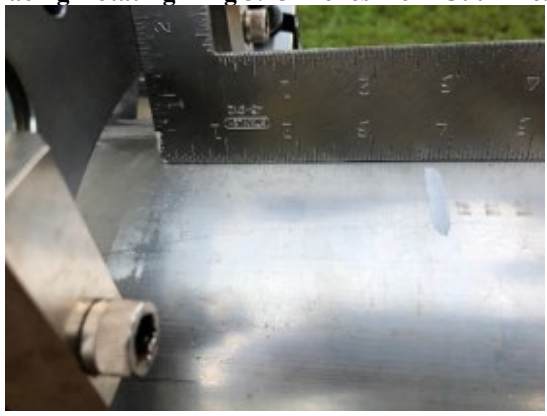
Step 1. Mount the cutter/groover on the pipe at the cutting location (**Figure 2.31**). For continuous runs of pipe, split the machine and assemble it around the pipe (**paragraph 2.3.8.7**).

Figure 2.31. Cutter/Groover Mounted on Pipe with Pinion Housing Side Up.



Step 2. Position the top of the rotating ring 3.75 inches from the cut line (**Figure 2.32**).

Figure 2.32. Placing Rotating Ring 3.75 Inches from Cut Line.

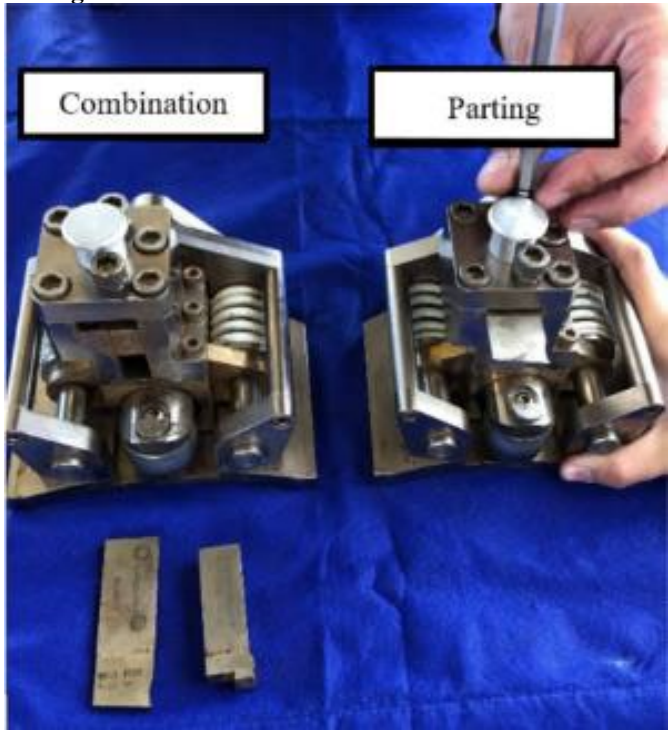


Step 3. Tighten the adjustable clamp legs by turning each screw a few turns while alternating between them until the machine is snug and centered on the pipe, verify the distance between the ring and cut mark (3.75 inches), then tighten the legs to 35-foot pounds of torque (**Figure 2.33**).

Figure 2.33. Tightening Adjustable Clamp Legs.

2.3.8.4. Assemble and Mount the Cutting Tool Slides. Set up and mount both the combination (parting/grooving) tool slide and parting tool slide (**Figure 2.34**) in the same manner.

Figure 2.34. Parting Tool Slide and Combination Tool Slide.



Step 1. Fully retract the slide on both tools by turning the star-wheel clockwise. Then turn the star-wheel counter-clockwise just enough to loosen it from the stop (**Figure 2.35**).

Figure 2.35. Turning Star-Wheel to Retract the Slide.

Step 2. To set the spring pressure, turn the jacking screw clockwise (**Figure 2.36**) until the gap between the guide bar support plate and tracking bar end plate is 5/16 inch, about the width of the wrench (**Figure 2.37**).

Figure 2.36. Setting Spring Pressure.

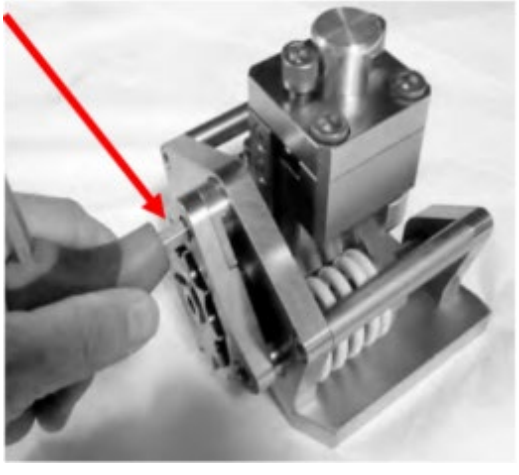


Figure 2.37. Checking Guide Bar Support Plate & Tracking Bar End Plate Gap.

Step 3. Select the grooving tool required for the cutter/groover machine and pipe size as listed in **Table 2.2**.

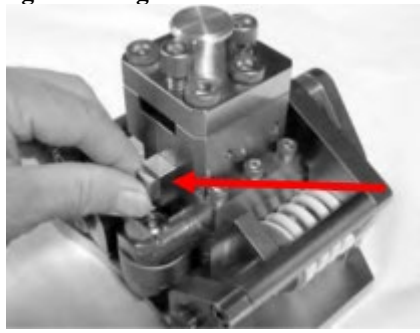
Table 2.2. Grooving Tool Selection Matrix.

MDSF Kit	Pipe Size	Grooving Tool Part No.
408	6”	12-053-7000-06
612	8”	12-053-7000-08
	10”	12-053-7000-10
1016	12”	12-053-7000-12
	14”	12-053-7000-14

Step 4. Install the selected grooving tool into the combination tool slide. The tool is marked FACE UP for correct orientation (**Figure 2.38**).

Note: If the tool is not marked “FACE UP”, install the tool with the cutting edge facing the right side of slide.

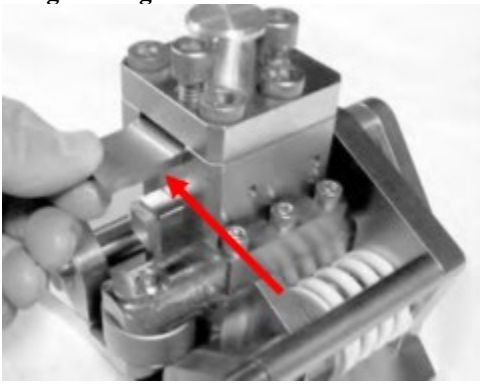
Figure 2.38. Installing Grooving Tool.



Step 5. Install a parting tool in both tool slides (**Figure 2.39**). The parting tools are marked THIS SIDE UP for the correct orientation. Use the same parting tools for all pipe sizes.

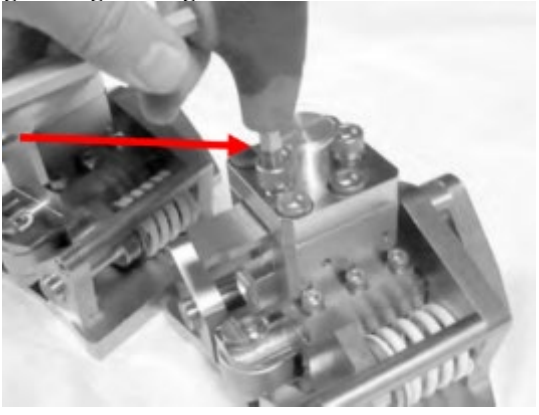
Note: If the tool is not marked “FACE UP”, install the tool with the cutting edge facing the right side of slide.

Figure 2.39. Installing Parting Tool.



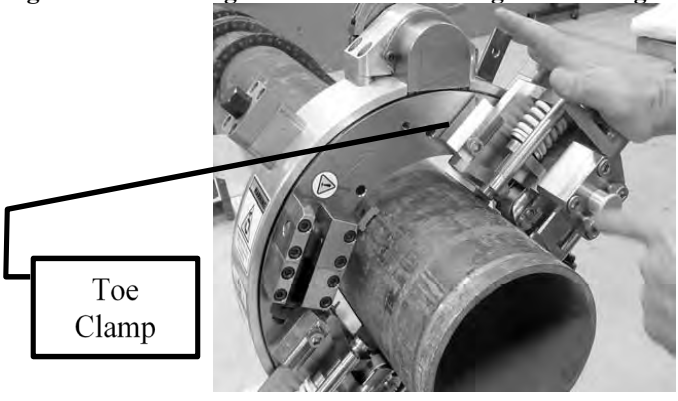
Step 6. Completely seat all parting tools in the holders and tighten the two setscrews on each slide (**Figure 2.40**).

Figure 2.40. Tightening Parting Tool Set Screws.



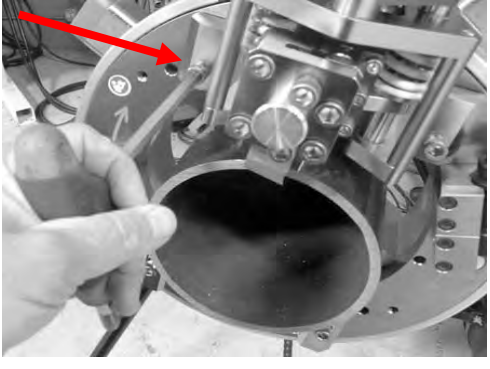
Step 7. Loosen screws in toe clamps on the cutter/groover rotating ring and slide the base plate of each slide between the toe clamps. Push the slide in until the tracking wheel is against the pipe surface (**Figure 2.41**).

Figure 2.41. Pushing Slide In until Tracking Wheel is Against Pipe Surface.



Step 8. Securely tighten the screw in each toe clamp (**Figure 2.42**).

Figure 2.42. Tightening Toe Clamp Screw.



Step 9. Firmly tighten the two setscrews (**Figure 2.40**).

Step 10. Turn jacking screws counterclockwise.

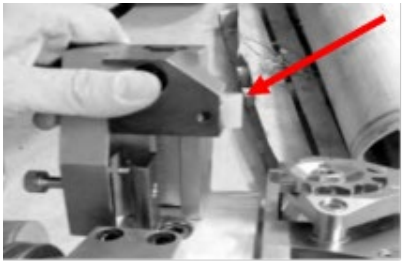
2.3.8.5. Mount Trip Assembly to Cutter/Groover.

Step 1. Align base of the trip assembly with the mounting post and tighten the trip mounting screw (**Figure 2.43**).

Step 2. Loosen the Trip Release handle and push the Trip Block down to the Engaged Position (trip block against the cutter/groover frame). Then, tighten the trip release handle (**Figure 2.44**).

Step 3. Turn rotating ring of cutter/groover to position one of the star-wheels near the trip (frame locking pins must be removed from the cutter/groover).

Figure 2.43. Aligning Base of Trip Assembly & Tightening Trip Mounting Screw.



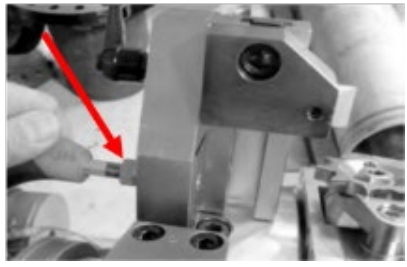
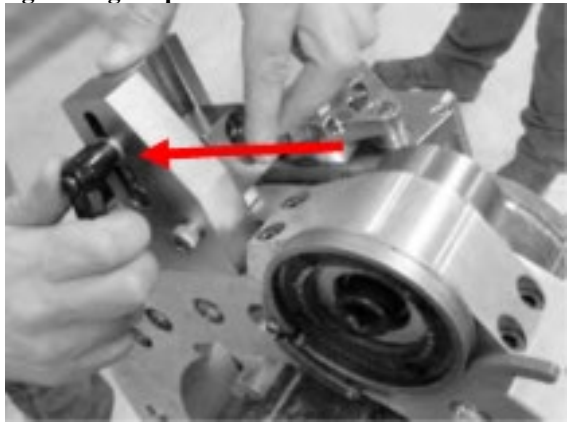
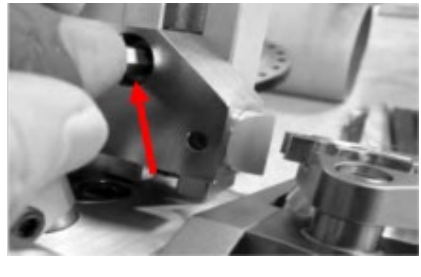


Figure 2.44. Tightening Trip Release Handle.



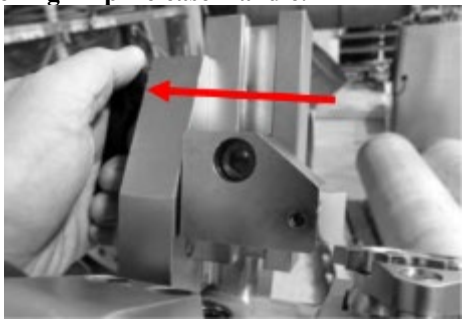
Step 4. Loosen trip position screw and slide the trip until aligned with the star-wheel. Then, tighten the trip position screw (**Figure 2.45)**.

Figure 2.45. Tightening Trip Position Screw after Aligning Trip to the Star-Wheel.



Step 5. Loosen trip release handle to set the trip to the disengaged position (**Figure 2.46**). The trip block is spring-loaded and will pop out when in the disengaged position.

Figure 2.46. Loosening Trip Release Handle.



2.3.8.6. Mount the Drive Motor to the Cutter/Groover.

Step 1. Align drive motor with drive adapter on the cutter/groover and insert the square shaft into the pinion.

Step 2. Adjust motor to a convenient position for operation and fasten it to the adapter with the spring clamp. **Figure 2.47** shows a mounted pneumatic motor, **Figure 2.48** shows the hydraulic motor mounted, and **Figure 2.49** shows the electric motor mounted.

Figure 2.47. Mounting Pneumatic Motor.

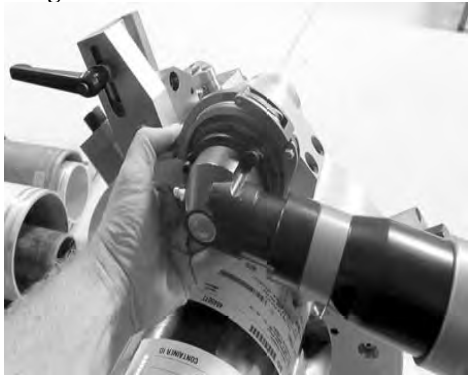
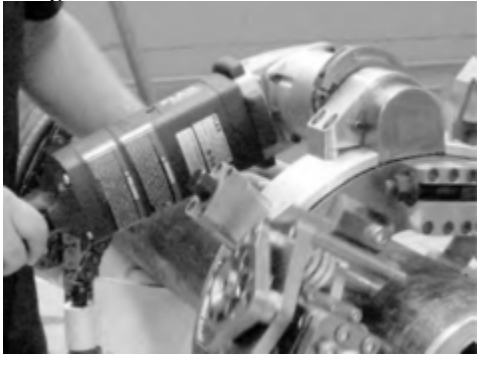


Figure 2.48. Mounting Hydraulic Motor.

Figure 2.49. Mounting Electric Motor.

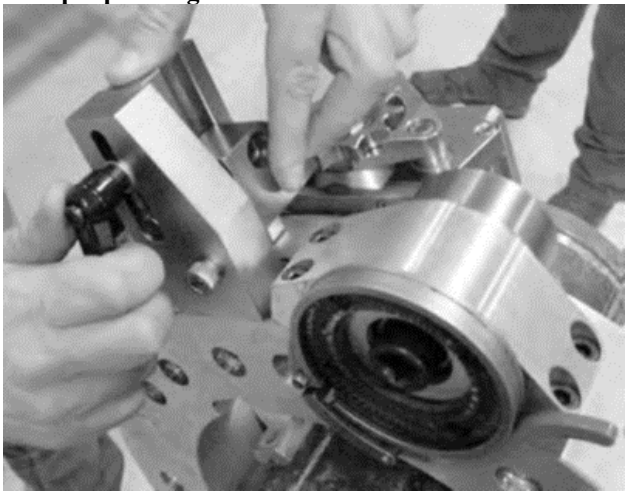


2.3.8.7. Perform the Cut-Off and Grooving Operation.

Step 1. Connect the power source (air compressor, hydraulic power unit, or generator) to the drive motor. Remove the frame locking pins from the cutter/groover before operating the machine.

Step 2. Loosen the trip release handle and engage the trip to the operating position (**Figure 2.50**).

Figure 2.50. Trip Operating Position.



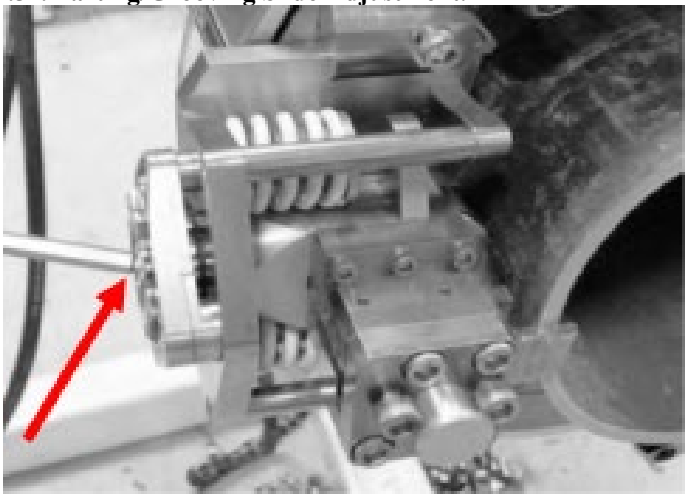
Step 3. Turn on the power source. Operate the drive motor at a slow speed through one rotation to make sure the trip turns the star-wheel.

Step 4. Adjust the drive motor to the desired operating speed. As the tool slide advances, the parting tool will begin to cut. Spray soapy water onto cutting surface to cool/lubricate the parting tool. Operate the cutter/groover until the cut is complete.

Caution: Support the piece to be cutoff before reaching the end of the parting cut.

Note: To reduce operating time, turn the star-wheel counter-clockwise to advance the combination tool slide to set the grooving tool close to the pipe surface (**Figure 2.51**).

Figure 2.51. Parting/Grooving Slide Adjustment.



Step 5. Turn on the drive motor and adjust to desired speed. As the tool slide advances, the grooving tool will begin to cut. Spray soapy water onto cutting surface to cool/ lubricate the grooving tool.

Step 6. Operate the cutter/groover until the combination tool slide grooving is complete and has advanced to the hard stop position. The spring-loaded trip assembly will not turn the star-wheel, which prevents the slide tool advancement. Operate the cutter/ groover through two more rotations to clean the groove; then, turn off the drive motor.

Step 7. Turn power source off and disconnect the drive motor from the power source.

Caution: The hydraulic drive motor hose connection will be hot after continuous use. Use gloves when removing the hoses and motor.

Step 8. Remove the drive motor from the cutter/groover.

Step 9. Using a hex wrench in the star-wheel, turn the star-wheel clockwise to retract the slide.

Step 10. Turn the jacking screws on the slides clockwise until the tracking wheels no longer touch the pipe surface.

Step 11. Remove the trip from the stationary ring of the cutter/groover.

Step 12. Loosen the screws in the toe clamps. Be sure to hold the slide if it is at the bottom of the machine so that it does not fall when releasing the toe clamps. Remove the slides from the cutter/groover.

Step 13. Loosen the adjustable clamping legs and remove the cutter/groover from the pipe. If necessary, separate the ring halves to remove the cutter/groover.

2.3.8.8. Splitting the Cutter/Groover Ring. To mount the cutter/groover on a continuous run of pipe, split the machine into halves by loosening the frame locking screws at the split points.

Note: Before mounting the machine on the pipe, have the clamp pads configured for the pipe size as required.

Step 1. Place machine on a secure surface with the rotating ring up.

Step 2. Insert the two frame locking pins to keep the rotating and stationary rings together (**Figure 2.52**).

Step 3. Using the 19 mm socket wrench, loosen nuts on the swing bolts in the rotating ring. Lift the bolts out of the blocks (**Figure 2.53**).

Figure 2.52. Frame Locking Pin.

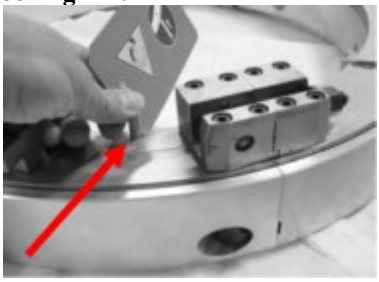
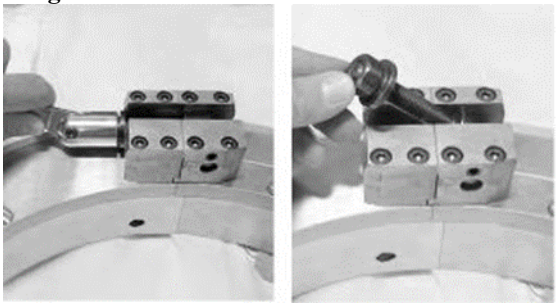
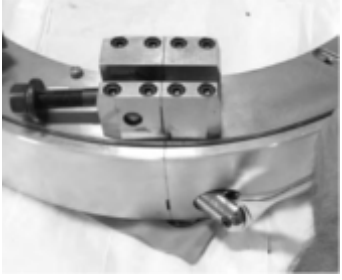


Figure 2.53. Swing Bolt Removal.



Step 4. Using the 19 mm socket wrench, loosen the frame locking bolts until they turn freely (**Figure 2.54**).

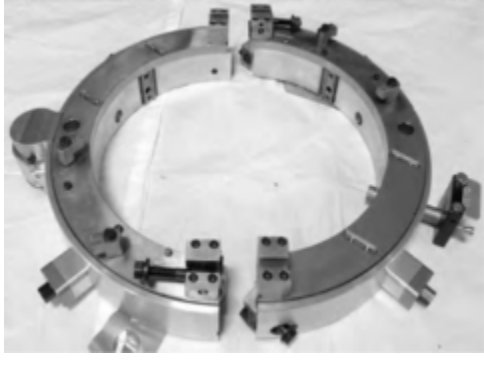
Figure 2.54. Frame Locking Bolt.



Step 5. Pull the halves of the machine apart at the split lines (**Figure 2.55**). Use equal force on each side to separate the halves without binding. **Figure 2.56** shows a separated ring.

Figure 2.55. Ring Halves Separation.

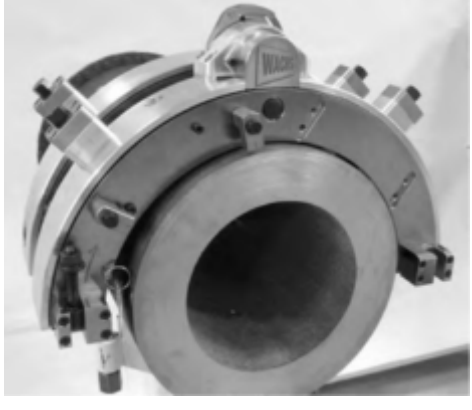
Figure 2.56. Separated Ring.



2.3.8.9. Mounting the Cutter/Groover. Prior to mounting the cutter/groover ring halves, ensure the mating surfaces are clean and free of debris. Wipe down the ends of the stationary and rotating rings thoroughly before putting the machine together.

Step 1. Set the two halves of the cutter/groover on top of the pipe (**Figure 2.57**).

Figure 2.57. Cutter/Groover Ring Halves.



Step 2. Move the halves to positions where you can press them together (**Figure 2.58**).

Figure 2.58. Positioning Cutter/Groover Halves.

Step 3. Engage the swing bolts in the blocks and snug the nuts to hold the halves together (**Figure 2.59**).

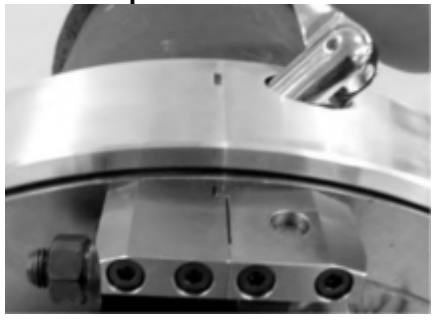
Figure 2.59. Swing Bolt Engagement.

Step 4. Snug the frame locking screws to bring the halves of the machine together (**Figure 2.60**).

Figure 2.60. Tightening Frame Locking Screws.

Step 5. Securely tighten the frame locking screws and the swing bolt nuts. Rotate the machine on the pipe to set the pinion housing at a convenient location for operating the drive motor (usually on the top). There should be no gap at the split line (**Figure 2.61**).

Figure 2.61. Cutter/Groover Split Line.



2.3.9. Air Compressor. Use the air compressor to supply air for pneumatic tools. The air compressor is portable and mounted on a trailer (**Figure 2.62**). Follow operating procedures listed on the equipment and/or in the operator's manual.

Figure 2.62. Portable Air Compressor.

2.3.10. Flowmeter. Use the flow meter (**Figure 2.63**) to measure fuel quantity in gallons. To find flow rate, determine amount of fuel passing through the

meter within one minute. This will be the rate of gallons per minute. See operating procedures listed in the operator's manual.

Figure 2.63. Fuel Flow Meter.

2.3.11. Generator. The diesel generator supplies power to electric tools. The generator is portable with the use of the generator wheel set. See operating procedures listed on the equipment and/or the operator's manual.

2.3.12. Alignment Bar. Use the alignment bar (**Figure 2.64**) to manipulate and align two pipe ends when installing a coupling.

Figure 2.64. Alignment Bar.

2.3.12.1. Use the chain with the ring (**Figure 2.65**) to lasso one of the pipe ends by wrapping the chain around the pipe and then feeding the loose end back through the ring. Feed the loose end of the chain through the ring welded to the sliding grab hook on the bar, then pulled tight, and hooked into the grab hook as shown in **Figure 2.66**. Once attached, manipulate the pipe to align and secure the coupling.

Figure 2.65. Alignment Bar Drawing.

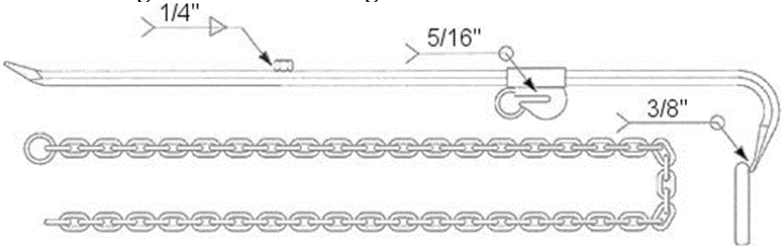
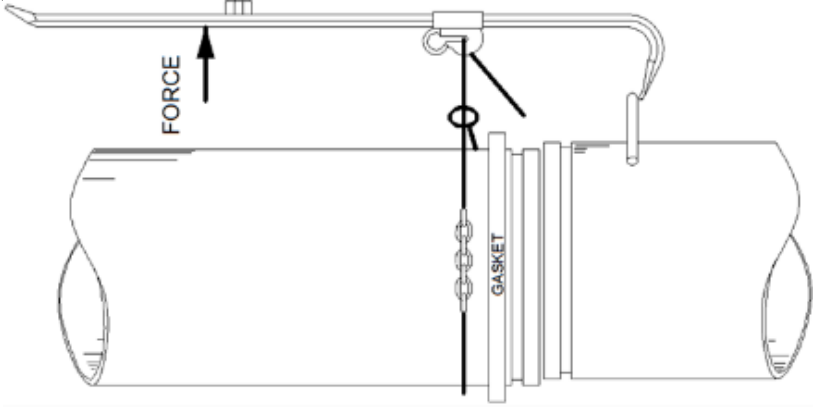


Figure 2.66. Chain Lassoed Around Pipe & Connected to Alignment Bar Chain Hook.

2.3.12.2. Attach the bar as shown in **Figure 2.67** and apply force to lever the pipe ends into alignment to allow installation of a grooved clamp.

Ensure the grooved clamp gasket is on the pipe as shown before bringing the pipes together.

Figure 2.67. Two Misaligned Pipe Ends with Alignment Bar Attached.



Note: In some cases, use the scissor jack to move and hold the pipe in position.

2.3.13. Ventilator. Use the ventilator to ventilate hazardous work areas (**Figure 2.68**). Use it in tight spaces as well as in open areas such as when performing an in-crater repair. There are both electric and pneumatic ventilators. Additional lengths of ducting are included to move vapors far enough to make the work area safe to occupy. For operation, see operating procedures listed in the operator's manual.

Figure 2.68. Ventilator.

2.3.14. Double Diaphragm Pump. Use the double diaphragm pump when pumping fuel or water (**Figure 2.69**). The primary use of this pump is to evacuate fuel or move small amounts of fuel or water from a specific location.

Figure 2.69. Double Diaphragm Pump.

2.3.14.1. Operating Procedures.

Step 1. Place pump inlet hose with the 2-inch strainer into the fuel or water.

Step 2. Connect the pump outlet hose to a fuel/water bladder or intended location.

Step 3. Ground pump using grounding equipment in UTC or to a nearby equipment ground (i.e., air compressor).

Step 4. Start the air compressor using the procedures in the manufacture's operator's manual.

Step 5. Lubricate the air drive by squirting a few drops of oil into the air fitting.

Step 6. Connect the hose from the air compressor to the air caddy, then the air caddy to the pump.

Step 7. Adjust the compressed air flow to modulate the flow of liquid.

2.4. Reconstitution of Consumables. Immediately reorder all items consumed through base supply to help ensure the UTC is kept in mission ready status.

Chapter 3

REPAIR AND BYPASS UTC (4FWRB)

3.1. Overview. This chapter provides procedures to perform expedient or semi-permanent repair and bypass operations to mission critical water and fuel pipelines, valves, manifolds, hydrant systems, and pump houses. Damage to these systems can effectively shut down operations and have a critical effect on combat sortie generation. Having the capability to quickly repair or bypass these systems is an essential capability to ensure the Air Force mission continues despite damage inflicted by adversaries.

3.2. Description. The Repair and Bypass UTC provides expedient repair and bypass capability for a damaged water or fuel system pipeline, valve, manifold, hydrant, or pump house. Repairs include using pipe or layflat hose, valve replacement, or hydrant riser capping. The Consolidated Tools and Equipment UTC supports this UTC.

3.3. UTC Components and Performance Capability. Repair and Bypass is the largest and most versatile WaFERS UTC and offers several solutions to address a wide range of damages. Key components include various valves; thrust and quick connect couplings; clamps, crosses, elbows, end caps; hose ends for cut-to-fit; hoses with pre-installed fittings; pre-grooved aluminum pipe; reducers; and high-pressure stoppers. **Attachment 2** lists all components of this UTC.

3.4. Installation and Operating Procedures. Knowledge and understanding of the existing piping system will facilitate an expedient repair. The Layflat Hose UTC supports repairs requiring long runs with additional hose length. The general capabilities and procedures of the Repair and Bypass UTC have two categories: Line Patch Repair, and Repair and Bypass.

3.5. Line Patch Repair. This UTC can repair four types of minor damage that may occur to a pipeline:

3.5.1. Hole. A single penetration made in a pipe wall (**Figure 3.1**).

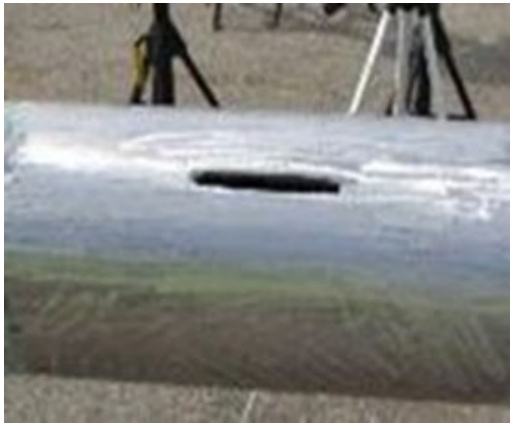
Figure 3.1. Hole in Pipe Wall.

3.5.2. Entrance/Exit Hole. Two penetrations in a pipe from a single projectile (**Figure 3.2**).

Figure 3.2. Entrance/Exit Holes.

3.5.3. **Pipe Slice.** A non-circular elongated penetration made in a pipe wall (**Figure 3.3**).

Figure 3.3. Pipe Slice.



3.5.4. Fitting Penetration. A penetration on an elbow, tee, or other pipe fitting (**Figure 3.4**).

Figure 3.4. Fitting Penetration.

3.6. Line Patch Repair Procedures. The UTC provides several options for repairing different types of damages that may occur on a pipe wall or fitting. These damages typically include small holes similar to bullet holes and slices usually caused by shrapnel. Damage may occur on different diameters of straight run pipe or on a pipe fitting, such as an elbow or tee. A thorough understanding of the different damage types, as well as the available repair methods, will facilitate proper expedient repair methods. The decision matrix in **Table 3.1** can aid in determining the proper repair procedure for given scenarios. Take into account pipe surface preparation and UTC hardware and material quantities when selecting a repair method.

Table 3.1. Line Patch Decision Matrix.

Repair Method (ANSI 150 Class)	Hole	Slice	Entrance/Exit Hole	Damaged Fitting	Notes:
Pajano Wood Plugs	A	S	A	S	Round/Semi-round Holes Above Grade Only
NRI Composite Wrap	S	A	A	A	Medium to Large Holes Above and Below Grade
PLIDCO® Pin Hole Clamp	A	N/A	N/A	S	Round Holes up to ¾-inch Above Grade Only
JCM 102 Universal Clamp	A	A	A	S	All Damage Shapes Above and Below Grade

Legend:

A	Acceptable for Use	S	Situationally Dependent, Verify Fit	N/A	Not Applicable for use

3.6.1. Wrap Kit. For ANSI 150 Class pipelines, use the wrap kit to repair holes, slices and entrance/exit holes in both straight pipe sections and fittings such as elbows or tees. The general procedure to perform this type of repair follows.

Caution: When using the wrap kit, do not allow the epoxy to contact skin. Wear nitrile gloves when working with epoxy.

Step 1. Obtain the wrap kit from the Repair and Bypass UTC and the bristle sander from the Consolidated Tools and Equipment UTC. Check the condition of the wrap kit components and ensure all parts are included and epoxy material is in a usable form (not hardened).

Step 2. Measure and mark 4 inches from each side of the defect area. Place painters' tape, or equivalent, around the pipe circumference four inches from edge of the damaged area.

Step 3. Remove any pipe coating, rust, or debris from the entire defect area (inside the taped area) using pipe surface preparation tools such as the bristle sander (**Figure 3.5**). Refer to **Chapter 2** for proper operation of the surface preparation tools and the air compressor. Clean the inside pipe surface around the defect area with the provided emery cloth.

Step 4. Put on the provided nitrile gloves and clean the pipe using the provided cleaning wipes. Clean off any lint remaining with a clean brush or nitrile gloved hands.

Figure 3.5. Pipe Surface Preparation.

Step 5. Place a corner of the yellow fiberglass sheet over the defect and trace a ring on the fiberglass sheet 0.5-inch in diameter larger than the defect for 4-inch diameter or smaller pipe, or 1-inch in diameter larger than the defect for 6-inch diameter or larger pipe.

Step 6. Cut out the ring traced on the fiberglass sheet with scissors.

Step 7. Cut a small slit into the center of the fiberglass patch. Place a flat washer onto the provided retaining bolt and insert the bolt with washer into the patch (**Figure 3.6**).

Figure 3.6. Fiberglass Patch with Retaining Bolt.

Step 9. Test patch size by carefully folding the patch and inserting into the pipe while being careful not to drop the patch or contaminate with fuel, water or other debris.

Step 10. Remove patch from the pipe and sand the patch surface where the patch will contact the pipe surface.

Step 11. Mix equal parts of epoxy. Immediately stir the two-part epoxy with a mixing stick until it is uniformly gray.

Step 12. Install patch in the pipe leaving room to apply the epoxy on inside pipe surface and the patch (**Figure 3.7**).

Figure 3.7. Patch Installed in Pipe.

Step 13. Apply mixed epoxy to the rough side of the patch with the mixing stick and apply the epoxy around the inside edge of the defect.

Step 14. Pull up on the patch and rotate the patch allowing the epoxy to spread on the entire patch and pipe surface.

Step 15. While holding the patch in place with the retaining bolt, apply the remaining mixed epoxy into the defect area, filling the void around the bolt and spreading the epoxy outward, away from the defect area (**Figure 3.8**).

Figure 3.8. Void Filled around Bolt.

Step 16. Place repair bridge over the retaining bolt and repair area making sure the bridge feet contact the pipe, not the defect area or epoxy. Lock retaining bolt into the repair bridge with the provided wing nut.

Note: The wing nut does not need to be tight, just thread the wing nut until it contacts the bridge. Overtightening will pull the patch into the defect area and separate the patch surface from the pipe surface.

Step 17. Let epoxy set for approximately five minutes. After setting, remove the wing nut and repair bridge. Cut the retaining bolt at the repair surface and lightly sand the epxoy surface (**Figure 3.9**). Then, clean with provided cleaning wipes.

Figure 3.9. Epoxy Set and Retaining Bolt Cut.

Step 18. Open wrap packaging. If wrap feels hard to the touch, discard and use a different package.

Step 19. Submerge roll of wrap in water and let soak for roughly 30 seconds.

Step 20. Remove and unroll. Starting in center of repair area, place start of roll on the pipe surface and wrap over defect area. Two people tightly wrap the pipe overlapping each wrap by half the width of the wrap (**Figure 3.10**). Spray water during application of the wrap to keep material wet.

Step 21. Continue wrapping pipe until reaching end of prepared surface. Make a full wrap on the end and continue wrapping back towards the

other end of the repair area overlapping each wrap by half the width of the wrap.

Step 22. Repeat this process until applying three total wraps on repair area. If repair is longer than 12 inches, add one wrap over entire repair for every additional four inches.

Figure 3.10. Applying Wrap.

Step 23. Using the compression film, perform same wrapping procedures starting where the wrap was completed and work in opposite direction as the wrapping was installed (**Figure 3.11**).

Figure 3.11. Applying the Compression Wrap.

Step 24. Wrap the pipe twice with the compression film and perforate (**Figure 3.12**).

Figure 3.12. Perforating Compression Film.

Step 25. Wait 30 minutes for the completed repair (**Figure 3.13**) to cure before pressurizing the pipe.

Figure 3.13. Completed Wrap Repair.

Step 26. After repair is set (hard/dry to the touch), begin fueling operations. Continuously monitor repair for leaks as the system pressure increases.

Step 27. If minor leaks occur, stop fueling operation and remove the wrap and plastic seal. Check surface conditions, re-surface pipe and install a new wrap repair following steps above.

3.6.2. Wood Plugs. For ANSI 150 Class pipelines, use wood plugs to repair holes up to five inches in diameter on straight pipe sections, or in some cases the straight section of large fittings if size allows. The general procedure to perform this repair follows.

Step 1. Obtain wood plugs (**Figure 3.14**) in the appropriate size, and mallet from the Repair and Bypass UTC. Obtain the 3-pound sledgehammer and water bucket from the Consolidated Tools and Equipment UTC.

Figure 3.14. Wood Plugs.

Step 2. Fill bucket with water and soak wood plugs for approximately 30 minutes.

Step 3. While plugs are soaking, remove any burrs or protrusions on the edges of the damage with a file.

Note: Coat wood plugs with epoxy from the wrap kit to ensure fuel does not soak into the wood plug.

Step 4. Insert appropriately sized wood plug into hole and use the mallet or sledgehammer to secure the plug (**Figure 3.15**). Drive the wood plug into the hole until the leak is sealed.

Figure 3.15. Inserting a Wood Plug into Hole.

Note: Use ratchet straps from the Consolidated Tools and Equipment UTC to strap the plug into the pipe after installation to improve holding strength (**Figure 3.16**).

Figure 3.16. Ratchet Strap Increasing Holding Strength of Wood Plugs.

Step 5. Begin fueling operations and continuously monitor repair for leaks as the system pressure increases. If minor leaks occur, place a container underneath repaired pipe and monitor for increased leakage.

3.6.3. Clamp Repair. For ANSI 150 Class pipelines, use the clamp repair to repair holes up to three-quarters inch on straight pipe sections, or in some

cases the straight section of large fittings, if size allows. The general procedure to perform this repair follows:

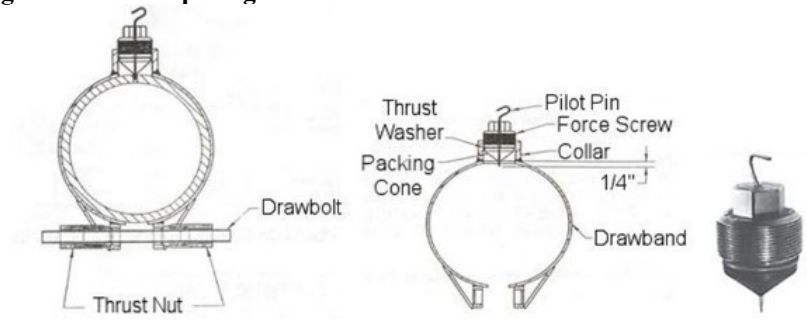
Step 1. Obtain clamp (**Figure 3.17**) in appropriate pipe size from the Repair and Bypass UTC and necessary tools required for the specific job from the Consolidated Tools and Equipment UTC.

Figure 3.17. Various Size Clamps.

Step 2. Using surface preparation tools from the Consolidated Tools and Equipment UTC, remove all coating, rust and scale from the pipe surface around the defect.

Step 3. Adjust pilot pin so it protrudes one quarter-inch beyond packing cone. Adjust force screw until the tip of packing cone is flush with inside surface of the clamp (**Figure 3.18**).

Figure 3.18. Clamp Diagram.



Step 4. Open clamp to fit around the pipe and position near the hole to repair.

Step 5. Use the pilot pin to locate the hole and position the clamp.

Step 6. Hold clamp firmly in position until the draw-bolt and thrust nuts are hand tightened.

Step 7. Tighten draw-bolt to the specified torque value as shown in **Table 3.2**.

Table 3.2. Draw-bolt Torque Specifications.

Draw Bolt Size (in.)	Torque (ft-lbs.)	Torque (Nm)
1/2 – 13	25 – 35	34 – 47
5/8 – 11	50 – 60	68 – 81

Step 8. Remove the pilot pin (**Figure 3.19**). Be aware if the line is pressurized the pin may become a projectile.

Figure 3.19. Removing the Pilot Pin.

Step 9. Tighten the force screw until the hole is sealed. The pilot pinhole will collapse on itself while tightening the force screw.

Step 10. Begin fueling operations and continuously monitor repair for leaks as the system pressure increases. If minor leaks occur, tighten the force screw again until the leak stops. If the leak will not stop, discontinue fueling operations and remove the clamp. Check the hole for irregularities, file down if necessary, and re-install the clamp as described above.

5.4.4. Universal Clamp Coupling. For ANSI 150 Class pipelines, use the universal clamp coupling to repair holes, slices, or entrance/exit holes in straight pipe sections. The general procedure to perform this repair follows.

Step 1. Obtain the appropriately sized universal clamp coupling (**Figure 3.20**) from the Repair and Bypass UTC and the necessary tools required for the specific job from the Consolidated Tools and Equipment UTC.

Figure 3.20. Universal Clamp Coupling.

Step 2. With surface preparation tools from the Consolidated Tools and Equipment UTC, clean and scrape the damaged pipe section. Remove any scale, pipe wrap, coating, debris or dirt that may interfere with the gasket sealing.

Step 3. Inspect pipe for integrity, size, outside diameter, and surface irregularities. Confirm the diameter of the repair clamp.

Step 4. Verify the damage does not exceed the width of the clamp. Mark width of clamp on the pipe to help center the clamp during installation.

Step 5. Lubricate pipe and clamp gasket with soapy water. DO NOT USE OIL BASED PIPE LUBRICANTS.

Step 6. Place clamp over the damaged area and hand-tighten bolts to hold clamp in place.

Step 7. Tighten bolts (5/8-inch bolts to 70 ft-lbs and 3/4-inch bolts to 90 ft-lbs) evenly with the torque wrench.

Step 8. Begin fueling operations and continuously monitor the repair for leaks as the system pressure increases. Tighten bolts if minor leaks occur. If leaks persist, an irregularity on the pipe surface may require additional

surface preparation or the clamp position requires adjustment to correct the issue.

Step 9. Continue to monitor repair for leaks.

3.7. Bypass Repair. After an attack or natural disaster, it is highly possible a section of fuel system piping would be damaged or destroyed and would need to be placed back in service as quickly as possible. In certain circumstances, UXO or other hazardous conditions may prevent reinstalling the pipe in the same location. The Repair and Bypass UTC provides the capability to redirect fuel around the hazardous areas and then reconnect into intact piping downstream (**Figure 3.21**). To minimize repair time, simultaneously perform many of the following steps where applicable. The following procedures are for 6-inch through 12-inch pipeline.

Figure 3.21. Typical Bypass Repair.

3.7.1. Safety. Adhere to the following safety precautions when bypassing UXO or other hazardous conditions. A vapor toxicity monitor is not included in WaFERS. Obtain from shop equipment and bring to work site.

3.7.1.1. Safety hazards such as UXO and explosive fuel vapors may exist. No one shall enter work area until directed by the Team Chief and LEL is below 1%.

3.7.1.2. Wires, airlines and hoses present tripping hazards. Be aware of these hazards or serious injury to personnel may happen.

3.7.1.3. Personnel will not enter a work area, and will leave the work area, when LEL is above 1%. LEL greater than 1% presents a breathing hazard.

3.7.1.4. Monitor LEL until repair is complete. Toxic fuel vapors could cause serious injury to personnel. Position vapor toxicity monitor sampling hose end at lowest point in work area. Set to ALARM position.

3.7.1.5. If LEL goes above 1% and/or alarm sounds, evacuate work area and start ventilator. Reenter work area when LEL is below 1%.

3.7.2. Operating Procedures.

Step 1. Expose a minimum of 20 inches of undamaged pipe that is free of debris, earth and obstructions to position tools and equipment for repair.

Step 2. Remove coating material from pipe using the pipe prep tool (**paragraph 2.3.7**) or bristle sander (**paragraph 2.3.2**). For yellow jacket coating, use a linoleum knife to remove the polyethylene outer layer and use the drawknife to remove heavy adhesive. Use mineral spirits to clean exposed metal as needed. Find knives and mineral spirits in the Consolidated Tools and Equipment UTC.

Note: The cutter/groover, guillotine pipe saw and the thrust couplings can typically handle hard surface coatings such as Fusion-Bonded Epoxy or paint if the surface is intact. Remove damaged coating to bare metal if it causes misalignment

while mounting equipment. Remove soft coatings such as insulation and lagging prior to repairs.

Note: Remove approximately nine inches of coating to mount the cutter/groover. Remove 12 inches of coating to mount the guillotine pipe saw.

Step 3. Visually inspect pipeline. Select and mark cut locations on both sides of damage where pipeline appears to be round and straight.

Step 4. Remove pipe coating and install ground clamp on exposed pipe.

Step 5. If necessary, drain pipeline of fuel using the fuel extraction kit (**paragraph 2.3.6)**.

Step 6. Use the cutter/groover to cut and install a groove on the pipes. If pipe stresses are a concern, use the guillotine pipe saw to first sever the pipe, and then use the cutter/groover to make the groove. Refer to **Chapter 2** for tool operating procedures.

Step 7. Use rags to clean and remove debris from inside and outside the pipe.

Caution: Cut edges are extremely sharp and may have burrs. Use a hand file to smooth edges if necessary.

Step 8. Lay material out for the new bypass line. Use elbows and hard hoses to bring bypass line out of the hazardous area. Use layflat hose to reconnect the line. Provide enough room for fittings, valves, reducers, pipes and hoses as needed.

Note: Multiple hard hoses may be required to connect the layflat hose safely to the prepared pipe. Assemble hard hoses outside the crater, then, if available, use the excavation equipment to put assembled hoses into the crater to make the pipe connection.

Note: Avoid running bypass in high traffic areas unless properly bridged.

Step 9. Cut Layflat hose to fit the repair, install the hose barb and install hose-clamping ring with bonding according to the procedures described in **Chapter 4**.

Note: Be aware layflat hoses may straighten when pressurized and may move until reaching a settling point. Remove any debris, equipment and tools from immediate vicinity of layflat hose before pressurizing to prevent damage.

Step 10. Assemble the bypass line between cut ends of the pipe using grooved couplings. Tighten the grooved coupling bolts until the coupling's end surfaces meet.

Note: If grooved couplings run short, use thrust couplings (capable of installing on grooved pipe ends) as a replacement. **Table 3.3** identifies torque requirements for the thrust couplings.

Table 3.3. Thrust Coupling Torque Specifications.

PIPE SIZE	TORQUE
6-inch	45 ft.lbs / 60 Nm
8-inch	75 ft.lbs / 100 Nm
10-inch	135 ft.lbs. / 180 Nm
12-inch	170 ft.lbs. / 230 Nm
14-inch	170 ft.lbs. / 230 Nm

3.7.3. Test Repair. Do not stand within 50 feet of the repair when being pressurized. If repair fails, serious injury to personnel could result.

Step 1. Notify the CE Unit Control Center (UCC) of repair completion and coordinate pressure test.

Step 2. Pressurize the pipeline. Stop fuel flow immediately if the repair fails or leaks a steady flow of fuel.

Step 3. Report any leakage to the CE UCC and request further instruction.

Note: If repair leaks, the CE UCC will determine if further action is required.

3.8. Bypass a Damaged Manifold. Utilize the Repair and Bypass UTC to continue fueling operations as quickly as possible after damage to, or destruction of, a piping manifold system (**Figure 3.22**). The following procedures cover repairs for 6-inch through 12-inch pipelines. To minimize repair time, perform many steps of the following procedures simultaneously. Follow steps shown in **paragraph 3.7.2** for each pipeline in the manifold system that requires repair. Expect installation of several bypasses to return the manifold back to operation.

Figure 3.22. Typical Pump House Manifold.

Note: Pay particular attention to each bypass layout. Organize lines to prevent tangling, overlaying, or interfering with other bypasses during pressurization.

Note: In certain circumstances, a main line may require branching into multiple outlet lines. Utilize grooved tees, crosses, reducers and elbows as needed to configure the pipe layout accordingly (**Figure 3.23**). Install grooved valves where necessary to control flow operations.

3.9. Bypass Damaged Pump House. Use this UTC in combination with the Water and Fuel Pump UTC and the Fuel Filter UTC to bypass a damaged or destroyed pump house and re-establish pumping capabilities (**Figure 3.24**).

3.9.1. Use the following general procedures to re-route fuel around a damaged or destroyed pump house. Reconnect to intact piping downstream with a pump and filter. The following procedures cover 6-inch through 12-inch pipelines. To minimize repair time, perform many steps in the following procedures simultaneously.

Figure 3.23. Multiple Bypass Lines and Branch Lines Example.

Figure 3.24. Typical Connected Fuel Pump and Fuel Filter.

3.9.2. Follow steps shown in **paragraph 3.7.2** to install the bypass line around the damaged pump house. Plan to connect the fuel pump and fuel filter at a suitable location in the line. Refer to **Chapter 5** for proper fuel pump setup and operation. Refer to **Chapter 6** for proper fuel filter setup and operation.

3.9.3. Hard hoses are required for the pump suction side. Use layflat hoses for the discharge side.

3.9.4. The fuel pump and fuel filter can be set up for 4-inch or 6-inch connections. If required, utilize reducer fittings to match.

3.10. Inline Repair. This repair replaces a damaged section of pipe with hard pipes or layflat hoses. The following procedures cover 6-inch through 12-inch pipelines. To minimize repair time, perform many steps in the following procedures simultaneously.

3.10.1. Safety. Adhere to the following safety precautions when performing an inline repair.

3.10.1.1. No one shall enter the work area until directed by the Team Chief and the LEL is below 1%. Safety hazards such as UXO and explosive fuel vapors may exist.

3.10.1.2. Wires, airlines and hoses present tripping hazards. Failure to exercise caution could cause serious injury to personnel.

3.10.1.3. Personnel will not enter a work area, or will leave a work area, when the LEL is above 1%. LEL greater than 1% will present a breathing hazard.

3.10.1.4. Monitor LEL until repair is complete. Toxic fuel vapors may cause serious injury to personnel.

3.10.1.5. Position vapor toxicity monitor sampling hose end at lowest point in the work area. Set to ALARM position.

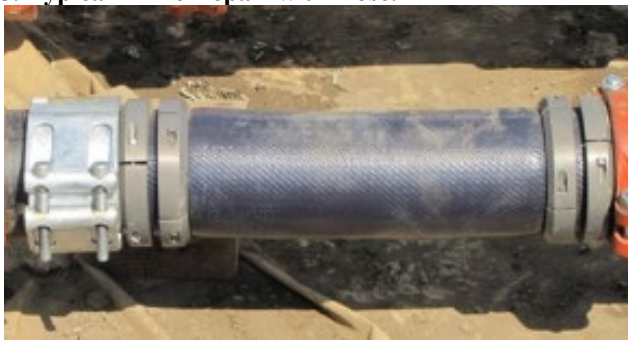
Note: A vapor toxicity monitor is not included with WaFERS. Obtain from shop equipment and bring to work site.

3.10.1.6. If LEL goes above 1% and/or alarm sounds, evacuate work area and start ventilator.

3.10.1.7. Reenter crater when LEL is below 1%.

3.10.2. Inline Repair Procedures with Layflat Hose. Make typical inline repairs using a grooved coupling on one end and a thrust coupling on the other. This allows simultaneous cuts using the cutter/groover and guillotine saw, as well as allowing for small clearance/fit issues on the thrust coupling side (**Figure 3.25**).

Figure 3.25. Typical Inline Repair with Hose.



3.10.2.1. Operating Procedures.

Step 1. Expose a minimum of 20 inches of undamaged pipeline. Ensure pipe is clear of debris, earth, and obstructions to allow positioning of repair tools and equipment.

Step 2. To remove typical pipe coating material, see procedures in **paragraph 2.3.7** for pipe prep tool, or **paragraph 2.3.2** for bristle sander instructions. For yellow jacket coating, use a linoleum knife to remove the polyethylene outer layer and use the drawknife to remove the heavy adhesive. Use mineral spirits to clean exposed metal as needed. Locate knives and mineral spirits in Consolidated Tools and Equipment UTC.

Note: The cutter/groover, guillotine pipe saw, and the thrust couplings can typically handle hard surface coatings such as Fusion Bonded Epoxy, or paint, if the surface is intact. Remove damaged coating to bare metal if it causes misalignment while mounting equipment. Remove soft coatings such as insulation and lagging prior to making repairs.

Note: Remove approximately nine inches of coating to mount the cutter/groover. For the guillotine pipe saw, remove 12 inches of coating for mounting.

Step 3. Visually inspect pipeline. Select and mark cut locations on both sides of the damage, where the pipeline appears to be straight and round.

Note: Minimum distance between the ends of the cut pipes should be no less than 24 inches. Misaligned pipe ends may require a slightly longer hose. Maximum repair length is dependent upon the amount of hose available.

Step 4. Install ground clamp.

Step 5. Drain fuel from pipeline into a suitable tank/container; use the fuel extraction kit if necessary. Refer to **paragraph 2.3.6** for operating procedures.

Step 6. Cut pipeline using the guillotine pipe saw or the cutter/groover. Use thrust couplings for guillotine pipe saw cuts and grooved couplings for cutter/groover cuts. Refer to **Chapter 2** for operating procedures of both tools.

Step 7. Use rags to clean and remove debris from inside and outside pipeline.

Caution: Cut edges are extremely sharp and may have burrs. Use a hand file to smooth edges if necessary.

Step 8. Measure distance between the cut ends.

Step 9. Cut the layflat hose to fit the length measured in Step 8, and then install the hose barb and hose clamping ring with bonding according to procedures described in **Chapter 4**. Repeat for other end of hose if necessary.

Step 10. Assemble the pipeline repair section with layflat hose between the cut ends of the pipe. Use thrust couplings, grooved couplings, or a combination of both to attach the hose to the pipe. **Table 3.3** identifies torque requirements for the thrust couplings. Tighten the grooved coupling bolts until the coupling surfaces meet.

Note: Both ends of the layflat hose will have grooved ends. Use the thrust coupling on a grooved pipe end if necessary.

Note: Recommend NOT using an inline repair with layflat hose in areas requiring backfill.

Step 11. Inform the CE UCC that the repair is complete and coordinate pressure test.

Warning: Do not stand within 50 feet when pressurizing a repair. If the repair fails, serious injury to personnel could result.

Step 12. Pressurize the pipeline. Stop fuel flow immediately if repair fails or leaks a steady flow of fuel.

Step 13. Report any leakage to the CE UCC and request further instruction.

Note: If repair is leaking, the UCC will determine if further action is required.

3.10.3. Inline Repair Procedures with Aluminum Pipe. The Repair and Bypass UTC contains 8-inch and 10-inch aluminum pipe for inline pipe repair. This UTC also contains 6-inch by 8-inch reducers and 10-inch by 12-inch reducers. With these components, repairs can be made on 6-inch through 12-inch pipeline (**Figure 3.26**). To minimize repair time, perform many steps in the following procedures simultaneously. Typically, make inline repairs using a grooved coupling on one end and a thrust coupling on the other. This allows cutting with both the cutter/groover and the guillotine saw simultaneously and tolerates small clearance/fit issues on the thrust coupling side.

Figure 3.26. Typical Inline Repair with Aluminum Pipe.

3.10.3.1. Operating Procedures.

Step 1. Expose a minimum of 20 inches of undamaged pipeline. Ensure pipe is clear of debris, earth, and obstructions to allow positioning of repair tools and equipment.

Step 2. Remove coating material from pipe; see procedures in **paragraph 2.3.7** for pipe prep tool, or **paragraph 2.3.2** for the bristle sander instructions. For yellow jacket coating, use a linoleum knife to remove the polyethylene outer layer and use the drawknife to remove the heavy adhesive. Use mineral spirits to clean the exposed metal as needed. Locate the knives and mineral spirits in the Consolidated Tools and Equipment UTC.

Note: Use the cutter/groover, guillotine pipe saw and the thrust couplings on hard surface coatings, such as Fusion Bonded Epoxy or paint, if the surface is intact. Remove damaged coating to bare metal if misalignment occurs when mounting equipment. Always remove soft coatings, such as insulation and lagging, prior to making repairs.

Note: Remove approximately nine inches of coating to mount the cutter/groover. For the guillotine pipe saw, remove 12 inches of coating to mount equipment.

Step 3. Visually inspect pipeline and select/mark cut locations where pipeline appears to be round and straight on both sides of damage.

Note: if pipe is not 8 inches in diameter, account for the additional space required to accommodate the necessary reducer fittings.

Note: Minimum distance between pipe ends is 12 inches. Distances less than 12 inches increases the difficulty when using the cutter/groover or guillotine saw. Combine the 7-foot sections of aluminum pipe for repairs longer than seven feet. Make distance between cuts divisible by seven, if possible, plus the length required for reducers, to minimize cutting and expedite the repair.

Step 4. Measure distance between selected cut locations.

Step 5. Install ground clamp.

Step 6. If necessary, drain pipeline of fuel using the fuel extraction kit. Refer to **paragraph 2.3.6** for operating procedures.

Step 7. Cut pipeline using the guillotine pipe saw or the cutter/groover. Use thrust couplings for guillotine pipe saw cuts, and use grooved couplings for cutter/groover cuts. Refer to **Chapter 2** for operating procedures of both tools.

Step 8. Use rags to clean and remove debris from inside and outside pipe adjacent to the cuts.

Caution: Cut edges are extremely sharp and may have burrs. Use a hand file to smooth edges if necessary.

Step 9. Cut aluminum pipe to the required length.

Note: The supplied aluminum pipes have a pre-cut groove at each end. Mount the pipe on the pipe stand and use the guillotine saw to cut the pipe at the proper length. When cut is complete, the pipe will have one grooved end and one plain end.

Note: If the pipe length required is more than the supplied 6-foot 8-inch section, multiple sections can be combined using grooved couplings and then cut to fit.

Step 10. Assemble repair section between the cut ends of the pipe. Use a grooved coupling to connect the grooved end to the pipe previously cut by the cutter/groover. Use a thrust coupling to connect the plain end to the pipe previously cut by the guillotine saw. If necessary, use a thrust coupling on the grooved pipe end. **Table 3.3** identifies the torque requirements for the thrust couplings. Tighten the grooved coupling bolts until the coupling's surfaces meet.

Step 11. Notify the CE UCC of repair completion and coordinate pressure test.

Warning: Do not stand within 50 feet when initially pressurizing a repair. Otherwise, serious injury to personnel could result if the repair fails.

Step 12. Have the pipeline pressurized. Stop fuel flow immediately if the repair fails or leaks a steady flow of fuel. Report any leakage to the CE UCC and request further instruction.

Step 13. If repair is successful, backfill repaired pipeline.

Warning: Adequately support pipe section(s) with bedding or fill material prior to backfilling. Failure to support the repaired pipeline could result in a catastrophic failure of the repair.

3.11. Cap Repair of Damaged Hydrant Valve. A destroyed aircraft refueling hydrant valve may require valve removal, and then plugging the standpipe to al-

low the intact sections of the hydrant loop to continue operating. Use this capability to make two 4-inch and two 6-inch hydrant cap repairs.

Warning: Valve pit areas are normally classified as confined space entries and require specialized procedures and equipment to safely work in. Refer to AFMAN 91-203, *Air Force Occupational Safety, Fire, and Health Standards* for confined space entry requirements before any personnel attempt entry. Utilize the tripod, winch, and safety harness for safe access into and emergency egress out of the valve pit (**Figure 3.27**).

Figure 3.27. Safely Accessing Valve Pit.

3.11.1. Operating Procedures.

Step 1. Assess the damaged area. Identify hydrant valves that require removal and capping to maintain system integrity.

Step 2. Secure the damaged hydrant valve to a backhoe with lifting straps or other material handling equipment to prepare for removal. If accessible, stuff a rag in the pipe to prevent metal shavings and other debris from entering the system.

Step 3. Use the reciprocating saw, or the mini guillotine saw, to cut the standpipe below the damaged hydrant valve. Keep saw blades lubricated during cutting. See **paragraph 2.3.1** for the reciprocating saw, and **paragraph 2.3.5** for the mini guillotine saw, operating procedures.

Step 4. Lift damaged hydrant valve out of the valve pit and properly discard (**Figure 3.28**).

Figure 3.28. Removing Damaged Hydrant from Valve Pit.

Step 5. Check remaining pipe stub for surface conditions and dents (**Figure 3.29**). Remove burrs or jagged edges. If necessary, cut pipe at a lower height for better pipe conditions. Use the mini guillotine saw or reciprocating saw to cut the pipe. See **Chapter 2** for saw operating procedures. Remove the rag previously placed inside the pipe and clean out any excess metal shavings inside the pipe.

Step 6. Install high-pressure pipe plug (**Figure 3.30**) and tighten with the pneumatic or manual impact wrench. Use the vent valve on the plug to release any trapped air within the system during system pressurization.

Warning: Ensure proper installation and torque of the plug; otherwise, this repair could become a projectile during system pressurization and surge.

Figure 3.29. Hydrant Valve Pipe Stub.

Figure 3.30. High Pressure Pipe Plug Installed.

Step 7. Notify the CE UCC of repair completion and coordinate a pressure test.

Warning: Do not stand within 50 feet of repair during pressurization. If the repair fails, serious injury to personnel could result.

Step 8. Have the pipeline pressurized. Stop fuel flow immediately if the repair fails or leaks a steady flow of fuel. Report any leakage to the CE UCC and request further instruction.

Note: If leaks are present, the CE UCC will determine if further action is required.

3.12. Special Considerations.

3.12.1. Standard material handling equipment, obtained from the base civil engineer shops or rented locally, will be required to move or position equipment and material.

3.12.2. Ventilation equipment may be required for confined space areas and is available in the Consolidated Tools and Equipment UTC.

3.12.3. Site preparation equipment is situationally dependent on items such as lighting and electrical generators, which are available in the Consolidated Tools and Equipment UTC.

3.12.4. Properly ground and/or bond all operating electrical equipment. Reference the Consolidated Tools and Equipment UTC for equipment specifications.

3.12.5. Ensure personnel use appropriate PPE when performing repairs.

3.12.6. Repairs require cutting metal pipes and may result in metal shavings remaining in the system, which may require flushing specific systems.

3.12.7. Atmospheric monitoring equipment is NOT contained in WaFERS. Utilize shop equipment for this function.

3.13. After Repair Actions. Check connections and hoses for leaks. Ensure hoses are not twisted and remain clear of sharp objects. Finally, check the overall condition of hoses and pipes.

3.14. Periodic Inspection. Perform frequent inspections of hoses, pipes and connections and monitor for leaks.

3.15. Reconstitution of Consumables. Immediately reorder all items consumed through base supply to ensure the UTC is in mission ready status.

Chapter 4

LAYFLAT HOSE UTC (4FWLH)

4.1. Overview. The Layflat Hose UTC is a collection of hoses, couplings and clamps to replace above grade pipe (**Figure 4.1**). Layflat hose is primarily a supplemental capability that provides extra hose required for long runs such as bypassing a pump house to get fuel to a hydrant system. The UTC contains 50-foot lengths of 6-inch, 8-inch and 10-inch diameter hoses and couplings to address the most common pipe sizes across the installation enterprise. Each hose has preinstalled end fittings to expedite installation. Also, use layflat hose for cut-to-length inline repairs. Find a full list of UTC components in **Attachment 2**. The Consolidated Tools and Equipment UTC support this UTC.

Figure 4.1. Assembling Layflat Hose.

Note: One 50-foot x 12-inch layflat hose is available in the Repair and Bypass UTC (4FWRB). Find additional couplings and fittings in the Repair and Bypass UTC.

4.2. Description. Use this UTC to replace long pipe runs and provide additional layflat hose with connectors to support bypass repair capabilities for a damaged water or fuel system pipeline, valve, manifold, hydrant, pump house, or hazardous area. Use layflat hoses to:

4.2.1. Temporarily replacing damaged pipe in above grade applications.

4.2.2. Bypass damaged areas with significant sections of above-grade pipe.

4.2.3. Create custom repair lengths with “cut-to-size” capability.

4.2.4 Repair systems with piping diameters of 6-inch, 8-inch and 10-inch.

4.2.5 Replace piping in pressurized systems as listed in **Table 4.1**.

4.3. General Safety. Be aware of hazardous conditions when installing layflat hose and adhere to the following safety guidelines.

4.3.1. Use of knives and shears pose slicing and cutting hazards.

4.3.2. Snap-on hose fittings pose pinching and crushing hazards.

4.3.3. Stand clear of hose while pressurizing.

4.3.4. When possible, avoid placing layflat hose across pedestrian walkways; an inflated hose poses an unexpected trip hazard.

4.3.5. Do not bury layflat hose.

4.3.6. Do not place hose in areas where vehicle traffic is required to pass over the hose unless a bridge is protecting the hose.

4.3.7. Do not use layflat hose in pump suction applications.

4.3.8. Avoid placing layflat hose on sharp objects.

4.4. Hose End Fitting Installation Procedures. Refer to **Table 4.1** for hose operating pressure and additional information and then perform the following steps to perform an inline repair.

Table 4.1. High Pressure Layflat Hose Properties.

Inside Diameter	**6”**	**8”**	**10”**	**12”**
Burst Pressure	725 PSI	575 PSI	450 PSI	410 PSI
Max Allowable Operating Pressure	290 PSI	230 PSI	220 PSI	170 PSI
Tensile Strength	40,000 LBS	44,000 LBS	80,000 LBS	121,000 LBS
Average Weight	1.5 LBS/FT	2.0 LBS/FT	2.5 LBS/FT	3.3LBS/FT
Note: Find 12-inch hose in the Repair and Bypass UTC.				

Note: Layflat fuel hose has small conductive copper wires molded within to provide a method to bond both ends of the hose electrically.

Note: The following procedure assumes a preinstalled, electrically bonded to at least one bond wire, hose end. If installation of both ends is required, add six extra inches to the required hose length, three inches for each end.

Step 1. Measure the required length of hose and add three inches. Cut the hose squarely to this length.

Step 2. Locate the electrical bonding wire electrically connected to the installed end and mark its location. Draw another line squarely 3 inches from the hose cut end (**Figure 4.2**).

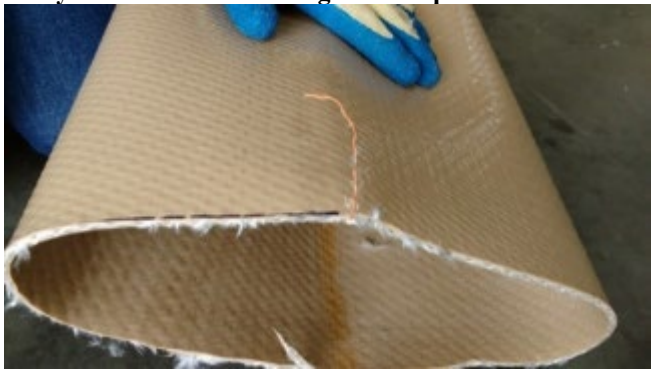
Note: If multiple bonding wires are present, use the same wire at each end to ensure electrical connection; use an electrical continuity meter to verify. Bonding wires typically run parallel with the hose length.

Step 3. Expose three inches of the electrical bonding wire from the hose wall.

Figure 4.2. Squarely Marking the Layflat Hose.

Step 4. Cut off the previously marked three inches of hose using care not to cut off the bonding wire. The outcome should look like **(Figure 4.3).**

Figure 4.3. Layflat Hose with Bonding Wire Exposed.



Step 5. Initiate inserting the correct size hose end fitting **(Figure 4.4)** into the end of the layflat hose as shown in **Figure 4.5**. This may require reaching into the hose end to push the hose wall out while pushing the hose end in as straight as possible. A rubber hammer may be required to assist in the initial insertion.

Figure 4.4. Layflat Hose End Fitting

Figure 4.5. Inserting Hose End Fitting into the Layflat Hose End

Step 6. Once the hose end starts to enter the hose, lift hose with the end downward and pound the hose, with the fitting partially inserted, onto a piece of wood as shown in **Figure 4.6**. If needed, spray hose and hose end fitting with soapy water to ease the insertion process.

Note: If the hose end fitting is powder coated or anodized, remove approximately 1-inch of coating from the surface where the bond wire will make contact before completely inserting and seating the hose end.

Figure 4.6. Installing Hose End Fitting.

Step 7. After completely inserting the hose end fitting, coil the bonding wire so that it will remain approximately ½-inch in diameter. Lift the hose end and carefully slide the coil between the hose and the end fitting using a small screwdriver or other instrument. It should look like **Figure 4.7** when finished.

Figure 4.7. Installed Hose End Fitting with Bond Wire.

Step 8. Perform a continuity test, using a multi-meter, on fittings of each hose end to ensure continuity (**Figure 4.8**). WaFERS UTCs do not include a multi-meter, shop equipment must be used for this test.

Figure 4.8. Performing Continuity Test on Hose End Fittings.

4.5. Hose End Fitting Clamp Installation Procedures. Clamp the layflat hose end fittings with either the Mine-Flex original hose end clamp (**Figure 4.9**), or the snap clamp (**Figure 4.10**).

Figure 4.9. Mine-Flex OEM Hose Fittings and Segmented Bolt-on Clamps.

Figure 4.10. Layflat Hose End Snap Clamp.

4.5.1. Layflat Hose End Original Equipment Hose Clamp Procedures.

Note: Two clamps are required to hold one hose end fitting on the 6-, 8-, and 12-inch MineFlex hose ends. One wide clamp made up of several segments is required for the 10-inch MineFlex layflat hose.

Step 1. Loosely assemble two clamp segments using the hex head cap screws and nylon locking nuts. Place the loosely assembled pieces around hose end fitting nearest hose end.

Note: Place hex head cap screws into the clamp segments, captivate the nylon hex nuts in a slot such that a wrench will not be required.

Note: The clamp segments are directional. Face tapered edges to the outside to ease dragging or moving the hose. The single band 10-inch segments are also directional with the longer end facing the hose.

Step 2. Complete the loose assembly of the clamps around the hose in the same fashion as the initial segments. Start tightening the hex head clamp cap screws.

Caution: Clamp segments must be equally spaced around hose. If clamp segments are unequally spaced, hose slippage may occur, resulting in significant loss of fuel and/or injury to personnel.

Step 3. Torque each bolt to 25 ft.-lbs. until tightening all bolt assemblies per coupling.

Step 4. Then, alternately torque each bolt assembly to 30 ft.-lbs while keeping equal space between clamp segments. Repeat alternate torque sequence above to verify each assembly has 40 ft.-lbs of torque on the 6”, 8”, and 12” hose, or 50 ft.-lbs. on the 10” clamp.

Step 5. Assemble the second set of clamp segments around hose end fitting next to the first clamp and install by following steps 2 through 4.

Step 6. Mark a line on the layflat hose adjacent to both sides of the clamp rings to facilitate inspection and easily recognize hose end movement or slippage (**Figure 4.11**). Write date of installation on the hose.

Caution: Stop system fuel flow if hose end slippage occurs. Install a hose pincher, located in the 4FWLF or 4FWRB UTCs, and repair the end ensuring torque and spacing are correct.

Figure 4.11. Completed OEM Hose End with Both Clamps Installed and Lines Drawn.

4.5.2. Layflat Hose End Snap Clamp Procedures. Two hose end snap clamps are required to hold one hose end fitting on a layflat hose.

Step 1. Without having the clamp on the hose, close the clamp and ensure both levers are snug, or somewhat snug, when closed. The clamps will apply pressure to hold the top and bottom halves of the clamp together as in **Figure 4.10** above.

Note: Tighten or loosen a lever by turning clockwise or counter-clockwise on the ball-joint rod ends.

Step 2. Open the clamp and fully tighten both levers. Then, loosen both levers 10 full turns to keep both sides even.

Step 3. Set the hose on the bottom clamp half nearest the hose end with the hinge pin heads facing away from the hose end as shown in **Figure 4.12**. Position top half of the clamp on the hose such that end gaps between the top and bottom clamp halves are equal on both sides. The cotter pins will be toward the hose end.

Figure 4.12. Position the Snap Clamp on the Installed Hose End Fitting.

Step 4. Hook/Grip both clamp handle indents to the top half of the clamp notch ridges, as shown in **Figure 4.13** and **Figure 4.14**, and depress both handles at the same time enough so that they are both resisting.

Note: The two lever arms have a slight notch machined into them to assist in hooking them onto the clamp notch ridge. Each of the two levers has a unique

lever rate as can be seen by looking at the lever notch end. The two levers are a different length beyond their fulcrum hinge.

Figure 4.13. Snap Clamp Hook and Notch

Figure 4.14. Hooking the Clamp Levers in the Notches.

Note: Do not depress a handle until both levers are hooked on their starting notch and gripping the clamp. The more you depress one handle, the less slack the opposite handle has.

Step 5. While keeping the second lever heavily resisted, snap down the first lever. This will press the hose into the groove of the hose end fitting.

Step 6. Compress second lever to further press the hose into the groove on the end fitting.

Note: If needed, back off the second lever just enough to allow the first lever to clamp down. Snap down the second lever to further press the hose into the groove on the end fitting.

Step 7. Unclamp both the first and second levers but, keep pressure on the clamp handles to prevent the hose from unsettling.

Step 8. Holding the clamp tight by hand, tighten the ball joint rod end on both the first and second levers 1 turn. Then, repeat steps 4 through 7. Wait at least 10 seconds between each cycle. Continue this process until training the hose material to stay in the grooves on the hose end fitting; the snap clamp levers will feel rigid.

Note: It is not necessary to snap down the second lever to settle the hose. Depress the second lever enough until right before it snaps into place as shown in **Figure 4.15**. Keep it there for at least 10 seconds.

Figure 4.15. First Lever Clamped and Second Lever Partially Clamped.

Step 8. After training hose material into the groove, slightly lift the first lever while keeping it hooked and gripping the notch. Tighten second lever's ball joint rod end.

Note: Ensure gaps on each side of the clamp are even throughout installation. If at any time a clamp upper and lower half come in contact (typically on the second lever side), loosen that side and tighten the opposite side ball joint rod end 3 to 4 turns and continue the steps described above.

Step 9. Once the second lever clamp requires serious force to snap it closed, the clamp is tight (**Figure 4.16**). Overcoming the resistance may require standing on the lever.

Figure 4.16. First Snap Clamp Installed.

Step 10. Place second snap clamp on other hose end fitting slot with pin-head side of clamp facing towards the first clamp **(Figure 4.17)**. Install second snap clamp following steps 4 through 9 above.

Figure 4.17. Second Snap Clamp Placement.

Step 11. Once both clamps are secure, **(Figure 4.18)** use cable ties to tie the levers together using the cable tie slot under the first lever **(Figure 4.19)**.

Figure 4.18. Both Snap Clamps Installed.

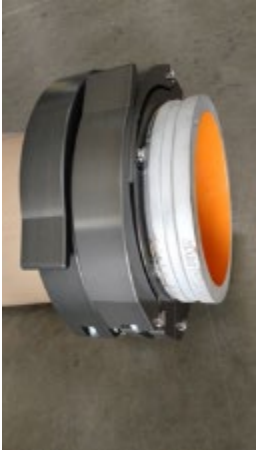
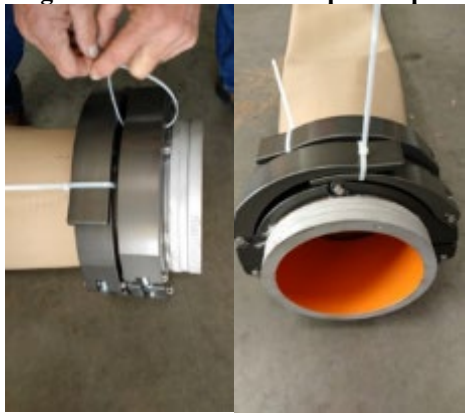


Figure 4.19. Installing Cable Ties on Both Snap Clamps.



Step 12. With a permanent marker, mark a circle around the hose and adjacent to the clamp in order to facilitate inspection of the fitting for slippage.

4.6. Special Considerations. In addition to compatible fittings (couplings and clamps), the Repair and Bypass UTC contains reducers to combine two hose sizes to lengthen the run of hose when necessary.

4.7. After Repair Action. Monitor for leaks. When operating above 150 PSI, continuously monitor the hose during pumping.

4.8. Periodic Inspection. Once the system is pressurized, check for leaks and ensure the layflat hose is free of kinks and clear of sharp and thin metal edges and pinch points.

4.9. Reconstitution of Consumables. Through base supply, immediately reorder all items consumed to ensure the UTC is in mission ready status.

Chapter 5

WATER AND FUEL PUMP UTC (4FWFP)

WARNING: If pump has been used to process fuel, it cannot be used to pump water.

5.1. Overview. The Water and Fuel Pump UTC is a system comprised of a 600-GPM pump along with accessories for use in several configurations. These configurations range from pumping liquids between two points, removing hazardous fuel from a work location, or as a pump house replacement including hydrant, transfer, and cut and cover tanks. Attach the pump (**Figure 5.1**) to in-place infrastructure using various hoses, piping and fittings.

Figure 5.1. WaFERS Pump.

5.2. Description. This UTC provides up to 600 GPM of water or fuel pumping capability when water and/or fuel systems are damaged by attack, natural disaster or catastrophic failure. Connect the pumps in series or parallel to meet flow requirements. A 10K gallon fuel bladder is required to store fuel and the Fuel Filter UTC is required for fuel filtering. The Consolidated Tools and Equipment UTC support the Water and Fuel Pump UTC. A full list of all UTC components is in **Attachment 2**.

5.3. General Capability of the Water and Fuel Pump UTC. There are five general capabilities for this UTC:

5.3.1. Water and Fuel Evacuation (piping, berms, puddles, spills, etc.). Evacuate water and fuel from an area to allow safe operations.

5.3.2. Water and Fuel Recovery. Recover usable water and fuel from damaged infrastructure such as tanks, large diameter piping, containments, etc.

5.3.3. Pump House Bypass. Provide pumping capability to bypass a damaged or inoperable pump house.

5.3.4. Bulk Water or Fuel Transfer. Transfer water or fuel from a point of origin to a destination or point of use.

5.3.5. Cut and Cover Tanks. Recover usable fuel from damaged cut and cover or below grade tanks.

5.4. General Safety.

5.4.1. Keep fingers away from rotating shafts.

5.4.2. To prevent carbon monoxide poisoning, operate the engine in a well-ventilated area. If the area is enclosed, vent exhaust fumes to the outside.

5.4.3. Utilize the ventilator from the Consolidated Tools and Equipment UTC in locations where excess fuel vapors are present.

5.4.4. The maximum highway trailer speed is 55 MPH.

5.5. WaFERS Pump General Quick Start and Operation Sequence. The procedures below briefly describe setup, start and operation procedures. See the Operations Manual for detailed operation and maintenance procedures.

Note: RPM approximately relates to GPM output (e.g., 600 RPM ≈ 600 GPM).

Note: Downstream system resistance to flow and pump settings influences discharge pressure.

Note: Priming is typically not required for suction hose lengths shorter than 30 feet.

Note: Do not run pump more than 2 minutes without fluid. Running the pump dry will damage pump seals and vanes.

Step 1. Position the pump as close to the source as possible with the suction (inlet) side of the pump towards the source. Then, place wheel chocks, set parking brake, and disconnect tow vehicle.

Step 2. Drive the attached ground rod to the appropriate depth (see **Table 5.1** for recommended grounding rod depths). Connect the ground rod cable to the ground rod, or to an adequately grounded system such as piping.

Note: Ensure underground utilities are not present when driving the ground rod.

Step 3. Remove the basket strainer cover and clean debris from the strainer screen. Inspect the O-ring and re-install the strainer screen and cover.

Step 4. Connect hard hoses to the pump inlet (suction side with the rectangular lid strainer). Connect the layflat hose to the pump outlet as required (**Figure 5.2**).

Table 5.1. Recommended Ground Rod Depths.

SOIL TYPE	GROUND ROD DEPTH
Coarse ground, cohesionless sands and gravels	6 ft (182.9 cm)
Inorganic clay, claying gravels, grave-sand-clay, claying sands, sandy clay, gravelly clay and silty clay	4 ft (121.2 cm)
Silty gravel, gravel-sand-silt, silty sand, sand, silt, peat, muck and swamp	3 ft (91.4 cm)

Figure 5.2. WaFERS Pump.

Note: Use the layflat hose on the pump inlet only if the hydraulic booster pump is used.

Step 5. Open suction and discharge valves.

Step 6. Position *Master Power* switch to ON.

Step 7. Ensure *Inlet Vacuum Limit* switch is in the NORMAL position.

Step 8. Lift and hold *Engine Power* switch to START position until engine is running.

Step 9. Rotate *Engine Throttle to achieve* 1,000 ***ENGINE*** RPM.

Step 10. Place *Down Hole Pump* Switch in the OFF position.

Step 11. Move pump *Hydraulic Drive Engagement* handle to ON.

Step 12. Rotate *Engine Throttle to achieve* 2,350 RPM.

Step 13. Rotate *Maximum Pressure* control to required Pressure or Flow Rate.

5.6. Water and Fuel Evacuation, Recovery, and Transfer; and Pump House Bypass.

5.6.1. Water and fuel evacuation is the process of removing liquid from areas where liquid may hinder repair efforts.

5.6.2. Water and fuel recovery is the process of collecting usable liquid from damaged infrastructure such as tanks, large diameter piping, etc.

5.6.3. Water and fuel transfer is the process of pumping usable liquid from one location, such as tank, to another usable location.

5.6.4. Use the pump-house bypass capability to replace a damaged pump house. The Fuel Filter UTC supports the pump-house bypass capability.

5.6.5. Using the pump Quick Start and Setup Procedures in **paragraph 5.5**, perform the following procedures for water and fuel evacuation, recovery, and transfer.

Note: Discharge location can vary depending on the urgency of the repair/operation; examples include a bladder, containment area, or truck. Contact the CE UCC for further direction if these options are not available.

Note: Any recovered jet fuel requires filtering (use Fuel Filter UTC), followed by testing and compliance with the base fuels operations office before fueling an aircraft with recovered fuel, or blended with a clean store of jet fuel.

Note: For additional or longer hose runs, acquire hoses from the Layflat Hose UTC.

Step 1. Position pump as close to the liquid as possible while avoiding potentially hazardous areas.

Step 2. Lower and pin the jacks, and vertical stabilizers, in place while keeping the pump as level as possible.

Step 3. Check diesel engine and hydraulic system fluids to ensure proper levels.

Step 4. Install the ground rod and cable when pumping fuel (ensure underground utilities are not present when driving the ground rod). Follow the depth recommendations in **Table 5.1**.

Step 5. Connect one end of a hard suction hose to the suction strainer and the other end to the pump inlet. Use as many of the five provided hard hoses as needed to span the distance between the liquid and pump inlet.

Step 6. Connect one end of a 6-inch layflat hose to the pump outlet and the other end to the system desired to receive the liquid.

Step 7. Start and monitor the pump until evacuation is completed.

5.7. Cut and Cover Tanks. Pumping from a below grade tank requires the hydraulically driven booster pump to lift fuel into the inlet of the WaFERS pump when the elevation difference between the pump inlet and the fuel level is more than 15 feet. Perform the following procedures for pumping from cut and cover tanks:

Step 1. Position the WaFERS pump as close to the tank's top manway, or liquid access point, as possible while avoiding potentially hazardous areas.

Step 2. Lower and pin the trailer jacks and vertical stabilizers in place while keeping the pump as level as possible.

Step 3. Place wheel chocks under both trailer tires.

Step 4. Disconnect the pump trailer from the tow vehicle.

Step 5. Install the ground rod and cable when pumping fuel (ensure underground utilities are not present while driving the ground rod). Follow the depth recommendations in **Table 5.1**.

Step 6. Connect one end of a 6-inch layflat hose to the outlet of the booster (**Figure 5.3**) pump and the other to the inlet of the discharge head fitting (**Figure 5.4**).

Step 7. Using another section of layflat or hard hose, connect the outlet of the discharge head fitting to the inlet of the WaFERS pump.

Step 8. Use a third 6-inch layflat hose (from Repair and Bypass UTC or Layflat Hose UTC) to connect the WaFERS pump outlet to the desired system to receive the fuel or water.

Step 9. Connect the booster pump's three hydraulic lines to both the booster pump and the WaFERS pump hydraulic drive quick disconnect fittings.

Note: When fittings will not connect, loosen the fittings on one end of a hydraulic hose to allow relief of internal pressure before the. This should allow fittings to connect.

Figure 5.3. WaFERS Pump Configuration Using Booster Pump.

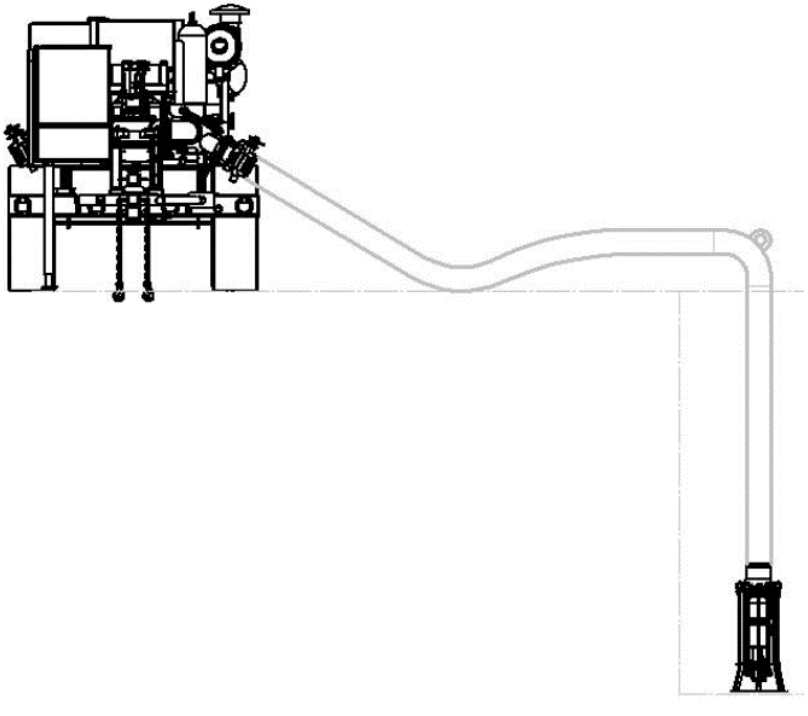


Figure 5.4. Discharge Head Fitting.

Step 10. Lower the booster pump into the manway of the cut and cover tank using the tripod provided in this UTC. Lower until the pump is on the bottom, the 6-inch hose is supporting the weight of the pump or the winch cable is fully unwound.

Step 11. Tie off the discharge head fitting to the side of the tank manway to take the weight of the pump off the aluminum WaFERS pump inlet manifold.

Step 12. Start booster pump using the WaFERS pump control panel (**Figure 5.5**). The control panel door has a placard on its inner side outlining the basic start sequence (**Figure 5.6)**.

Figure 5.5. Booster Pump and Control Panel.

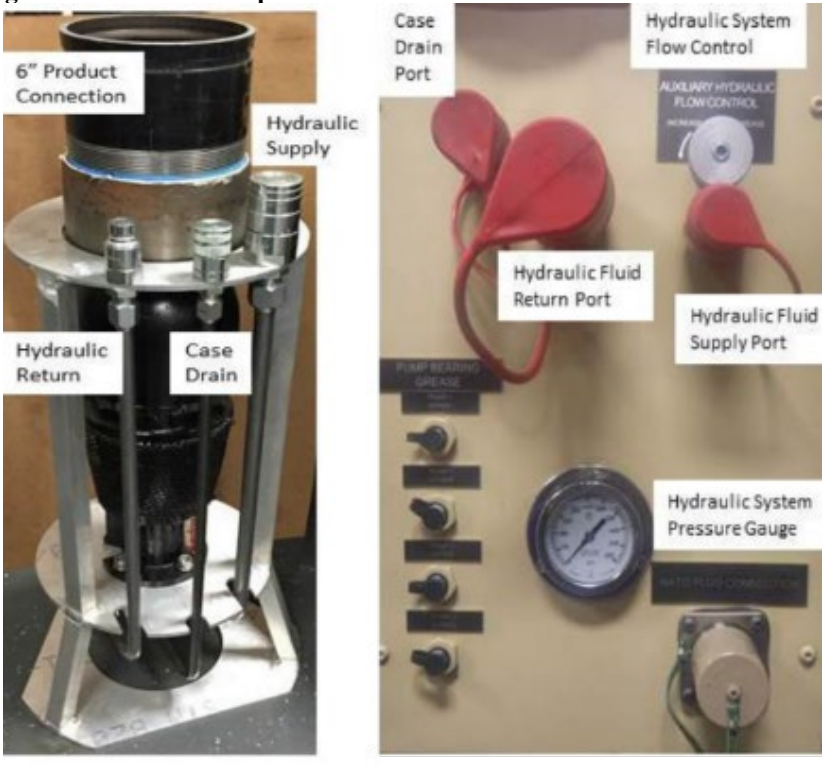
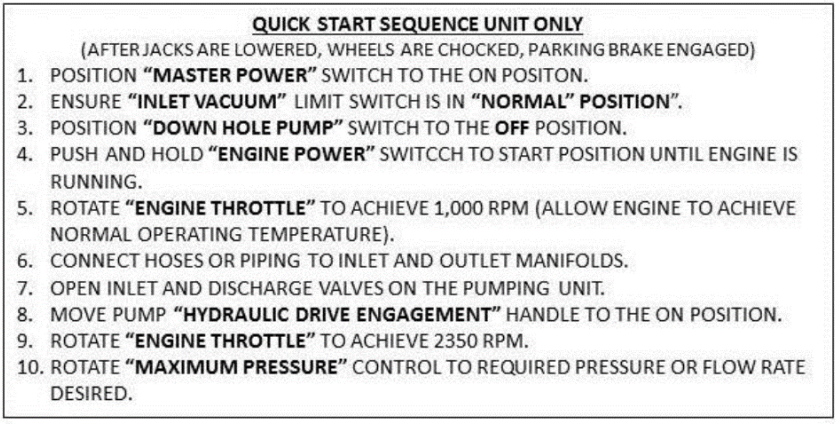


Figure 5.6. Booster Pump Quick Start Procedures.



Step 11. Position *Inlet Vacuum Limit Switch* to *"Series / Downstream"* mode (**Figure 5.7**).

Figure 5.7. Inlet Vacuum Limit Switch on WaFERS Control Panel.

Warning: Do not hold hand or finger over any hydraulic leak. Hydraulic fluid under high pressure will penetrate skin. Failure to comply could result in death or serious injury. If injured, seek emergency medical help.

Step 12. Start diesel engine, adjust idle speed to 850 RPM, and allow engine to achieve normal operating temperature.

Note: Anchor intake hose and hydraulic lines on top of manhole to avoid excess strain on the pumping unit connection points.

Step 13. Make piping connections on the discharge side of pumping unit and open discharge valve.

Step 14. Turn *Maximum Pressure Control* knob four turns clockwise.

Step 15. Place the *Down Hole Pump* switch in the ON position.

Step 16. Place the *Hydraulic Drive Engagement* lever in the ON position.

Note: With the *Inlet Vacuum Limit* Switch in the "*Series / Downstream"* position, the main product pumps will not operate until achieving 5-psi on the Intake Pressure Gauge.

Step 17. Throttle engine up to operating speed (2,450 RPM).

Step 18. Adjust *Maximum Pressure Control* knob to achieve the pressure or flow rate required by the application.

Step 19. Adjust the *Auxiliary Hydraulic Flow Control* knob to maintain between 10- and 15-psi on the Intake Pressure Gauge.

Note: Control product discharge rate with the Maximum Pressure Control knob. Diesel engine must be at max rated RPM to achieve 600 GPM at 150 PSI. If reaching maximum pressure stop on the Maximum Pressure Control, but not achieving maximum pumping rate, ensure diesel engine speed is at its 2,450-RPM maximum.

Note: To begin operations, refer to the WaFERS pump O&M manual for setup and startup of pumping trailer unit.

Caution: Never run booster pump dry; otherwise, serious damage to the booster pump will occur.

Note: Refer to fuel or water performance curve charts on inside of control panel door for guidance in making adjustments in engine RPM to affect flow rate.

Note: The pumping trailer is equipped with an "Electronic Pressure Set and Hold" feature (**Figure 5.8**). With this feature engaged, the Maximum Pressure Control

knob cannot change the discharge pressure set on the unit without first disengaging the "Electronic Pressure Set and Hold" feature. To engage or disengage this feature, hold the switch for 30 seconds to affect change.

Figure 5.8. Lower Control Panel.

5.7.1. Procedures when Booster Pump is Shutdown.

Step 1. Turn *Maximum Pressure Control* (**Figure 5.8**) knob slowly counterclockwise until reaching the stop to decrease discharge pressure.

Step 2. Turn *Hydraulic Drive Engagement* lever (**Figure 5.8**) to the OFF position.

Step 3. Reduce engine RPM to idle speed (850 RPM) by turning throttle control clockwise and then pushing in throttle control.

Caution: Stopping engine immediately after it has been operating under a load may result in overheating and accelerated wear of engine components.

Step 4. Move the *Aux Hydraulics Engagement* switch (**Figure 5.8**) to the OFF position.

Step 5. Allow engine to idle between 3 and 5 minutes to allow engine to cool.

5.8. Actions After Repair. Perform frequent inspections of hose connections and monitor for leaks.

5.9. Periodic Inspection. Perform operational checks as described in the operator's manual. Appropriately maintain liquid pumping rates.

5.10. Reconstitution of Consumables. Track all used WaFERS consumables (e.g., gaskets, filter elements, layflat hose) and order replacements through base supply as quickly as the mission allows. This helps ensure each WaFERS UTC is in mission ready status.

Chapter 6

FUEL FILTER UTC (4FWFF)

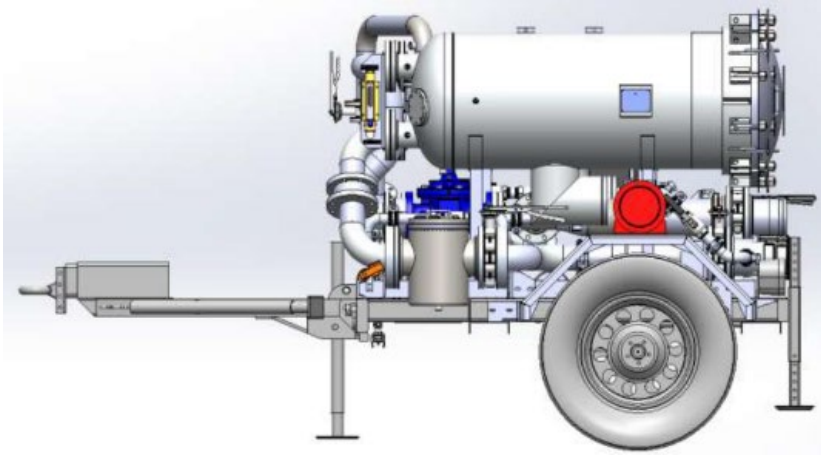
6.1. Introduction. The Fuel Filter UTC consists of two 600-GPM filter separators mounted on an all-terrain trailer. This fuel filtering capability comes with numerous hose connection adapters to facilitate connection to various systems, including Fuels Operational Readiness Capability Equipment. **Attachment 2** provides a detailed inventory of this UTC.

6.2. Description. This UTC provides expedient filtering of stored or recovered fuel from pipelines, berms, craters and storage tanks damaged by attack, natural disaster, or catastrophic failure. Fuel filtering provides suitable advanced filtration for contaminated fuels reintroduced into fuel storage or distribution systems. Two 10K fuel bladders are required for temporary fuel storage and the Water and Fuel Pump UTC is required for pumping. In addition, the Consolidated Tools and Equipment UTC support this UTC.

6.2.1. The filter has the capability to filter heavily contaminated fuel from earthen craters, containment areas and damaged storage tanks. The two 600 GPM horizontal filter separators are designed to meet American Petroleum Institute/Energy Institute 1581-5th edition, category M standards and is intended for use with aviation jet fuels including JP-8. Each horizontal filter separator is equipped with a sight gauge, differential pressure gauge and air eliminator. Each filter separator contains two stages of filtration. The first stage contains consumable filter coalescer elements that filters the solids and coalesces water from the fuel. The second stage contains cleanable separator elements to separate water from the fuel and allows water to drain into the sump.

6.2.2. The filter trailer has a hitch for towing and jack mounts for stabilization (**Figure 6.1**). The filter fits within a tricon container for storage and shipment.

Figure 6.1. Fuel Filter and Trailer.



6.2.3. The filtration system is capable of four configurations as listed below:

6.2.3.1. Duplex Configuration. Using the duplex single filter filtration configuration, either separator can be in service at 600 GPM to clean up heavily contaminated fuel. In this operation mode, one separator can be out of service to change the filter elements while the other one remains operational.

6.2.3.2. Independent Configuration. The independent configuration filters two independent 600 GPM flows from two independent sources going to two independent stores.

6.2.3.3. Parallel Configuration. In a parallel configuration, both filters work together to filter up to 1200 GPM with output going to a single location.

6.2.3.4. Double (Series) Configuration. In a double filtration configuration, separators plumbed in series provide one double filtered 600 GPM

flow rate. This provides mandated filtrations requirements when fueling aircraft directly.

6.3. General Uses of Fuel Filter UTC. The fuel filter has many different capacities and configurations, depending on the situation for recovering fuel or filtering fuel. Listed below are the three main uses for the fuel filter.

6.3.1. Filter Dirty Fuel for Reclamation. This configuration filters spilled fuel from secondary containments, puddles, trucks, sumps and anywhere substantial amount of fuel is pooled and suitable for reuse. In this situation, a duplex filter configuration is typical.

6.3.2. Inline Filtering. The purpose of inline filtering is to satisfy requirements for aircraft or other fueling trucks (e.g., R-11 and R-12). In this situation, use a double (series) configuration.

6.3.3. Pump House Bypass. Provides filtering capability while bypassing an unserviceable, or damaged beyond repair, pump house. In this situation, an independent configuration is typical for routing to different systems or use a parallel configuration to handle large flow rates up to 1200 GPM.

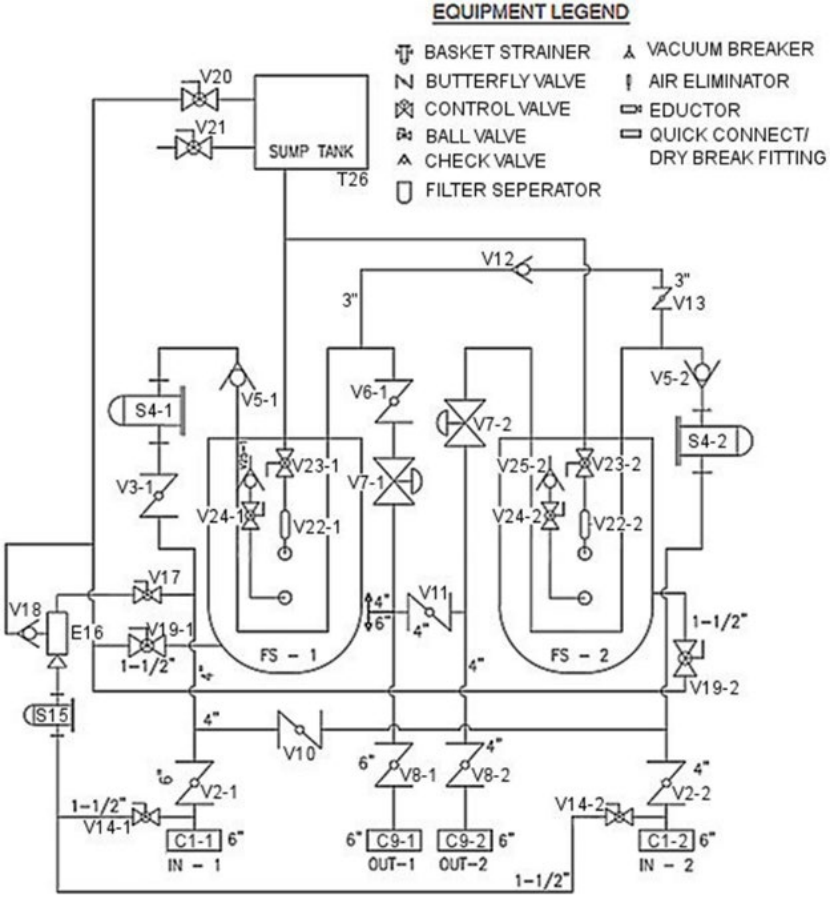
6.4. General Safety. All personnel must practice proper safety procedures when repairing water and fuel systems. Individuals should guard against electrical, fire, tripping, falling, engulfment, and explosion hazards. In particular, flammable fuels, hazardous atmospheric conditions, pressurized piping and explosive conditions are considerable hazards. Failure to comply with safety instructions and warnings in this publication may result in injury or death. Wear appropriate PPE according to applicable technical information and standards.

Note: Drain water more frequently when operating in freezing weather to avoid freezing, which could rupture the filter separator vessel.

Note: Filter separators must be empty before towing the cart at more than 10 MPH due to high center of gravity.

6.5. Fuel Filter Basic Setup and Operating Procedures. The line diagram in **Figure 6.2** shows the filter trailer piping and component arrangement. Setup instructions for each of the four configurations follows.

Figure 6.2. Filter Trailer Line Diagram.



6.5.1. Trailer Set Up. Use the following procedures to setup the Fuel Filter Trailer.

Step 1. Park the trailer on level ground, apply brakes, and chock the wheels.

Step 2. Lower and set the four stabilizer jacks.

Step 3. Drive the attached ground rod into the ground (see **Table 5.1** for recommended grounding rod depths). Connect the ground rod cable to the ground rod.

Step 4. Slowly fill both separator vessels with fuel.

Step 5. Align valves in the configuration required for the filter application.

6.5.2. Filling Filter Vessels. Use the following procedures to fill both filter separator vessels with fuel safely.

Warning: An explosion could occur when filling the vessel rapidly. Slow filling is the only authorized method for refilling a filter separator. The rule of thumb is "never fill a vessel in less than ten minutes."

Step 1. Connect a 6-inch hose to inlet (C1-1).

Step 2. Connect a 6-inch hose to outlet (C9-1).

Step 3. Open Fuel Separator (FS)-1 inlet valve (V3-1) and FS-1 outlet valve (V6-1).

Step 4. Open inlet block valve (V10), outlet block valve (V11), and crossover manual valve (V13).

Step 5. Open eductor supply manual valve (V14-1), eductor strainer shut-off valve (V14-3) and eductor shut-off manual valve (V17).

Step 6. Open filter evacuation valves (V19-1) and (V19-2).

Step 7. Open the air eliminator valves (V23-1) and (V23-2).

Step 8. Open vacuum breaker shut-off valves (V24-1) and (V24-2).

Step 9. Briefly open manual thermal relief valves (V28-1) and (V28-2) to relieve any thermal pressure build up.

Step 10. Start fuel flow to the filter trailer with the WaFERS pump.

Step 11. To fill the trailer slowly, perform the following actions on the WaFERS pump.

1. Start the WaFERS pump.
2. Adjust WaFERS pump engine speed to 1,200 RPM.
3. Turn hydraulic drive engagement lever to the on position.
4. While watching the outlet pressure gauge, slowly turn the maximum pressure control knob clockwise to increase hydraulic pump speed. Once the gauge needle moves, stop turning the control knob. This will allow sufficient hydraulic pressure for the pump to operate at the lowest speed and flow rate.

Step 9. Partially open inlet valve (V2-1) to fill the vessel slowly.

Note: Air will be coming out of the air vent located on recovery tank (T26). The filter is not full of fuel if air is escaping from the air vent located on recovery tank (T26).

Note: During initial start-up, test the water slug-control pilot-valve(s) and flow control valve(s). Refer to the operation's manual for test procedures.

Step 10. Once the filter separator is full and no air is discharging from the air vent on recovery tank (T26), close inlet valve (V2-1) and shut down WaFERS pump.

6.5.3. Duplex Filter Configuration using only Fuel Separator-1 (FS-1). When placed in this configuration, place either filter in service for continued fueling operation; the other filter is available for maintenance. In this example, FS-1 provides single filter filtration at 600 GPM. **Figure 6.3** shows the open and closed valve arrangement when the filters are in a duplex configuration with arrows indicating the flow path. In this arrangement, the second separator (FS-2) is out of service. After filling the filter vessels with fuel (**paragraph 6.5.2**) and all valves on the filter trailer are closed, perform the steps that follow.

Step 1. Connect a 6-inch hose to the inlet (C1-1).

Note: Use a hard-wall or layflat hose for the inlet(s) and outlet(s). Recommend using a hard-wall hose on the filter connections to ease in positioning hoses and alleviate potential kinks when using layflat hose.

Step 2. Connect a 6-inch hose to the outlet (C9-1).

Step 3. Open the air eliminator valves (V23-1) and (V23-2).

Step 4. Open vacuum breaker shut-off valves (V24-1) and (V24-2).

Step 5. Open outlet valve (V8-1).

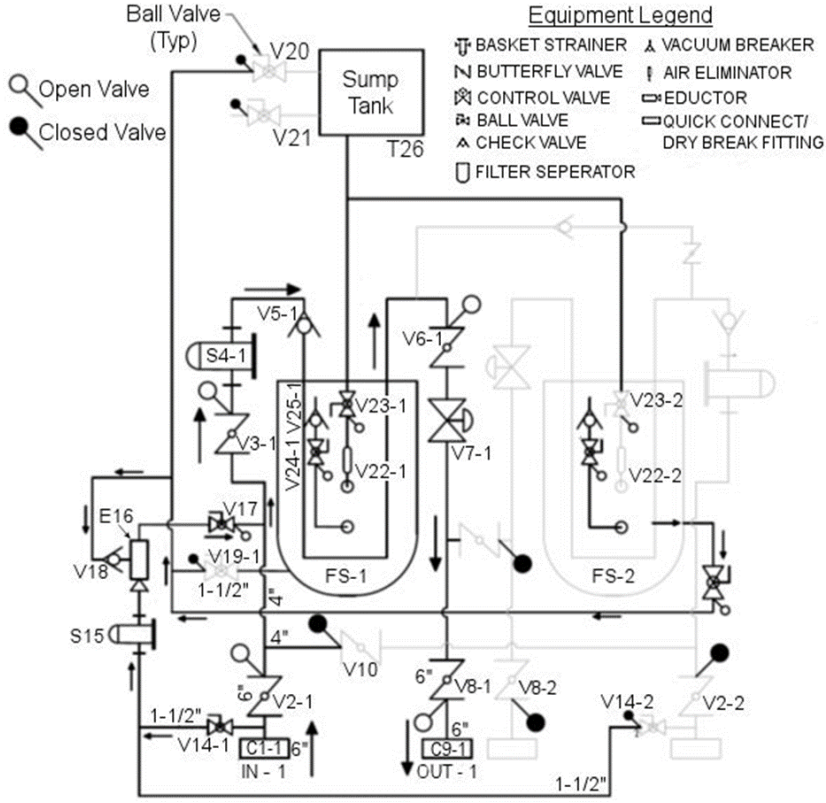
Step 6. Open the FS-1 inlet valve (V3).

Step 7. Open FS-1 outlet valve (V6).

Step 8. Open the inlet valve (V2-1).

Step 9. Slowly start fuel flow to filter trailer with the WaFERS pump until achieving desired flow rate.

Figure 6.3. Filter Trailer Duplex Configuration (FS-1).



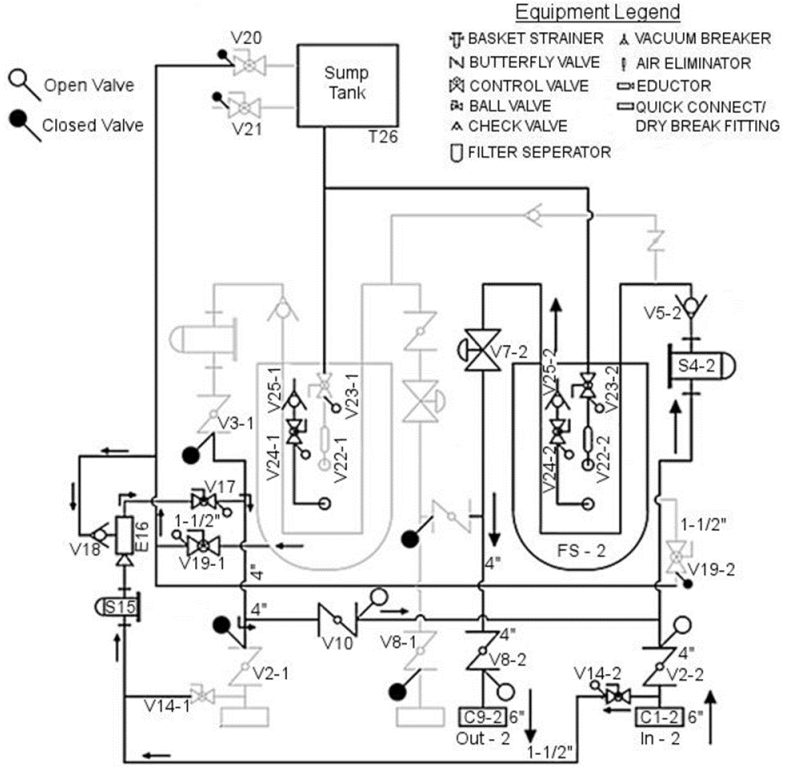
Warning: Before fueling operations start, fill the filter vessel with fuel. If not previously filled with fuel, use the procedures in **paragraph 6.5.2** to fill both vessels with fuel safely.

Step 10. Monitor the differential pressure gauge across the separator. If the differential pressure exceeds 15 psi, change the elements.

Step 11. Monitor the recovery tank level to prevent overflow/fuel spillage.

6.5.4. Duplex Filter Configuration Using FS-2 Only. When placed in this configuration, place either filter in service for continued fueling operation, and when necessary, take the other filter out of service for maintenance. **Figure 6.4** shows single filter filtration with FS-2 in operation at 600 GPM and the open and closed valve arrangement with arrows indicating the path of flow. In this arrangement, the second separator FS-1 is out of service. After filling the filter vessels with fuel (see **paragraph 6.5.2**), and all valves on the filter trailer are closed, perform the steps that follow.

Figure 6.4. Filter Trailer Duplex Configuration (FS-2).



Note: This configuration will use the same inlet and outlet connections as Filter Trailer Duplex Configuration (FS-1).

Step 1. Open the air eliminator valves (V23-1) and (V23-2).

Step 2. Open vacuum breaker shut-off valves (V24-1) and (V24-2).

Step 3. Open outlet valve (V8-1).

Step 4. Open the inlet block valve (V10).

Step 5. Open the outlet block valve (V11).

Step 6. Open the inlet valve (V2-1).

Step 7. Slowly start fuel flow to the filter trailer with the WaFERS pump until reaching desired flow rate.

Warning: Before fueling operations start, fill the filter vessel with fuel. If not previously filled with fuel, use procedures in **paragraph 6.5.2** to fill both vessels with fuel safely.

Step 9. Monitor the differential pressure gauge across the separator. If the differential pressure exceeds 15 psi, change the elements.

Step 10. Monitor the recovery tank level to prevent overflow/fuel spillage.

6.5.5. Independent Filter Configuration. This configuration provides two independent 600 GPM filter flows from two independent sources going to two independent locations. **Figure 6.5** shows the open and closed valve arrangement with arrows indicating the path of flow. In this arrangement, both separators are in service with output going to two independent connections. After filling the filter vessels with fuel (**paragraph 6.5.2**), and all valves on the filter trailer are closed, perform the steps that follow.

Step 1. Connect a 6-inch hose to FS-1 inlet (C1-1).

Note: Use hard-wall or layflat hose for inlet(s) and outlet(s). Recommended using a hard-wall hose on filter connections to ease hose positioning and alleviate potential kinks when using layflat hose.

Step 2. Connect a 6-inch hose to FS-2 inlet (C1-2).

Step 3. Connect a 6-inch hose to FS-1 outlet (C9-1).

Step 4. Connect a 6-inch hose to FS-2 outlet (C9-2).

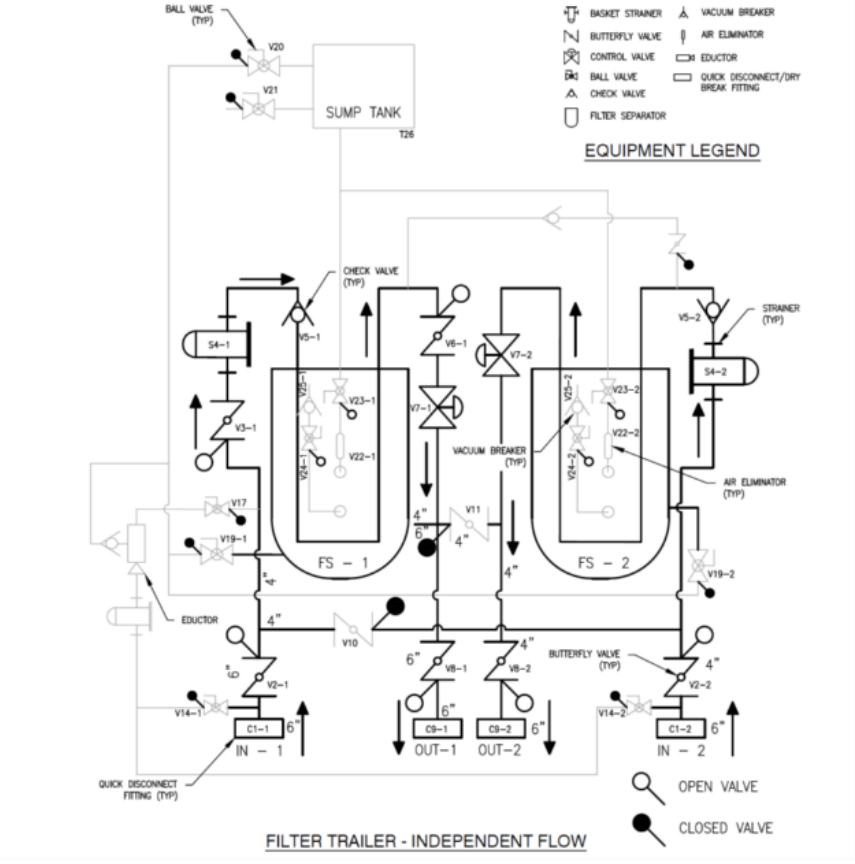
Step 5. Open the air eliminator valves (V23-1) and (V23-2).

Step 6. Open vacuum breaker shut-off valves (V24-1) and (V24-2).

Step 7. Open outlet valves (V8-1) and (V8-2).

Step 8. Open FS-1 inlet valve (V3).

Figure 6.5. Filter Trailer Independent Flow.



Step 9. Open FS-1 outlet valve (V6).

Step 10. Open inlet valves (V2-1) and (V2-2).

Step 11. Slowly start fuel flow to the filter trailer with the WaFERS pump until achieving desired flow rate.

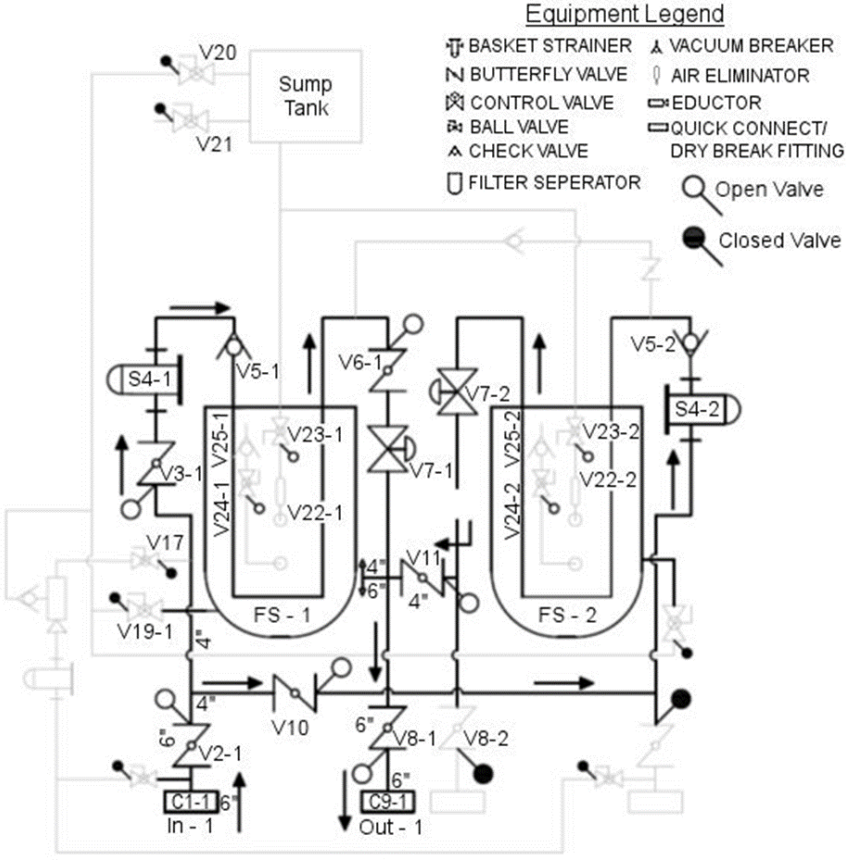
Warning: Before fueling operations start, fill the filter vessel with fuel. If not previously filled with fuel, use procedures in **paragraph 6.5.2** to fill both vessels with fuel safely.

Step 12. Monitor the differential pressure gauge across each separator. If the differential pressure exceeds 15 psi, change the elements.

Step 13. Monitor the recovery tank level to prevent overflow/fuel spillage.

6.5.6. Parallel Filter Configuration. When using both filters in parallel (paired), a single location may receive a 1,200 GPM output. **Figure 6.6** shows the open and closed valve arrangement with arrows indicating the path of flow. In this arrangement, both separators are in parallel at 600 GPM service each, with a combined output going to a single connection at 1,200 GPM. After filling the filter vessels with fuel (**paragraph 6.5.2**), and all valves on the filter trailer are closed, perform the steps that follow.

Figure 6.6. Filter Trailer Parallel Filtration – 1200 GPM.



Step 1. Connect a 6-inch hose to outlet (C9-1).

Note: Use a hard-wall or layflat hose for inlet(s) and outlet(s). Recommend using a hard-wall hose on the filter connections to ease hose positioning and alleviate potential kinks when using layflat hose.

Step 2. Connect a 6-inch hose to inlet (C1-1).

Step 3. Connect a 6-inch hose to inlet (C1-2).

Step 4. Open the air eliminator valves (V23-1) and (V23-2).

Step 5. Open vacuum breaker shut-off valves (V24-1) and (V24-2).

Step 6. Open outlet valve (V8-1).

Step 7. Open FS-1 inlet valve (V3).

Step 8. Open FS-1 outlet valve (V6).

Step 9. Open outlet block valve (V11).

Step 10. Open inlet valves (V2-1) and (V2-2).

Step 11. Slowly start fuel flow to the filter trailer with the WaFERS pump until achieving desired flow rate.

Warning: Before fueling operations start, fill the filter vessel with fuel. If not previously filled with fuel, use procedures in **paragraph 6.5.2** to fill both vessels with fuel safely.

Step 12. Monitor the differential pressure gauge across each separator. If the differential pressure exceeds 15 psi, change the elements.

Step 13. Monitor the recovery tank level to prevent overflow/fuel spillage.

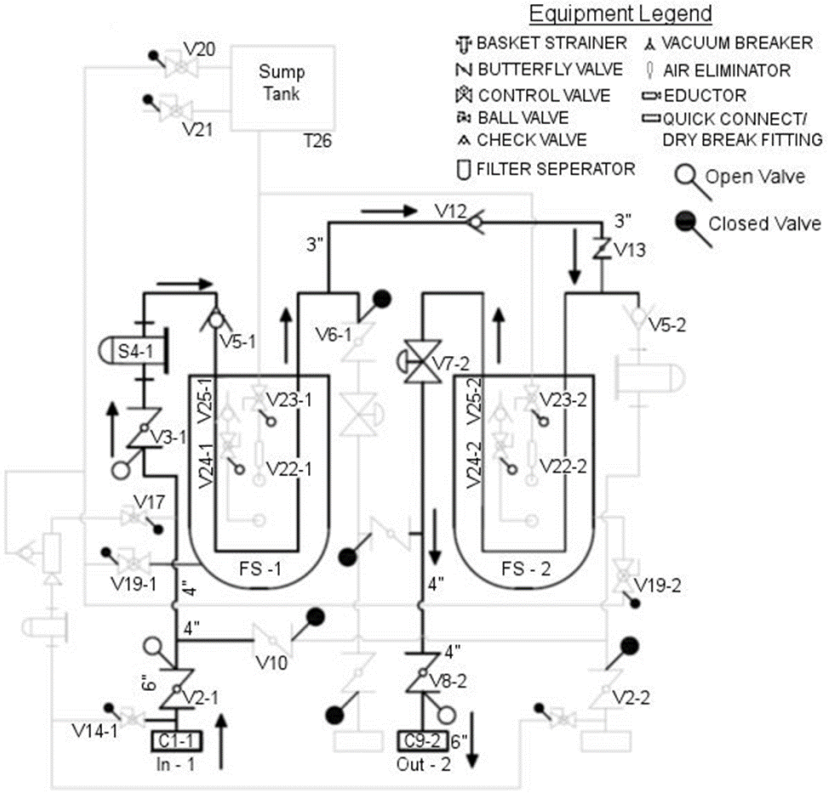
6.5.7. Double Series Filtration Configuration. When separators operate in series, a double filtered 600 GPM flow rate is provided. **Figure 6.7** shows the open and closed valve arrangement with arrows indicating the path of flow.

In this arrangement, both separators are operating in series providing a 600 GPM doubled filtered product. After filling the filter vessels with fuel (**paragraph 6.5.2**), and all valves on the filter trailer are closed, perform the steps that follow.

Note: Use a hard-wall or layflat hose for inlet(s) and outlet(s). Recommend using a hard-wall hose on filter connections to ease hose positioning and alleviate potential kinks when using a layflat hose.

Step 1. Connect a 6-inch hose to outlet (C9-2).

Figure 6.7. Double Series Filtration.



Step 2. Connect a 6-inch hose to inlet (C1-1).

Step 3. Open the air eliminator valves (V23-1) and (V23-2).

Step 4. Open vacuum breaker shut-off valves (V24-1) and (V24-2).

Step 5. Open outlet valve (V8-2).

Step 6. Open the FS-1 inlet valve (V3).

Step 7. Open crossover manual valve (V13).

Step 8. Open inlet valve (V2-1).

Step 9. Slowly start fuel flow to the filter trailer with the WaFERS pump until achieving desired flow rate.

Warning: Before fueling operations start, fill the filter vessel with fuel. If not previously filled with fuel, use procedures in **paragraph 6.5.2** to fill both vessels with fuel safely.

Step 10. Monitor the differential pressure gauge across each separator. If the differential pressure exceeds 15 psi, change the elements.

Step 11. Monitor the recovery tank level to prevent overflow/fuel spillage.

6.5.8. Eductor Evacuation. The purpose of eductor evacuation is to evacuate a filter separator vessel to allow changing of the filter elements during ongoing filtering operations.

Note: If necessary to drain the fuel filter trailer completely, eductor evacuation will only remove fuel from one separator vessel. Gravity-drain the second separator vessel and dispose of the collected fuel.

6.5.8.1. FS-1 Evacuation.

Step 1. Stop flow to the filter trailer.

Step 2. Close all valves.

Step 3. Open vacuum breaker valve (V24-1) on the filter separator FS-1.

Step 4. Open valves V14-2, V17, V10 and V8-2. This routes flow through filter FS-2.

Step 5. Initiate pumping flow through FS-2 inlet C1-2 and discharging through FS-2 outlet C9-2.

Step 6. Open filter evacuation valve (V19-1) on filter FS-1.

Step 7. Continue flow until the filter is empty. A change in sound will indicate when the vessel is empty (approximately 5-6 minutes). The filter is now ready for servicing. See the separate filter servicing section.

Step 8. After servicing filter, slowly fill the vessel.

6.5.8.2. Filter FS-2 Evacuation. Drain filters for storage or maintenance as follows.

Step 1. Stop flow to the unit.

Step 2. Close all valves.

Step 3. Open vacuum breaker valve (V24-2) on the filter separator FS-2.

Step 4. Open valves V14-1, V17, V3-1, V6-1 and V8-1. This routes flow through filter FS-1.

Step 5. Initiate pumping flow through FS-1 inlet C1-1 and discharging through FS-1 outlet C9-1.

Step 6. Open filter evacuation valve (V19-2) on filter FS-2. Continue flow until the filter is empty. A change in sound indicates when the vessel is empty (approximately 5-6 minutes).

Step 7. Service the filter. See the separate filter servicing section.

Step 8. After servicing the filter, slowly fill the vessel.

6.5.9. Recovery Tank Evacuation. Open drain valve V21 to drain recovery tank T26 manually. The following procedures are for eductor evacuation of recovery tank T26 during filter evacuation on FS-1 (**paragraph 6.5.8.1**) or FS-2 (**paragraph 6.5.8.2**).

Step 1. Open recovery tank evacuation valve (V20) on recovery tank T26.

Step 2. Observe the recovery tank sight-gauge and evacuate until empty.

Step 3. Close the recovery tank evacuation valve (V20).

6.5.10. Cleaning Strainer Baskets. Perform the following steps to check or clean the strainer baskets:

Step 1. Close inlet and outlet isolation valves on the basket to clean.

Caution: Use a small container to catch any released fuel during the following step.

Step 2. Open drain on the strainer to clean; this vents any trapped pressure and drains the strainer.

Step 3. Loosen nuts on top to the strainer.

Step 4. Pull up on the front and back of the cover; then, rotate to gain access to the strainer basket.

Step 5. Clean the basket (refer to the equipment manual).

Step 6. Once baskets are clean, return to strainer and properly seat in the housing.

Step 7. Inspect the cover O-ring (replace if damaged) and then place the cover over the opening. Carefully align the cover and then press into housing to avoid damage to the O-ring.

Step 8. Tighten the retaining nuts.

Step 9. Close the vent valve on top of the housing.

6.5.11. Actions during Filter Separator Operation. Make a visual inspection of all connections, joints and piping components for visible leaks. Drain water as needed, by opening the water drain valve.

Caution: Stop fueling operations and change the elements if the differential pressure gauge indicates above 15 psi when the system is flowing fuel at full flow rate and pressure. See **paragraph 6.5.8** for eductor evacuation operation.

6.5.12. Shutting Down or Stopping Filter Separators.

Step 1. Stop the system pumping to the filter trailer.

Step 2. Close the two inlet valves.

Step 3. Close the two outlet valves.

Step 4. Drain any accumulated water by opening the water drain valve.

6.5.13. Filter Element Maintenance. Change filter elements every year, or when differential pressure exceeds 15 psi. Reference the periodic inspection and maintenance schedule in **Attachment 3**.

Note: The filter element types are as follows:

(6) Coalescer elements, 6-in X 44-in.

Velcon # I-644C5TB, 6 lbs/ea and (2) separator elements, 4-in x 36-in.

Velcon # S0-436V, 2 lb/ea and match current capability used at many locations.

6.5.14. Filter Element Replacement.

Step 1. Stop fuel flow to the filter separator by closing the inlet and outlet valves. For filter element replacement during operation, reference eductor evacuation in **paragraph 6.5.8**.

Step 2. Position a container to catch draining fuel.

Step 3. Open water drain valve and drain the vessel.

Step 4. Remove filter separator cover retaining bolts, nuts and washers.

Step 5. Swing cover away from the vessel.

Step 6. Remove nuts and washers to release the filter element's retainer plate.

Caution: Do NOT touch the elements with bare hands or any oily material. Oil or grease will harm the separator and reduce effectiveness.

Step 7. Unscrew filter elements from their sockets.

Step 8. Clean any sludge or dirt from the interior of the filter separator.

Step 9. Install new filter elements by screwing them into the sockets. Tighten elements to 30 ft-lbs. Replace the filter element's retainer plate and nuts and tighten to 5 ft-lbs.

Step 10. Replace the cover, making sure that the O-ring is in good condition and seated in the groove on the end of the vessel. Tighten cover bolts in a cross pattern to the specified torque values listed in **Table 6.2**.

Table 6.2. Torque Recommendations.

ITEM	TORQUE (ft-lbs)
Threaded Coalescer Elements	30
Threaded Coalescer Element Retaining Nuts	5
3/8-in Retainer Plate Bolts	15-20
Separator Retainer/Seal Nut	5
Separator Retainer/Seal Nut Jam Nut	5
3/4-in Cover Retainer Nuts	100-110
1/2-in Cover Retainer Nuts	65-75
3/8-in Float Pilot Valve Bolts	25
7/16-in Float Pilot Valve Bolts	30
1-in Eye Bolts-Filter Cover	110-125

Step 11. Place filter separator back into service.

6.5.15. Separator Element Removal and Cleaning. Inspect separator elements when replacing the filter elements. Follow procedures in **paragraph 6.5.14** to open the vessel cover.

Step 1. Remove nuts and separator retainer.

Step 2. Remove seal bolts to release the separator elements.

Caution: Do NOT touch the screen with bare hands or any oily material. Oil or grease will disarm the separator and reduce effectiveness.

Step 3. Clean separator elements by submerging them in clean fuel and gently brushing the screen surfaces with a soft bristle brush. Inspect exterior surfaces for tears or other damage. Inspect rubber gaskets.

Step 4. Replace separator elements in the vessel. Correctly seat rubber gaskets on the knife-edge of the separator seat.

Step 5. Reinstall the seal bolts and tighten to 5 ft-lbs of torque.

Step 6. Inspect the O-ring to ensure it is in good condition and properly seated in the groove. Tighten cover bolts, in a cross pattern, to the specified torque values listed in **Table 6.2**.

Step 7. Place the filter separator back in service as described in **paragraph 6.5**.

6.5.16. Recommended Flange Tightening Process. Ensure flange faces are clean and free of imperfections before tightening flanges. **Table 6.2** provides recommended tightening torques for filter monitors and filter water separators.

Step 1. Carefully remove any solid residue from the flanges using scrapers, wire brush, or both.

Step 2. Carefully fit gasket into position taking care not to damage the gasket surface.

Step 3. Install studs/bolts hand-tighten in turn.

Step 4. Initially torque bolts to 30% of the final torque in a cross-pattern sequence.

Step 5. Next, torque to 60% of the final torque value using the same tightening sequence.

Step 6. Torque to the final torque value using the same tightening sequence.

Step 7. Continue with one final pass tightening the bolts/studs in a clockwise sequence to the final torque value.

6.6. Special Considerations.

6.6.1. Filter separators must be empty before towing the cart at more than 10 MPH due to high center of gravity.

6.6.2. Filter separator elements will not filter water. The filter separator elements are approved to filter only JP-5, JP-8, Jet-A, kerosene and diesel fuel.

6.7. After Repair Actions. Clean and inspect tools and equipment per **Attachment 3**.

6.8. Periodic Inspection. Perform frequent inspections of hose connections, monitor for leaks, operational checks (water level and differential pressure). Verify correct valve alignment.

6.9. Reconstitution of Consumables. Immediately reorder all consumed items through base supply to keep the UTC in mission ready status.

Chapter 7

RECONSTITUTION AND RETURN TO NORMAL OPERATIONS

7.1. Reconstitution. All consumable items (e.g., gaskets, filter elements, layflat hose, etc.) used should be replenished through base supply as quickly as the mission allows to ensure each UTC is kept in mission ready status. If reconstituted at the WRM storage location, the process may add more time to the UTC being in a non-deployable status. Clean, lubricate and inspect all equipment and tools after use. Store equipment and tools in the appropriate place in the storage container.

7.2. Return to Normal Operations. This phase begins when an appropriate authority directs the return to normal operations. During this phase, begin implementing plans to reconstitute WaFERS equipment, materials and vehicles. Returning to normal operations requires permanent repairs to be scheduled and financially programed to allow the removal of temporary repairs and replacement with permanent system components, pieces and parts. Depending upon recovery actions after the attack(s), the shop's normal operations may include additional tasks. The following information discusses those added tasks (not all-inclusive).

7.2.1. Reusable Items. Reusable items removed during permanent repair should be reconstituted and returned to the appropriate UTC. Costs should determine repair or replacement of repairable items removed from the system. If a damaged item is beyond feasible repair, procure a new replacement item.

7.2.2. Restock for WRM. When returning UTCs to WRM status, accomplish a complete inventory of every component. Replace any item taken from a UTC for repairs before declaring the UTC mission capable.

7.2.3. Establishing a Permanent Repair. Initiate contracts to replace WaFERS temporary repairs with permanent repairs. Continue routine inspections on temporary repairs until replaced.

Note: Certain repairs utilizing WaFERS assets may be equivalent to semi-permanent repairs. For example, weld the PLIDCO® Smith+Sleeve in place once the environment is safe to do so. Capping of the hydrant outlet and the inline pipe replacement using mechanical clamps are other examples.

Note: Layflat hoses and epoxy wrap repairs are examples of temporary repairs made to a system. Closely monitor and verify condition while temporary repairs are in place.

Chapter 8

DAMAGE SCENARIOS

8.1. Overview. To demonstrate the capability of WaFERS, this chapter uses a fictitious fuel system as an example to discuss possible repair solutions. The example portrays possible damages and facilitates a discussion to determine repair solutions that apply to real military base fuel systems. The repairs presented here are suggestions that may require modifications depending on local conditions.

8.2. Fictitious Fuel System. Figure 8.1 portrays a fictitious fuel system having components similar to those found in a typical airbase fuel system. Component descriptions follow.

A. Bulk JP-8 Fuel Storage Facility. The fuel storage facility includes three aboveground storage tanks (AST) and one underground storage (UST) tank. The UST has a turbine pump installed which is the only method to transfer fuel to the Hydrant Loop Storage Tanks from this tank. The ASTs are contained in a concrete containment berm and a downstream pump house at an independent location.

B. Bulk transfer Fuel Pump and Filter House. This facility is used to transfer fuel from the ASTs to the Hydrant Loop Storage Tanks.

C. Transfer piping. This piping transfers fuel from the ASTs to the Bulk transfer Fuel Pump and Filter House. This piping is both above and below grade.

D. Transfer piping from the UST turbine pump. This piping is the transportation route to the hydrant pump-house storage tanks. This piping is both above and below grade. In this example, the piping connects above ground at a valve run with the Bulk Transfer Fuel Pump and Filter House to Point B piping.

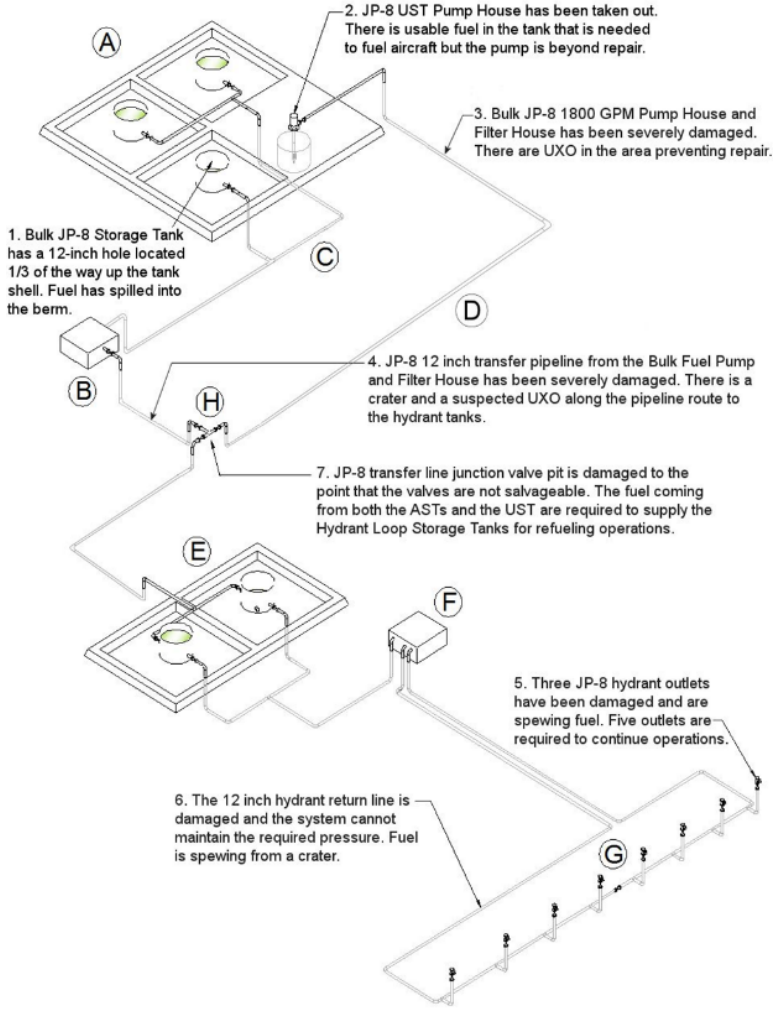
E. Hydrant Loop Storage Tanks. This facility consists of two hydrant Loop ASTs contained in a concrete berm.

F. Hydrant Loop Pump House. The Hydrant loop Pump House is used to pressurize the Hydrant Loop to approximately 100 PSI. This pump house has an automatic variable flow rate to ensure the hydrant loop maintains the set pressure, regardless of the number of aircraft fueling simultaneously.

G. Hydrant Loop. The hydrant loop is a manifold of large piping used to carry fuel to the R-12 Fueling truck. The truck connects the hydrant loop to the aircraft via the hydrant outlet.

H. JP-8 Transfer Line Junction Valve Pit. This Valve Pit controls the source of fuel from either the ASTs and bulk-transfer pump house or the UST.

Figure 8.1. Fictitious Fuel System with Damage Identified.



8.3. Damages to Fictitious Fuel System and UTC Selection. The following paragraphs describe the damage done to the fuel system portrayed in **Figure 8.1** and discusses the preferred UTC(s) used to repair each of the damages described. In all cases, the Consolidated Tools UTC will be required in addition to those mentioned in each scenario.

8.3.1. Damage Scenario 1. Bulk JP-8 Storage Tank has a 12-inch diameter hole located one-third of the way up the tank shell. Fuel has spilled into the berm.

8.3.1.1. In order to perform a repair on this compromised tank, relocate fuel in the berm first. The fuel in the tank berm is slightly contaminated, but usable since it is contained in a concrete containment. Filter this fuel with the Fuel Filter UTC. Use the Water and Fuel Pump UTC to pump fuel through the filter. A storage location could be any tank with capacity to accept the fuel, or request fuel bladders. Follow steps in **Chapters 5** and **6** for using the Water and Fuel Pump UTC and Fuel Filter UTC.

8.3.1.2. Once access to the tank is possible, evaluate the tank to determine if repair is feasible. If so, follow steps in **Chapter 5** to install a tank patch over the 12-inch hole. If a repair is not feasible, isolate connections to and from the tank and place it out of service.

8.3.2. Damage Scenario 2. JP-8 UST Pump House destroyed. There is usable fuel in the tank to fuel aircraft, but the pump is beyond repair.

8.3.2.1. In this scenario, there is usable fuel in the below grade storage tank needed to prevent disruption of the Air Tasking Order (ATO). One solution is to pump fuel from the tank using the Water and Fuel Pump UTC with the booster pump. The booster pump will be lowered into the below grade tank to push fuel up to the WaFERS pump, which will be connected to the pipeline leading to the airfield fuel tanks. Connect the Fuel Filter UTC inline to ensure the aircraft fuel is clean.

8.3.2.2. Follow steps in **Chapters 5** and **6** for instructions on the Water and Fuel Pump UTC and Fuel Filter UTC.

8.3.3. Damage Scenario 3. Bulk JP-8 1,800 GPM Pump House and Filter House severely damaged. Multiple UXO in the area are preventing repair.

8.3.3.1. This pump and filter house is the primary means by which the base moves fuel from bulk storage to the various points of use on base. The solution to restore this capability is to bypass the filter/pump house using multiple fuel filters and three 600 GPM WaFERS Pumps.

8.3.3.2. The Fuel Filter UTC has the capability of filtering 1,200 GPM as described in **Chapter 5**. Each WaFERS pump is capable of pumping 600 GPM; therefore, use two Fuel Filter UTCs, and Water and Fuel Pump UTCs for this scenario. Follow steps in **Chapters 5** and **6** for using the Water and Fuel Pump UTC and Fuel Filter UTC.

8.3.3.3. It may be necessary to bypass the unsafe UXO area with the Repair and Bypass UTC, as described in **Chapter 3**, by relocating fuel lines to a safe staging area for the WaFERS pump and fuel filter setup.

8.3.4. Damage Scenario 4. JP-8 12-inch transfer pipeline from the Bulk Fuel Pump House and Filter House severely damaged. There is a crater and a suspected UXO along the pipeline route to the hydrant tanks.

8.3.4.1. Before repairs to this pipeline can occur, Explosive Ordnance Disposal personnel must mitigate the UXO. However, removing or rendering the UXO safe will take extensive time.

8.3.4.2. The best option is to bypass the damage and explosive hazard area using a 10- or 12-inch layflat hose. Follow steps in **Chapter 3** for utilizing the Repair and Bypass UTC.

8.3.4.3. Pump fuel through a filter (Fuel Filter UTC) to a usable storage point.

8.3.5. Damage Scenario 5. Three JP-8 hydrant outlets have damage and spewing fuel. Five outlets are required to continue operations.

8.3.5.1. The entire hydrant loop becomes unusable due to leaking hydrant outlets, as the loop requires continuous pressure. In order to use the undamaged hydrants, plug the leaking outlets.

8.3.5.2. Plug the hydrants by using one of two methods: capping with a pipe cap or plugging with a pipe plug. In both repair types, make a straight cut through the pipe. The components required are contained in the Repair and Bypass UTC. Refer to **Chapter 3** for instruction on capping or plugging a pipe.

8.3.6. Damage Scenario 6. The 12-inch hydrant return line is damaged and the system cannot maintain required pressure. Additionally, fuel is spewing from a crater.

8.3.6.1. As described in Damage Scenario 5, the hydrant requires continuous pressure for proper operation; consequently, rapidly repair the leak in the hydrant loop by using one of the several methods described below.

8.3.6.2. For a pipe penetration, available repair methods include epoxy-based wrap, line clamps and hole plugs. Refer to **Chapter 3** for instructions on the use of the various types of line patches.

8.3.6.3. For severely damaged pipes perform an in-line repair by using aluminum pipe sections (below grade) or layflat hose (above grade). Follow steps in **Chapter 3** for repair instructions.

8.3.7. Damage Scenario 7. JP-8 transfer-line junction valve pit damaged to the point that valves are not salvageable. The Hydrant Loop Storage Tanks need the fuel coming from both the ASTs and the UST for refueling operations.

8.3.7.1. In some cases, it may not be feasible to repair an entire valve pit; make decisions using available information at the point of repair.

8.3.7.2. A valve pit is similar to a piping manifold and can be replaced with temporary connections and valves. Refer to **Chapter 3** for instructions on bypassing a damaged manifold.

TOM D. MILLER
Lieutenant General, USAF
DCS/Logistics, Engineering & Force Protection

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

AFI 10-209, *RED HORSE Program,* 11 June 2019
AFI 10-210, *Prime Base Engineer Emergency Force (BEEF) Program*, 25 October 2023
AFI 33-322, *Records Management and Information Governance Program*, 28 July 2021
AFPAM 10-219, Volume 4, *Airfield Damage Repair Operations*, 28 May 2008
AFDP 3-34, *Engineer Operations*, 6 October 2021
American Petroleum Institute/Energy Institute 1581, *Specifications and Qualification Procedures for Aviation Jet Fuel Filter/Separators*, 5th edition

Prescribed Forms

None

Adopted Forms

DAF Form 847, *Recommendation for Change of Publication*

Abbreviations and Acronyms

AFI—Air Force Instruction
AFPAM—Air Force Pamphlet
AFDP—Air Force Doctrine Publication
ANSI—American National Standards Institute
AST—Above Ground Storage Tank
CE—Civil Engineer
FS—Fuel Separator
GPM— gallons per minute

LEL—Lower Explosive Limit
MDSF—Modular Design Split Frame
Nm—Newton meter
PPE—Personal Protective Equipment
UCC—Unit Control Center
UST—Underground Storage Tank
UTC—Unit Type Code
UXO—Unexploded Explosive Ordnance
WaFERS—Water and Fuel Expedient Repair System
WRM—War Reserve Material

Office Symbols

None

Terms

Tricon—a mini shipping container that is one-third the size of a standard 20ft container. They are usually 6ft or 6.5ft / 1.82m or 1.98m long, 8 ft / 2.43m wide, and 8 ft / 2.43m high. When placed together, the footprint of three containers is equivalent to that of a 20ft ISO container.

Attachment 2

CONSOLIDATED TOOLS AND EQUIPMENT UTC (4FWCT).

Note: Components in this inventory may change in-between the publication of AFTTP revisions. Contact AFCEC/CXA for the most up to date item list.

Table A2.1. Consolidated Tools and Equipment UTC (4FWCT).

NOMENCLATURE	QUANTIY	U/M
AIR COMPRESSOR	2	EA
AIR HOSE, 1-INCH X 50 FEET, CHICAGO FITTINGS	2	EA
AIR HOSE, 3/4-INCH X 10 FEET, QD FITTINGS	2	EA
AIR HOSE, 3/4-INCH X 50 FEET, CHICAGO FITTINGS	2	EA
AIR CADDY	2	EA
OIL, TOOL	2	EA
ALIGNMENT BAR, JD	2	EA
ANTI SIEZE COMPOUND	2	EA
DRILL BIT, 1/4-INCH PILOT	4	EA
DRILL BIT, 1/4-INCH PILOT	2	EA
BOX CUTTER	5	EA
BRICK LIGHT, LED LIGHT, 110VOLT	2	EA
MAGNETIC ACCESSORY (BRICK LIGHT)	2	EA
STAND (BRICK LIGHT)	2	EA
SANDER, BRISTLE	1	EA
BELTS BB-034-10 (BRISTLE SANDER)	2	EA
BELTS BB-033-10 (BRISTLE SANDER)	2	EA
BRUSH, WIRE	10	EA
BRUSH, WIRE, STAINLESS STEEL	4	EA

NOMENCLATURE	QUANTIY	U/M
C-CLAMP, 6-INCH STEEL	4	EA
CHAIN, COME ALONG	2	EA
DRIVE ADAPTER, 1/2-INCH - 3/4-INCH	2	EA
DRIVE ADAPTER, 3/4-INCH - 1/2-INCH	2	EA
1-1/4-INCH THIN WALL SOCKET, 1/2-INCH DRIVE	2	EA
1-7/16-INCH THIN WALL SOCKET, 1/2-INCH DRIVE	2	EA
IMPACT SOCKET SET, DEEP WELL, 1/2-INCH DRIVE	1	EA
IMPACT SOCKET SET, DEEP WELL, 3/4-INCH DRIVE	1	EA
FLASHLIGHT	10	EA
FRAMING SQUARE	2	EA
GENERATOR, 5KW	2	EA
WHEEL SET, GENERATOR	2	EA
BATTERY, GENERATOR	2	EA
GLOVES, KEVLAR	20	PR
GLOVES, NITRILE, LARGE	2	BX
GROUNDING ROD, 9 FEET	3	EA
HAMMER, 20 OZ STRAIGHT-CLAW	2	EA
HARNESS	1	EA
HEAD LAMP	10	EA
HYDRAULIC DRILL	1	EA
KNIFE, DRAW	5	EA
KNIFE, LINOLEUM	5	EA
KEYS, HEX (FRACTIONAL AND METRIC) 17-PIECE SET	1	EA

NOMENCLATURE	QUANTIY	U/M
LADDER, ALUMINUM	1	EA
LEVEL (MAGNETIC), 9-INCH PROFESSIONAL	2	EA
LOCKING CLAMP, FAST RELEASE 11-INCH	2	EA
PAINT MARKER, WHITE BOLD	12	EA
PRY BAR, 15-1/2-INCH SUPER WONDER	4	EA
PRY BAR, 6 FOOT	2	EA
PUMP, DOUBLE DIAPHRAGM, 2-INCH	1	EA
DISCHARGE HOSE, 2-INCH X 10 FEET (DOUBLE DIAPHRAGM PUMP)	4	EA
DISCHARGE HOSE, 2-INCH X 25 FEET, (DOUBLE DIAPHRAGM PUMP)	4	EA
SUCTION STRAINER, (DOUBLE DIAPHRAGM PUMP)	1	EA
COUPLER, SUCTION STRAINER TO HOSE (DOUBLE DIAPHRAGM PUMP)	1	EA
RATCHET	2	EA
RATCHET, 1/2-INCH FLEX HEAD	2	EA
SAW, RECIPROCATING, PNEUMATIC	1	EA
SAW BLADES, RECIPROCATING, MC220/18	20	EA
CUTTER/GROOVER, 6-INCH - 14-INCH	1	EA
SAW, GUILLOTINE, 6-INCH - 14 INCH	1	EA
FORM TOOL, 6-INCH (CUTTER/GROOVER)	6	EA
FORM TOOL, 8-INCH (CUTTER/GROOVER)	6	EA
FORM TOOL, 10-INCH (CUTTER/GROOVER)	6	EA
FORM TOOL, 12-INCH (CUTTER/GROOVER)	6	EA
FORM TOOL, 14-INCH (CUTTER/GROOVER)	6	EA
PARTING TOOL (CUTTER/GROOVER)	30	EA

NOMENCLATURE	QUANTIY	U/M
SAW BLADE, GUILLOTINE	25	EA
SAW, GUILLOTINE, MINI, 2-INCH - 6 INCH	1	EA
SAW BLADE, GUILLOTINE, MINI	25	EA
HYDRAULIC POWER UNIT	1	EA
HOSE SET, HYDRAULIC W/ QUICK DISCONNECTS	1	EA
SCISSOR JACK, 1 TON	4	EA
SCREW DRIVER, FLAT HEAD, 6-INCH	2	EA
SCREW DRIVER, PHILLIPS, 6-INCH	2	EA
SCREW DRIVER, SHORT, FLAT HEAD	2	EA
SCREW DRIVER, SHORT, PHILLIPS	2	EA
SHOVEL, ROUND NOSE	2	EA
SLEDGE HAMMER, 20LB STEEL	2	EA
SLEDGE HAMMER, 3LB STEEL	2	EA
SLING HOOK, 2-INCH	4	EA
SLING, 10 FOOT	2	EA
SNIPS, TIN	2	EA
SOCKET SET, 1 7/8-INCH DEEP IMPACT	2	EA
IMPACT WRENCH KIT, MANUAL	1	EA
TAPE, TEFLON	12	RL
CASE, PIPE PREP TOOL	1	EA
PIPE PREP TOOL	1	EA
TRIPOD, 7 FOOT	1	EA
WINCH ASSEMBLY	1	EA
DUCTING, 12-INCH X 20 FEET (VENTILATOR)	2	EA
CONTAINER, DUCTING (VENTILATOR)	2	EA

NOMENCLATURE	QUANTIY	U/M
VENTILATOR	1	EA
MOTOR, VENTILATOR, EXPLOSION PROOF	1	EA
STAND, TRIPOD, PNEUMATIC (VENTILATOR)	1	EA
STAND, TRIPOD, ELECTRIC (VENTILATOR)	1	EA
THROTTLE VALVE, PNEUMATIC (VENTILATOR)	1	EA
CABLE, BONDING (VENTILATOR)	1	EA
VISE, PIPE	2	EA
WRENCH SET, COMBINATION, STANDARD AND METRIC	2	EA
WRENCH, 1-5/8" SLUG	4	EA
WRENCH, 250 FT-LB TORQUE	1	EA
WRENCH, ADJUSTABLE, 6-INCH	4	EA
WRENCH, ADJUSTABLE, 12-INCH	2	EA
WRENCH, ADJUSTABLE, 18-INCH	2	EA
WRENCH, PIPE, ALUMINUM, 18-INCH	2	EA
WRENCH, PIPE, ALUMINUM, 24-INCH	2	EA
WRENCH, PIPE, ALUMINUM, 36-INCH	2	EA
WRENCH, IMPACT, PNEUMATIC 3/4-INCH DRIVE	2	EA
MACHINE, TAPPING (FUEL EXTRACTION KIT)	2	EA
HOLE SAW, 2-INCH (FUEL EXTRACTION KIT)	4	EA
DRIVE, PNEUMATIC (FUEL EXTRACTION KIT)	2	EA
VALVE, CORPORATION, 2-INCH (FUEL EXTRACTION KIT)	5	EA
EVACUATION STINGER (FUEL EXTRACTION KIT)	2	EA
SADDLE, SERVICE, 6-INCH (FUEL EXTRACTION KIT)	1	EA

NOMENCLATURE	QUANTIY	U/M
SADDLE, SERVICE, 8-INCH (FUEL EXTRACTION KIT)	1	EA
SADDLE, SERVICE, 10-INCH (FUEL EXTRACTION KIT)	1	EA
SADDLE, SERVICE, 12-INCH (FUEL EXTRACTION KIT)	1	EA
PIPE CUTTER, HINGED ROTARY, 2-INCH - 4-INCH	1	EA
PIPE CUTTER, HINGED ROTARY, 6-INCH - 8-INCH	1	EA
PIPE CUTTER, HINGED ROTARY, 10-INCH - 14-INCH	1	EA
ADAPTER, PIPE, FEMALE, 2-INCH	2	EA
METER, FLOW RATE INDICATOR	1	EA
EXTINGUISHER, FIRE 10 LB, ABC HANDHELD	2	EA

Attachment 3

REPAIR AND BYPASS UTC (4FWRB)

Note: Components in this inventory may change in-between the publication of AFTTP revisions. Contact AFCEC/CXA for the most up to date item list.

Table A3.1. Repair and Bypass UTC (4FWRB)

NOMENCLATURE	QUANTITY	U/M
BUCKET, COLLAPSIBLE CANVAS, LARGE	2	EA
KIT, EPOXY WRAP	4	EA
CLAMP, FULL-CIRCLE, 6-INCH	4	EA
CLAMP, FULL-CIRCLE, 8-INCH	4	EA
CLAMP, FULL-CIRCLE, 10-INCH	4	EA
CLAMP, FULL-CIRCLE, 12-INCH	4	EA
CLAMP, PIN HOLE, 6-INCH	4	EA
CLAMP, PIN HOLE, 8-INCH	4	EA
CLAMP, PIN HOLE, 10-INCH	4	EA
CLAMP, PIN HOLE, 12-INCH	4	EA
STRAP, RACHET	8	EA
KIT, WOODEN PLUG	2	EA
VALVE, BUTTERFLY, GROOVED, 4-INCH	2	EA
VALVE, BUTTERFLY, GROOVED, 6-INCH	2	EA
VALVE, BUTTERFLY, GROOVED, 8-INCH	2	EA
VALVE, BUTTERFLY, GROOVED, 10-INCH	2	EA
VALVE, BUTTERFLY, GROOVED, 12-INCH	2	EA
COUPLING, STRAUB METAL GRIP THRUST, 4-INCH	6	EA

NOMENCLATURE	QUANTITY	U/M
COUPLING, STRAUB METAL GRIP THRUST, 6-INCH	4	EA
COUPLING, STRAUB METAL GRIP THRUST, 8-INCH	4	EA
COUPLING, STRAUB METAL GRIP THRUST, 10-INCH	4	EA
COUPLING, STRAUB METAL GRIP THRUST, 12-INCH	4	EA
COUPLING, GROOVED, SNAP JOINT, 6-INCH	10	EA
COUPLING, GROOVED, SNAP JOINT, 8-INCH	10	EA
COUPLING, GROOVED, 8-INCH	10	EA
COUPLING, GROOVED, 10-INCH	10	EA
COUPLING, GROOVED, SNAP JOINT, 12-INCH	10	EA
CROSS, ALUMINUM, GROOVED, 6-INCH	1	EA
CROSS, ALUMINUM, GROOVED, 8-INCH	1	EA
CROSS, ALUMINUM, GROOVED, 10-INCH	1	EA
CROSS, ALUMINUM, GROOVED, 12-INCH	1	EA
ELBOW, 90 DEGREE, ALUMINUM, GROOVED, 6-INCH	4	EA
ELBOW, 90 DEGREE, ALUMINUM, GROOVED, 8-INCH	4	EA
ELBOW, 90 DEGREE, ALUMINUM, GROOVED, 10-INCH	4	EA
ELBOW, 90 DEGREE, ALUMINUM, GROOVED, 12-INCH	4	EA
END CAP, ALUMINUM, GROOVED, 4-INCH	6	EA
END CAP, ALUMINUM, GROOVED, 6-INCH	4	EA
END CAP, ALUMINUM, GROOVED, 8-INCH	2	EA
END CAP, ALUMINUM, GROOVED, 10-INCH	2	EA

NOMENCLATURE	QUANTITY	U/M
END CAP, ALUMINUM, GROOVED, 12-INCH	2	EA
HOSE, SUCTION, 6-INCH, 10 FEET LONG, W/GROOVED ENDS	2	EA
HOSE, SUCTION, 8-INCH, 6 FEET LONG, W/GROOVED ENDS	4	EA
HOSE, SUCTION, 10-INCH, 6 FEET LONG, W/GROOVED ENDS	4	EA
HOSE, SUCTION, 12-INCH, 6 FEET LONG, W/GROOVED ENDS	4	EA
FITTING, HOSE END, MINEFLEX, 6-INCH	10	EA
FITTING, HOSE END, MINEFLEX, 8-INCH	4	EA
FITTING, HOSE END, MINEFLEX, 10-INCH	4	EA
FITTING, HOSE END, MINEFLEX, 12-INCH	4	EA
FITTING, HOSE END, MINEFLEX, 8-INCH (BODY ONLY)	4	EA
FITTING, HOSE END, MINEFLEX, 10-INCH (BODY ONLY)	4	EA
FITTING, HOSE END, MINEFLEX, 12-INCH (BODY ONLY)	4	EA
CLAMP, HOSE END, LAYFLAT, 8-INCH	8	EA
CLAMP, HOSE END, LAYFLAT, 10-INCH	8	EA
CLAMP, HOSE END, LAYFLAT, 12-INCH	8	EA
HOSE, LAYFLAT, 6-INCH X 50 FEET	1	EA
HOSE, LAYFLAT, 8-INCH X 50 FEET	1	EA
HOSE, LAYFLAT, 10-INCH X 50 FEET	1	EA
HOSE, LAYFLAT, 12-INCH X 50 FEET	1	EA
PIPE, ALUMINUM, SCHEDULE 40, GROOVED, 8-INCH X 6.7 FEET	4	EA

NOMENCLATURE	QUANTITY	U/M
PIPE, ALUMINUM, SCHEDULE 40, GROOVED, 10-INCH X 6.7 FEET	4	EA
REDUCER, PIPE, ALUMINUM, GROOVED, 8-INCH X 6-INCH	4	EA
REDUCER, PIPE, ALUMINUM, GROOVED, 10-INCH X 8-INCH	4	EA
REDUCER, PIPE, ALUMINUM, GROOVED, 12-INCH X 10-INCH	4	EA
STOPPER, HIGH PRESSURE, 4-INCH, VITON SEAL- PAK	2	EA
STOPPER, HIGH PRESSURE, 6-INCH, VITON SEAL, PAK	2	EA
GASKET, GROOVED COUPLING, FLEXIBLE, 8-INCH	5	EA
GASKET, GROOVED COUPLING, 6-INCH	5	EA
GASKET, GROOVED COUPLING, 8-INCH	5	EA
GASKET, GROOVED COUPLING, 10-INCH	5	EA
GASKET, GROOVED COUPLING, 12-INCH	5	EA

Attachment 4

LAYFLAT HOSE UTC (4FWLH)

Note: Components in this inventory may change in-between the publication of AFTTP revisions. Contact AFCEC/CXA for the most up to date item list.

Table A4.1. Layflat Hose UTC (4FWLH)

NOMENCLATURE	QUANTITY	U/M
HOSE, LAYFLAT, 6-INCH X 50 FEET	4	EA
HOSE, LAYFLAT, 8-INCH X 50 FEET	8	EA
HOSE, LAYFLAT, 10-INCH X 50 FEET	8	EA
FITTING, HOSE END, MINEFLEX, 6-INCH	4	EA
FITTING, HOSE END, MINEFLEX, 8-INCH	12	EA
FITTING, HOSE END, MINEFLEX, 10-INCH	12	EA
FITTING, HOSE END, MINEFLEX, 8-INCH (BODY ONLY)	12	EA
FITTING, HOSE END, MINEFLEX, 10-INCH (BODY ONLY)	12	EA
CLAMP, HOSE END, LAYFLAT, 8-INCH	24	EA
CLAMP, HOSE END, LAYFLAT, 10-INCH	24	EA
COUPLING, GROOVED, 6-INCH	8	EA
COUPLING, GROOVED, 8-INCH	16	EA
COUPLING, GROOVED, 10-INCH	16	EA
GASKET, GROOVED COUPLING, 6-INCH	4	EA
GASKET, GROOVED COUPLING, 8-INCH	8	EA
GASKET, GROOVED COUPLING, 10-INCH	8	EA

Attachment 5

WATER AND FUEL PUMP UTC (4FWFP)

Note: Components in this inventory may change in-between the publication of AFTTP revisions. Contact AFCEC/CXA for the most up to date item list.

Table A5.1. Water and Fuel Pump UTC (4FWFP)

NOMENCLATURE	QUANTITY	U/M
PUMP, 600GPM, W/TRAILER	1	EA
ADAPTER, FLANGE, 6-INCH, STYLE 741	2	EA
ADAPTER, FLANGE, 8-INCH, STYLE 741	1	EA
ADAPTER, FLANGE, 10-INCH, STYLE 741	1	EA
ADAPTER, FLANGE, 12-INCH, STYLE 741	1	EA
NIPPLE, ALUMINUM, GROOVED, 6-INCH DIAMETER X 10-INCH	4	EA
NIPPLE, ALUMINUM, GROOVED, 8-INCH DIAMETER X 10-INCH	1	EA
NIPPLE, ALUMINUM, GROOVED, 10-INCH DIAMETER X 10-INCH	1	EA
NIPPLE, ALUMINUM, GROOVED, 12-INCH DIAMETER X 10-INCH	1	EA
NIPPLE, ALUMINUM, 6-INCH, GROOVED/NPT (STRAINER ADAPTER)	1	EA
STRAINER, PLATED STEEL, 6-INCH	1	EA
COUPLER, QUICK DISCONNECT, ALUMINUM, 4-INCH (STRAINER ADAPTER)	1	EA
STRAINER, PLATED STEEL, 4-INCH	1	EA
VALVE, BUTTERFLY, GROOVED, 12-INCH	1	EA
TRI-POD	1	EA
FITTING, QUICK DISCONNECT, 6-INCH FEMALE X 4-INCH FEMALE	1	EA

NOMENCLATURE	QUANTITY	U/M
FITTING, QUICK DISCONNECT, 6-INCH FEMALE X 4-INCH MALE	1	EA
FITTING, QUICK DISCONNECT, 6-INCH FEMALE X 6-INCH FEMALE	2	EA
FITTING, QUICK DISCONNECT, 6-INCH MALE X 4-INCH FEMALE	1	EA
FITTING, QUICK DISCONNECT, 6-INCH MALE X 4-INCH MALE	1	EA
FITTING, QUICK DISCONNECT, 6-INCH MALE X 6-INCH MALE	2	EA
HOSE, SUCTION, 4-INCH, 10 FEET, W/MALE X FEMALE QUICK DICSONNECT FITTINGS	10	EA
HOSE, DISCHARGE, 4-INCH, 25 FEET, W/MALE X FEMALE QUICK DICSONNECT FITTINGS	7	EA
COUPLING, GROOVED, 6-INCH	20	EA
COUPLING, GROOVED, 8-INCH	2	EA
COUPLING, GROOVED, 12-INCH	3	EA
ELBOW, ALUMINUM, 6-INCH	2	EA
ELBOW, ALUMINUM,12-INCH	1	EA
END CAP, ALUMINUM, 8-INCH	1	EA
END CAP, ALUMINUM, 12-INCH	1	EA
HOSE, SUCTION, 6-INCH, 10 FEET	5	EA
HOSE, DISCHARGE, 6-INCH, 50 FEET	3	EA
TEE, ALUMINUM, 8-INCH X 8-INCH X 6-INCH	1	EA
TEE, ALUMINUM, 12-INCH X 12-INCH X 6-INCH	1	EA
GASKET, ADAPTER FLANGE, 6-INCH	1	EA
GASKET, ADAPTER FLANGE, 8-INCH	1	EA
GASKET, ADAPTER FLANGE, 10-INCH	1	EA
GASKET, ADAPTER FLANGE, 12-INCH	1	EA

NOMENCLATURE	QUANTITY	U/M
GASKET, GROOVED COUPLING, 6-INCH	10	EA
GASKET, GROOVED COUPLING, 8-INCH	1	EA
GASKET, GROOVED COUPLING, 12-INCH	1	EA

Attachment 6

FUEL FILTER UTC (4FWFF)

Note: Components in this inventory may change in-between the publication of AFTTP revisions. Contact AFCEC/CXA for the most up to date item list.

Table A6.1. Fuel Filter UTC

NOMENCLATURE	QUANTITY	U/M
FILTER, FUEL, 600 GPM, TRAILER MOUNTED	1	EA
FILTER KIT, SEPARATOR ELEMENT (3 PER KIT)	1	EA
FILTER KIT, COALESCER ELEMENT (6 PER KIT)	2	EA
KIT, GROUNDING	1	EA
ADAPTER, 6-INCH, MALE QUICK DISCONNECT X GROOVED	2	EA
ADAPTER, 6-INCH, FEMALE QUICK DISCONNECT X GROOVED	2	EA
ADAPTER, QUICK DISCONNECT, 4-INCH FEMALE X 6-INCH MALE	2	EA
ADAPTER, QUICK DISCONNECT, 6-INCH-FEMALE X 4-INCH MALE	2	EA
ADAPTER, QUICK DISCONNECT, 6-INCH FEMALE X 6-INCH FEMALE	2	EA
ADAPTER, QUICK DISCONNECT, 6-INCH MALE X 6-INCH MALE	2	EA
COUPLING, GROOVED, SNAP JOINT, 4-INCH	4	EA
COUPLING, GROOVED, SNAP JOINT, 6-INCH	21	EA
CROSS, ALUMINUM, GROOVED, 6-INCH	1	EA
ELBOW, 45 DEGREES, ALUMINUM, GROOVED, 6-INCH	4	EA

ELBOW, 90 DEGREES, ALUMINUM, GROOVED, 6-INCH	4	EA
END CAP, ALUMINUM, GROOVED, 6-INCH	2	EA
NIPPLE, ALUMINUM, GROOVED, 6-INCH X 10-INCH	2	EA
VALVE, BUTTERFLY, GROOVED, 4-INCH	2	EA
VALVE, BUTTERFLY, GROOVED, 6-INCH	2	EA
GASKET, GROOVED COUPLING, 4-INCH	2	EA
GASKET, GROOVED COUPLING, 6-INCH	10	EA

Attachment 7

14-INCH GUILLOTINE SAW PERIODIC MAINTENANCE AND INSPECTION SCHEDULE

Table A7.1. 14-Inch Guillotine Saw Periodic Inspection and Maintenance Schedule.

Eqpt	System	MFG	Model	Location	Man hours	Dly	Wkly	Mntly	Qtrly	SA	Anually	BA	TA	Notes
Super C+	Cutting	WACHS		4FWCT Tricon										
Combined Tools 4FWCT - Visual and Mechanical Inspection (IN STORAGE)														
Lubricate all grease fittings with a good grade of soft grease. Careful not to over lubricate.					.25						X			
Lubricate the fitting for the cam follower beneath the cover at the top of the saw bow					.25						X			
Wipe all surfaces with light oil					.15					X				
Put oil in the air motor oiler and operate the motor for a few seconds with dry air to lubricate its internal components.					.15					X				
In Storage Total Man Hours					.8									
AFTER USE														
Clean debris from all moving parts, including the guide shafts, reciprocating shafts, and saw frame guides					.25									
Neutralize any corrosive fluids					.25									
Lubricate all grease fittings with a good grade of soft grease. Careful not to over lubricate.					.25									

Lubricate the fitting for the cam follower beneath the cover at the top of the saw bow	.25	
Put oil in the air motor oiler and operate the motor for a few seconds with dry air to lubricate its internal components.	.5	
Wipe all surfaces with light oil	.15	
After Use Total Man Hours	1.65	

Attachment 8

MINI GUILLOTINE SAW PERIODIC INSPECTION AND MAINTENANCE SCHEDULE

Table A8.1. Mini Guillotine Saw Periodic Inspection and Maintenance Schedule.

Eqpt	System	MFG	Model	Location	Man hours	Dly	Wkly	Mntly	Qtrly	SA	Anually	BA	TA	Notes
MGS	Cutting	WACHS		4FWCT Tricon										
Combined Tools 4FWCT - Visual and Mechanical Inspection (IN STORAGE)														
Remove from case					.25					X	X			
Lubricate all grease fittings with a good grade of soft grease. Careful not to over lubricate.					.25						X			
Lubricate the fitting for the cam follower beneath the cover at the top of the saw bow					.25						X			
Wipe all surfaces with light oil					.25					X				
Put oil in the air motor oiler and operate the motor for a few seconds with dry air to lubricate its internal components.					.5					X				
In Storage Total Man Hours					1.5					X	X			
AFTER USE														
						Once verified, resume “In Storage” Maintenance								
Clean debris from all moving parts, including the guide shafts, reciprocating shafts, and saw frame guides					.25									
Neutralize any corrosive fluids					.25									
Lubricate all grease fittings with a good grade of soft grease. Careful not to over lubricate.					.25									

Lubricate the fitting for the cam follower beneath the cover at the top of the saw bow	.25	
Put oil in the air motor oiler and operate the motor for a few seconds with dry air to lubricate its internal components.	.5	
Wipe all surfaces with light oil	.15	
After Use Total Man Hours	1.65	

Attachment 9

6-INCH MEDIUM DUTY SPLIT FRAME CUTTER GROOVER PERIODIC INSPECTION AND MAINTENANCE SCHEDULE

Table A9.1. 6-Inch Medium Duty Split Frame Cutter Groover Periodic Inspection and Maintenance Schedule.

Eqpt	Sys-tem	MFG	Model	Loca-tion	Man hours	Dly	Wkly	Mntly	Qtrly	SA	Anu-ally	BA	TA	Notes
MDSF6	Cut-ting & Groo ving	WACHS		4FWCT Tri-con										
Combined Tools 4FWCT - Visual and Mechanical Inspection (IN STORAGE)														
Lubricate with light oil the feed screws and slide rails on the slides					.25					X				
Split the ring into halves and clean and lubricate inside the rotating and stationary rings					.50					X				
Apply a few drops of way oil to the felt wipers in the stationary ring					.25					X				
Put oil in the air motor oiler, and operate the motor for a few seconds with dry air to lubricate its internal components					.25					X				
In Storage Total Man Hours					1.25									
AFTER USE														
Using a clean cloth, wipe out the raceway of the stationary ring to remove oil and dirt.					.25	Once verified, resume “In Storage” Maintenance								
Split the ring into halves and clean and lubricate inside the rotating and stationary rings					.50									
Lubricate with light oil the feed screws and slide rails on the slides					.25									
Put oil in the air motor oiler, and operate the motor for a few seconds with					.25									

dry air to lubricate its internal component		
After Use Total Man Hours	1.25	

Attachment 10

8-10 INCH MEDIUM DUTY SPLIT FRAME CUTTER GROOVER PERIODIC INSPECTION AND MAINTENANCE SCHEDULE

Table A10.1. 8-10 Inch Medium Duty Split Frame Cutter Groover Periodic Inspection and Maintenance Schedule.

Equipment	System	MFG	Model	Location	Man hours	Dly	Wkly	Mntly	Qtrly	SA	Anually	BA	TA	Notes
MDSF 8-10	Cutting & Grooving	WACHS		4FWCT Tricon										
Combined Tools 4FWCT - Visual and Mechanical Inspection (IN STORAGE)														
Lubricate with light oil the feed screws and slide rails on the slides					.25					X				
Split the ring into halves and clean and lubricate inside the rotating and stationary rings					.50					X				
Apply a few drops of way oil to the felt wipers in the stationary ring					.25					X				
Put oil in the air motor oiler, and operate the motor for a few seconds with dry air to lubricate its internal components					.25					X				
In Storage Total Man Hours					1.25									
AFTER USE														
Using a clean cloth, wipe out the raceway of the stationary ring to remove oil and dirt.					.25	Once verified, resume “In Storage” Maintenance								
Split the ring into halves and clean and lubricate inside the rotating and stationary rings					.50									
Lubricate with light oil the feed screws and slide rails on the slides					.25									
Put oil in the air motor oiler, and operate the motor for a few seconds with					.25									

dry air to lubricate its internal component		
After Use Total Man Hours	1.25	

Attachment 11

10- TO 16-INCH MEDIUM DUTY SPLIT FRAME CUTTER GROOVER PERIODIC INSPECTION AND MAINTENANCE SCHEDULE

Table A11.1. 10- to 16-Inch Medium Duty Split Frame Cutter Groover Periodic Inspection and Maintenance Schedule.

Equipment	System	MFG	Model	Location	Man hours	Dly	Wkly	Mntly	Qtrly	SA	Anually	BA	TA	Notes
MDSF 10-16	Cutting & Grooving	WACHS		4FWCT Tricon										
Combined Tools 4FWCT - Visual and Mechanical Inspection (IN STORAGE)														
Lubricate with light oil the feed screws and slide rails on the slides					.25					X				
Split the ring into halves and clean and lubricate inside the rotating and stationary rings					.50					X				
Apply a few drops of way oil to the felt wipers in the stationary ring					.25					X				
Put oil in the air motor oiler, and operate the motor for a few seconds with dry air to lubricate its internal components					.25					X				
In Storage Total Man Hours					1.25									
AFTER USE														
Using a clean cloth, wipe out the raceway of the stationary ring to remove oil and dirt.					.25	Once verified, resume “In Storage” Maintenance								
Split the ring into halves and clean and lubricate inside the rotating and stationary rings					.50									
Lubricate with light oil the feed screws and slide rails on the slides					.25									
Put oil in the air motor oiler, and operate the motor for a few seconds with					.25									

dry air to lubricate its internal component		
After Use Total Man Hours	1.25	

Attachment 12

HYDRAULIC POWER UNIT PERIODIC INSPECTION AND MAINTENANCE SCHEDULE

Table A12.1. Hydraulic Power Unit Periodic Inspection and Maintenance Schedule.

Equip-ment	Syst em	M FG	Mo del	Lo-ca-tion	Ma n hou rs	D ly	W kly	M ntl y	Qtr ly	S A	Anu-ally	B A	T A	Not es
Hy-draulic Power Unit	HPU	WAC HS	HC M-D2 3	4FW CT Tri-con										
Combined Tools 4FWCT - Visual and Mechanical Inspection (IN STORAGE)														
Inspect all fasteners, hydraulic hoses, belts, and fittings. Replace if cracked or damaged.					1.0						X			
Replace hydraulic fluid and filter					1.5								X	
Replace engine oil and oil filter					1.0						X			
Check air filter, replace if required.					.15						X			
Drain and clean fuel tank & replace fuel filter					1.0								X	
Check voltage of battery and charge					.25				X					
Start hydraulic unit and run minimum of 15 minutes					.50						X			
Run Hydraulic motor					.15						X			
Whip down equipment from dirt and oil after use with oily cloth					.25						X			
In Storage Total Man Hours					5.8									
AFTER USE														
Whip down equipment from dirt and oil after use with oily cloth					.25	Once verified, resume “In Storage” Maintenance								

Check air filter, replace if required.	.15	
After Use Total Man Hours	.40	

Attachment 13

GENERATOR PERIODIC INSPECTION AND MAINTENANCE SCHEDULE

Table A13.1. Generator Periodic Inspection and Maintenance Schedule.

Equipment	Syst	MFG	Model	Location	Man hours	Dly	Wkly	Mntly	Qtrly	SA	Anually	BA	TA	Notes
Generac Generator	Gen	Generac	XD 5000E	4FWCT Tricon										
Fuel Filtering 4FWFF - Visual and Mechanical Inspection (IN STORAGE)														
Check engine oil leaks					.08						X			
Check for fuel leaks					.08						X			
Check for damaged or missing parts					.17						X			
Check for loose, missing, or damaged fasteners					.17						X			
Check the electrical harnesses for cracks, abrasions, and damaged or corroded connectors					.17					X	X			
Check hoses for cracks, abrasions, and damaged, loose or corroded connectors					.17						X			
Check spark arrestor for cracks or other damage					.17					X				
Check diesel fuel and engine oil level					.17						X			
Replace engine oil					.50						X			
Clean/inspect engine oil filter					.33						X			
Clean inlet fuel screen					.50						X			
Clean air cleaner element					.50						X			
Replace engine oil and clean/ inspect engine oil filter					.50						X			
Check engine speed control					.33						X			
Drain the fuel tank and replace outlet fuel filter					.50						X			

Inspect, Clean, and Test fuel injection nozzle	.50						X			
Inspect fuel system hoses	.50								X	
In Storage Total Man Hours	5.33									
AFTER USE										
Wipe down	.33	Once verified, resume “In Storage” Maintenance								
Refill Diesel Fuel	.33									
After Use Total Man Hours	0.66									

Attachment 14

WaFERS PUMP TRAILER PERIODIC INSPECTION AND MAINTENANCE SCHEDULE

Table A14.1. WaFERS Pump Trailer Periodic Inspection and Maintenance Schedule.

Equipment	System	MFG	Model	Location	Man hours	Dly	Wkly	Mntly	Qtrly	SA	Anually	BA	TA	Notes
WaFERS Pump Trailer	Pumping	PSG	GEN IV	4FWFP Tri-con										
Fuel Filtering 4FWFP - Visual and Mechanical Inspection (IN STORAGE)														
Check for Leaks					.25					X				
Walk around and check for damage					.25					X				
Cycle Valves and Check Condition (4)					.25					X				
Inspect tires for cracking and air pressure and correct					.5					X				50 PSI
Check Ground Rod and ground reel					.2					X				
Check Fire Extinguisher and change if low					.2				X					
Check taillights, area and operator lights					.25					X				
Check Hand Brake for Operation and adjust					.2					X				
Check engine oil level					.25						X			
Check Hydraulic Hoses for cracks					.25						X			
Replace hydraulic reservoir breather caps (2)					.5						X			
Change tires					2									10-Yrs

Change hydraulic fluid	1.5									BEFORE USE
Grease pumps	.25									BEFORE USE
In Storage Total Man Hours	6.6									
AFTER USE										
Change fuel filters	1	Once verified, resume “In Storage” Maintenance								
Walk around and check for damage	.25									
Check for leaks of any kind and determine source	.25									
Ground rod is present	.25									
Ground Reel for operation	.25									
Inlet and outlet caps are replaced	.25									
Butterfly valves are in good condition	.25									
Drain Sump tanks	.25									
Piping and tubing condition	.25									
Tires for condition and air pressure	.25									
Jack Stands condition	.25									
Safety Chain condition	.25									
Hitch condition	.25									
Fire Extinguisher condition and is charged	.25									
Strainer basket clean and empty	.25									
Hand Brake for Operation	.25									
After Use Total Man Hours	4.75									