Los Angeles City Fire Department

TRAINING BULLETIN

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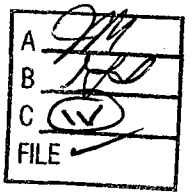

COMPRESSED AIR FOAM BRUSH PATROL APPARATUS

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I. CLASS "A" FOAM BASICS

A. Introduction

1) Class "A" Foam

Class "A" Foam is a synthetic, detergent based, hydrocarbon surfactant, that enhances the fire suppressant properties of plain water. It is designed for use on Class "A" fires (ordinary combustibles).

Surface tension holds water together, making it bead up and run off most fuels. Surfactants are nothing more than detergents similar to what we use to clean dishes and clothing. Firefighting effectiveness of water improves when a surfactant is added because:

a. Water penetrates the fuel faster
b. Increased absorption occurs
c. Fog nozzle droplets are three times smaller resulting in increased surface area of water applied
d. Water becomes slippery, reducing friction loss
e. Water is attracted to carbon

2) Wetting Agents

Wetting agents have most of the properties of surfactants. Unlike Class "A" Foam, wetting agents are designed to prevent foaming. This enhances penetration characteristics required during overhaul to reach deep-seated fires. The LAFD utilizes "wet water" in portable bladder style proportioners.

3) Class "B" Foams

Class "B" Foam, ATC or AFFF, are specifically formulated for burning flammable liquid fires. Class "A" foams do not work the same way and are not safe to use on flammable liquid fires.

B. Class "A" Foam Characteristics And Properties

1) Concentrate

Class "A" Foam concentrate has all of the properties of surfactants. It is a specially formulated detergent that is designed to produce foam.

2) Solution

When Class "A" Foam concentrate is added to water, foam solution is produced. Recommended foam mixtures range from .1% (1gallon concentrate to 1000 gallons of water) to 1% (1 gallon concentrate to 100 gallons water). Foam solution is not agitated and does not have bubbles. Foam solution will spread over the fuel and penetrate better than straight water, however, it will not stay in place long enough to absorb all the heat it is capable of absorbing.

3) Foam

The addition of air to the foam solution produces foam. Foam holds the water in solution on the fuel longer allowing it to absorb more heat.

4) Expansion Ratio

The expansion ratio is the measure of foam produced compared to the amount of foam solution used to make the foam. Mathematically, the expansion ratio is calculated by dividing the volume of foam by the volume of foam solution. If 100 gallons of foam is produced from 10 gallons of foam solution, then the expansion ratio is 10 to 1. Expansion ratios are divided into three categories; low, medium and high.

Ranges of Expansion Ratios:

Low	1:1 to 20:1
Medium	20:1 to 200:1
High	200:1 to 1,000 to 1

Low expansion ratios have a wide range of application including flame knockdown, immediate wetting and mop-up.

Medium expansion ratios are suited for putting down barriers, exposure protection and some mop-up applications.

High expansion ratios are effective insulators and suited for exposure protection.

5) **Drain Time**

Drain time is the time required for a certain amount of foam solution to drain away from the foam mass. Drain time is an indication of the durability of the foam and how quickly the foam solution will be released. Foams with quick drain times are suited for flame knockdown, immediate wetting and mop up. Foams with longer drain times are better suited to exposure protection.

6) **Foam Type**

Foam type describes the combined attributes of a foams expansion ratio and drain time. Foam types are segregated as follows:

a. Foam solution
(1) A clear to milky fluid
(2) Lacks bubble structure
(3) Mostly water, very little air

b. Wet foam
(1) Watery
(2) All sizes of bubbles present, small to large
(3) Lacks body
(4) Fast drain times

c. Fluid foam
(1) Consistency similar to watery shaving cream
(2) Small to medium bubbles present
(3) Flows easily
(4) Moderate drain times

d. Dry foam
(1) Consistency similar to dry shaving cream
(2) Small to medium bubbles present

(3) Mostly air
(4) Clings to vertical surfaces
(5) Slow drain times

7) Mix Ratios

Compressed Air Foam (CAF) is comprised of water, air and concentrate. The combination of the three components is called the "Mix Ratio". The consistency of CAF can be adjusted by changing the mix ratio.

C. Extinguishing Properties Of Class "A" Foam

1) Direct Application

The advantage of foam over plain water is that foam remains on the fuel and continues to cool and wet long after the foam is applied. A wet, fluid foam with a fast drain time is best suited for this application. For best results direct the stream towards the base of the flame and sweep from edge to edge. When covering the edge direct a portion of the foam stream to adjacent unburned fuels to prohibit extension of the fire. The foam has a smothering effect on fire, however, deep-seated fires will smolder and the foam may hide or mask the fire from view.

2) Indirect Application (Exposure Protection)

A dry, stiff foam will adhere to vertical surfaces and provide and insulating layer to exposed combustibles. Apply dry foam (low drain time) to outside walls, eaves, roofs, columns, or other exposed surfaces. Loft the foam stream to avoid breakdown and runoff that occurs due to impact of additional foam. A ½" foam layer is appropriate. Apply foam until it begins to slough off.

A fluid foam can be utilized to provide a firebreak or to increase the defensible area around a structure. Wet the entire fuel layer to ensure that the fire will not burn under the layer of foam.

3) Mop-up

The vapor suppressing, penetrating and cooling properties of foam speed up the mop-up stage of firefighting. Foam solution (no bubbles) or wet foam is best for this application.

D. Personal Safety

Foam concentrates have health effects similar to those of household detergents. Concentrates can produce eye irritation and can dry the skin. The following precautions should be taken when handling the product:

1) Wear goggles, waterproof gloves, and rubber boots when mixing concentrates.
2) Clothing soaked in concentrates should be rinsed out.
3) Eyes splashed with concentrate or solution should be flushed with clean water for 15 minutes.
4) Hand lotion should be used to avoid dry skin and chapping.
5) Spilled concentrate should be cleaned up with an absorbent material. Avoid walking over an area blanketed with foam as it may conceal objects and holes.
6) Avoid contaminating water sources with concentrate or solution.
7) When using CAFS, avoid opening valves quickly since this can result in a firefighter losing control of the hose or being knocked down.

E. LAFD Class "A" Foam Applications

1) Aerial Water Drops

A .1% Class "A" Foam mixture is utilized for aerial water drops on brush fires. The .1% mixture results from adding approximately 1/3 of a gallon of concentrate to the helicopter water tank after the tank is filled with water. Concentrate is poured directly from the container to the tank. No measuring device is currently utilized.

Fire 3 has a new water tank that has an automatic foam injection system. Manual addition of concentrate is not necessary when filling this helicopter.

2) Class "A" Foam Proportioner (Flow Mix Model 500)

The Flow Mix Model 500 is a self-contained, positive pressure proportioner. It has been installed on selected mountain fire district engine companies. Information regarding this proportioner can be found in Training Bulletin 95.

3) "Robwen" Model 750BCF Built-in Foam System

This "Robwen" foam system is "built-in" on the 1998 Pierce engine apparatus. The system includes:

a. Dual 7-½ gallon foam tanks. The dual tank system is designed to be able to change from one tank to another when one tank becomes empty. This provides uninterrupted flow of Class "A" Foam from one tank while the empty tank is being refilled.
b. A 2 ½" discharge gate outlet dedicated to Class "A" foam on each side of the apparatus.
c. A single differential proportioning valve.
d. Two electric refill pumps.
e. An integral 30-gallon foam concentrate cell built into the water tank.
f. A control panel mounted on the left side of the pump panel area. This panel includes a foam level gauge for the main 30-gallon storage tank.

4) Slide-in CAF System On 1998 Ford Brush Patrol Apparatus

The removable CAF system includes:

a. 150 gallon water tank
b. 10 gallon foam tank
c. Water pump capacity of 50 gpm
d. Air compressor capacity of 50 cfm

Design highlights of the 1998 Ford Brush Patrol Apparatus:

a. 4-wheel drive
b. Single rear wheel axle
c. 4-door extended cab
d. 7.9 Powerstroke diesel engine

II. OPERATING INSTRUCTIONS, 1998 FORD BRUSH PATROL APPARATUS

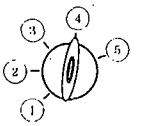
A. Starting

1) Prior to starting vehicle engine:

a. Make sure all fluid levels are at appropriate levels.
b. Make sure all vehicle occupants have properly fastened their seat belts.
c. Make sure all vehicle electrical accessories are off.
d. Make sure vehicle parking brake is set.

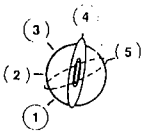
e. Make sure the gearshift lever is in the P (PARK) position.

2) Starting vehicle engine:



a. Turn the ignition key to position 4 (ON).

b. Make sure vehicle dash warning lights have displayed.



c. Turn the ignition key to position 5 (START) and release as soon as the engine starts.

d. Monitor the instruments and warning lights displayed in the instrument panel for any signs of malfunctions.

B. Two-Wheel Drive

The 2WD OVERDRIVE MODE operates the transmission in gears one through four and transmits power back to the rear wheels only. Optimal fuel economy and reduced equipment wear is maximized in this mode. The OVERDRIVE feature of this vehicle automatically defaults to the ON position whenever the vehicle is started. The OVERDRIVE feature can be disengaged by pressing the Transmission Control Switch (TCS) on the end of the gearshift lever. When OVERDRIVE is deactivated the transmission control indicator light (TCIL) located on the end of the gearshift lever will display the word "OFF". The transmission will then operate in gears one through three only. Deactivating the OVERDRIVE function is useful, for example, when more engine braking is required as when operating with a heavy load up or down steep hills. 2WD OVERDRIVE mode is recommended when driving on dry, hard pavement and encountering moderate road grades.

1) Shift sequences for 2WD mode:

a. After idling for a few seconds, apply the brakes and release the parking brake.

While depressing brake pedal, pull the gearshift lever towards you and downward to move the shift lever to the D (DRIVE) position. The brake pedal must be depressed in order to move shift selector from P (PARK) to D (DRIVE) position.

b. To shift from OVERDRIVE to DRIVE press the Transmission Control Switch on the end of the gearshift lever. The word "OFF" will be displayed on the end of the gearshift lever. The transmission will now operate in gears one through three.

c. Use 2 (SECOND) to start up on slippery roads or to provide additional engine braking on downgrades. Pull the gearshift towards you and downward to move the shift lever to the 2 (SECOND) position.

d. Use 1 (LOW) to provide maximum engine braking on steep downgrades. Pull the gearshift towards you and downward to move the shift lever to the 1 (LOW) position.

e. Use R (REVERSE) to move the vehicle backward. Always come to a complete stop before shifting into and out of R (REVERSE). Pull the gearshift lever towards you and upwards from the LOW position to the R (REVERSE) position.

f. Use P (PARK) for parking. Always come to a complete stop before shifting into P (PARK). Make sure the gearshift is securely latched in P (PARK). This position locks the transmission and prevents the rear wheels from turning. Pull the gearshift lever towards you and upwards from R (REVERSE) to the P (PARK) position.

C. Four-Wheel Drive

When the 4WD mode is selected power is supplied to all four wheels through a transfer case for increased traction ability. This vehicle features electronic controls on the transmission that provide safeguards against improper shift commands from the driver. The 4WD system is further divided into both HIGH and LOW modes.

The 4WD system used on this vehicle is an electronic shift on the fly (ESOF) 4x4 system allowing "4x4 HIGH" engagement and disengagement while the vehicle is moving. When four-wheel drive "4x4 HIGH" is engaged power is supplied to all four wheels allowing increased traction during slippery road conditions. The 4WD HIGH mode can be engaged with the vehicle moving up to speeds of 55 mph. Do not engage the 4WD HIGH mode above speeds of 55 mph and/or if the front wheels are slipping. The 4WD system used on this vehicle is equipped with automatic hub locks allowing for automatic four-wheel drive hub lock-up when the instrument panel rotary switch is positioned correctly.

The automatic hub locks on the front axle can also be manually overridden by rotating the hub lock control on the axle from AUTO to LOCK in the event of an automatic hub lock-up system failure.

1) Shift sequences for 4WD mode:

a. Engage 4WD HIGH by rotating the instrument panel rotary switch from 2WD to "4x4 HIGH". "4x4" will illuminate in the instrument panel when this mode is selected. Shifts may be made at any speed(s) up to 55mph. The OVERDRIVE function may be engaged or disengaged while in 4WD HIGH mode as well.

b. Engage "4x4 LOW" by first bringing the vehicle to a complete stop. Second, depress the brake pedal and place the gearshift lever in the N (NEUTRAL) position. Last, rotate the instrument panels rotary switch to the "4x4 LOW" position. "4x4 LOW RANGE" will illuminate in the instrument panel when this mode is selected.

E. Driving Tips

1) When driving off-road with 4WD maintain steering wheel control at all times, especially in rough terrain. Since sudden changes in terrain can result in abrupt steering wheel motion, make sure you grip the steering wheel from the outside. Do not grip the spokes. If the vehicle is stuck it may be rocked out by shifting from forward and reverse gears, stopping between shifts, in a steady pattern. Press lightly on the accelerator in each gear.

2) When driving on hilly or sloping terrain avoid driving crosswise or turning on steep slopes. You could lose traction and slip sideways. Drive straight up, straight down or avoid the hill completely. Know the conditions on the other side of a hill before driving over the crest.

3) When climbing a steep hill, start in a lower gear rather than downshifting to a lower gear from a higher gear once the ascent has started. This reduces strain on the engine and the possibility of stalling.

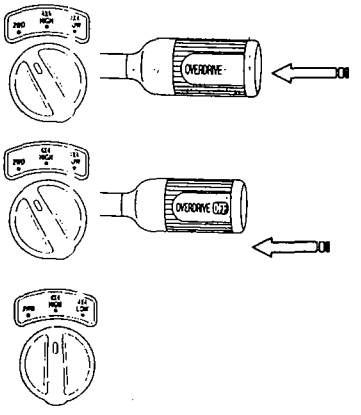
4) When descending a steep hill, avoid sudden braking. Rapid pumping of the brake pedal will help slow the vehicle and still maintain steering control.

5) When driving over sand, try to keep all four wheels on the most solid area of the road. Apply the accelerator slowly and avoid spinning the wheels.

6) When driving through water, determine the depth; avoid water higher than the bottom of the hubs (if possible) and proceed slowly. Once through water, always try the brakes. Wet brakes do not stop the vehicle as effectively as dry brakes. Drying can be improved by moving the vehicle slowly while applying light pressure on the brake pedal.

7) After driving through mud, clean off residue stuck to rotating driveshafts and tires. Excess mud stuck on tires and rotating driveshafts causes an imbalance that could damage drive components.

E. Traction Shift Selection Summary



1) **2WD OVERDRIVE MODE:** On-highway, dry, hard pavement where maximum fuel economy is desired.

2) **2WD MODE:** On-highway, dry, hard pavement with maximum loads; where steep roads are encountered.

3) **4WD HIGH MODE:** On-highway and off-highway; unpaved graded (fire road) road surfaces.

4) **4WD LOW MODE:** Off highway; extreme conditions: unpaved, steep road surfaces; off road, varied terrain: mud, sand, water.

E. Driving Q & A

1) **Q** Do I need to manually lock the axle hubs for 4WD operation?
A NO. The hubs will automatically lock when the rotary switch is moved to "4x4 HIGH".

2) **Q** When would I need to manually lock up the front hubs?
A If the vacuum/electric automatic front wheel lock-up system fails, the manual front lock up feature enables you to lock up the front wheels in order to operate in 4WD mode.

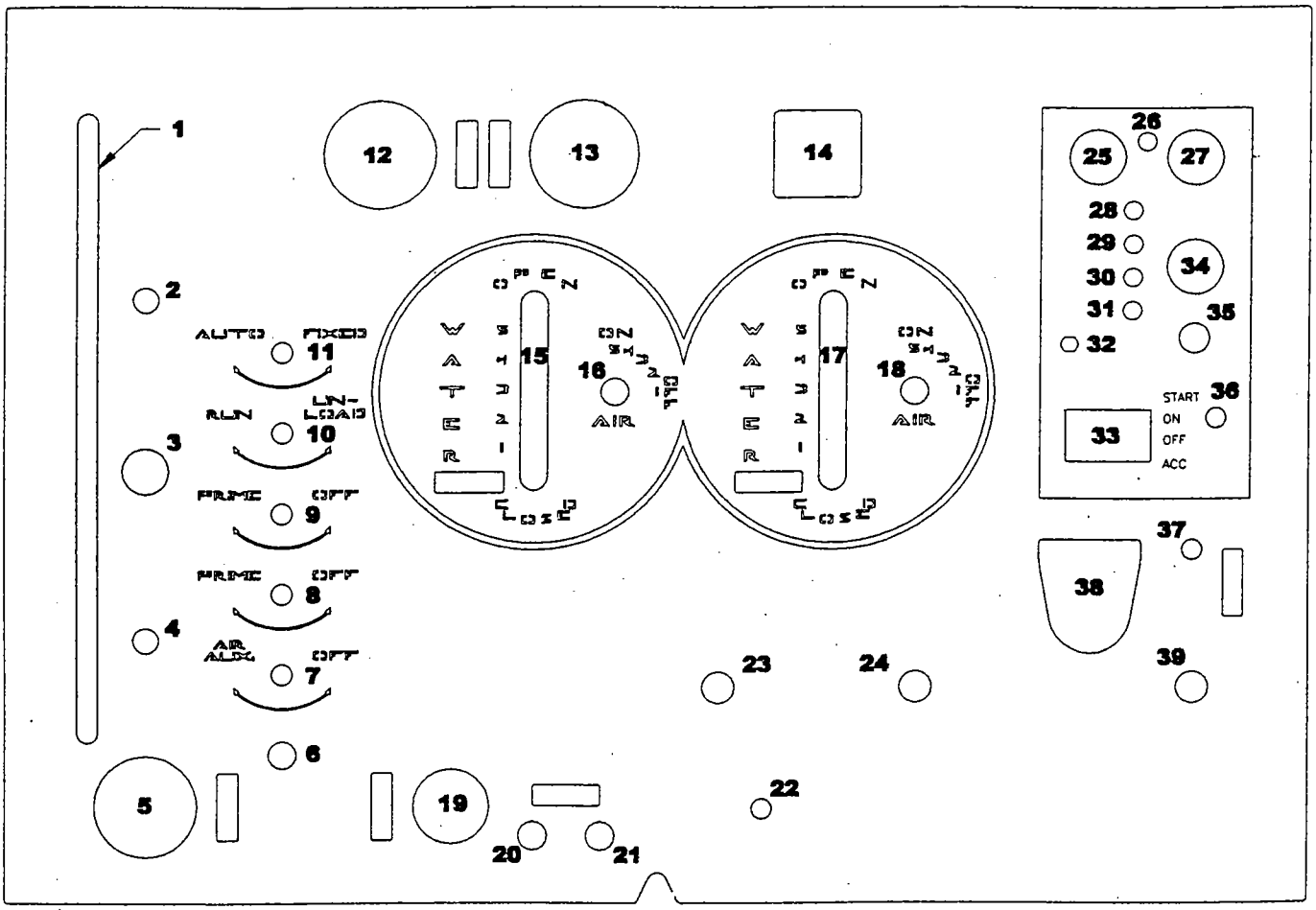
3) **Q** Will the OVERDRIVE feature work in both 2WD and 4x4 HIGH mode?
A YES.

4) **Q** Can I shift from 2WD to "4x4" at any speeds?
A YES. You may shift into "4x4" at any speed up to 55 mph.

5) **Q** Could I damage the vehicle if I were to incorrectly shift the transmission or transfer case?
A NO. The Ford ESOF automatic transmission will prevent shifting until all moving components are synchronized. However, the potential always exists for damage due to incorrect shifting.

NOTE: To prevent damage, the electronic shift 4WD system is designed to allow up to 45 seconds before the shift command is performed. In the event that conflicting shift commands are selected, allow up to 45 seconds for the shift command to be performed prior to reporting any shift concerns to shop maintenance.

III. PUMP PANEL LAYOUT CONTROLS



1) Water level sight gauge
   a. Accurate on level ground. Be wary when parked on a hill.

2) Tank to pump valve
   a. Open when pushed in.

3) Tank fill valve
   a. To open, rotate knob counterclockwise 90°.
   b. It is not necessary to open this valve during pumping operations. The heat exchanger line flows a sufficient amount of water to cool the pump.

4) Suction inlet valve
   a. Pull to open.

5) Suction inlet connection
   a. 2 ½" female inlet.

6) Auxiliary air port
   a. Type "C" connector.
   b. Up to 40 cfm.

7) Auxiliary air valve
   a. Controls air supplied to the auxiliary air port (item 6 above).

8) Water primer valve #2
   a. Pulls air out of the suction piping.
   b. When water pressure is achieved, close immediately and open tank fill valve.

9) Air primer valve #1
   a. Provides air venture with air power. The air venture provides vacuum for priming operations.

10) Compressor Control #2
   a. Unload
      (1) Turns off balance valve that automatically tracks air pressure to water pressure. Use this position to pump water or foam solution without compressed air.
   b. Run
      (1) Activates balance valve. Air pressure will automatically track to water pressure. Use this position to pump compressed air foam.

11) Compressor Control #1
   a. Auto
      (1) Place control in "Auto" position during system start-up and to automatically balance air pressure to water pressure.
      (2) Under static conditions with pressure between 75 and 120, this control will balance air and water pressures within 5 psi.
   b. Fixed
      (1) Place control in "Fixed" position for priming and air only operations.

12) Water pressure compound gauge
    a. Minimum – 40 psi.
    b. Maximum -- 160 psi.

13) Air pressure gauge

14) CFM gauge
    a. Shows volume of compressed air used.
    b. Red line points to cfm used.

15) Water valve -- Panel discharge
    a. For water only open fully (#5 position).
    b. For CAF, open half-way (#3 position).

16) Air valve -- Panel discharge
    a. For water only, leave closed.
    b. For CAF, open half-way (#3 position)

17) Water valve -- Side discharge
    a. For water only open fully (#5 position).
    b. For CAF, open half-way (#3 position).

18) Air valve -- Side discharge
    a. For water only, leave closed.
    b. For CAF, open half-way (#3 position).

19) 1 ½" panel discharge

20) Compressor oil drain

21) Engine oil drain

22) Master batter switch

23) Panel discharge drain

24) Side discharge drain

25) Compressor temperature gauge
   a. Safe temperature range: 100° to 170°.
   b. 180° -- warning light and audible alarm sound.
      (1) Check to see there is water in the tank.
      (2) Check the temperature of water in the tank.
      (3) Check heat exchanger circuit strainer for clogs.

26) Warning light

27) Engine temperature gauge
   a. Safe temperature range: 100° to 220°.
   b. 220° -- warning light and audible alarm sound.
      (1) Hot conditions are caused by
         a) Hot ambient conditions
         b) Long pumping operations under heavy load conditions.
      (2) To correct problem, open auxiliary engine cooler (#39).

28) Oil psi light
   a. If oil psi light remains lit with engine running immediately turn engine off to prevent damaging engine.

29) Fuel filter
   a. Light stays on when water is in fuel filter.
   b. Loosen bottom on fuel filter and drain water out of clear tube.

30) Glow plug
   a. Light illuminates when ignition is turned on.
   b. After 5 seconds, when light turns off, turn ignition switch to 'start" position to engage engine.

31) Alternator light
   a. Disregard this warning light as the alternator has been disabled on these units.

32) Electrical box latch

33) Foam pro panel
   a. Place on-off switch to "on" position to pump foam solution of CAF.
   b. Use dial to select mixture ratio.

34) Fuel level gauge

35) Audio warning alarm

36) Ignition switch
   a. Accessory position (powers panel lights and gauges).
   b. Off
   c. On
   d. Start

37) Throttle
   a. Rotate counter-clockwise to increase engine rpm.
   b. Push center button to quickly reduce engine rpm to idle.

38) Fuel fill
   a. Use DIESEL fuel only.
   b. 10-gallon capacity.

39) Auxiliary engine cooler
   a. Normally kept in closed position.
   b. Open if engine temperature exceeds 210°.

IV. COMPRESSED AIR FOAM OPERATING GUIDELINES

A. CAF Unit Starting Procedures

1) Leave vehicle running to preclude battery drain. Turn light bar off when possible.

2) Ensure there is water in the CAF tank (Observe level of tank through sight gage). The main water pump cools the air compressor. Water is continually circulated back to the tank, slowly heating residual tank water. When operating during a long standby situation or during extreme low flow situations, an overheat condition could result. Continuously refreshed water supply eliminates this concern.

3) Confirm that the air compressor is in the start position by placing the compressor controls in the Auto and Run positions.

4) Open the tank-to-pump valve.

5) Turn the master battery switch to the on position.

6) Turn ignition switch to the on position and wait for the glow plug light to turn off. Immediately turn the ignition switch to the start position and hold until the engine has fully started.

7) Ensure that the low oil pressure light turns off when engine starts. If it remains lit the engine should be shut down immediately as there is a problem with the engine

B. Priming the Pump

1) Set throttle out -- approximately 1/3 open.

2) Set controls in the following positions:

Compressor control 1	Fixed
Compressor control 2	Run
Prime 1	Prime
Prime 2	Prime

3) Open tank to pump valve.

4) Close suction valve.

5) When pressure develops, return both primer controls to the "off" position.

C. Pumping Water

1) Complete steps 1-7 "CAF Unit Starting Procedures".

2) Attach desired hose lines to discharge.

3) Set controls in the following positions:

Compressor control 1	Auto
Compressor co[illegible]	Unload
Foam switch	Off

4) Open discharge gate.

5) Throttle to desired pressure. If pressure does not develop, prime the pump.

6) Water psi is controlled by engine RPM. Minimum pressure is 40 psi and maximum pressure is 160 psi.

D. Pumping Foam Solution

1) Complete steps 1-7 "CAF Unit Starting Procedures".

2) Attach desired hose lines to discharge gate.

3) Set controls to the following positions:

Compressor Control 1	Auto
Compressor Control 2	Unload
Foam switch	On
Foam selector knob	Desired percentage

4) Open discharge gate.

5) Throttle to desired pressure. If pressure does not develop, prime the pump.

E. Pumping Compressed Air Foam (CAF)

1) Complete steps 1-7 "CAF Unit Starting Procedures".

2) Attach desired hose lines to discharge gate.

3) Set controls to the following positions:

Compressor Control 1	Auto
Compressor Control 2	Run
Foam switch	On

4) Foam selector knob — Desired percentage

5) Set throttle pressure required for hose lay. If pressure does not develop, prime the pump.

6) For a 1" hose line.
   a. Open water control valve (15 or 17) to #3 position.
   b. Rotate air control valve (16 or 18) until cfm gauge (14) indicates 20-30 cfm of air flowing.
   c. Use ¾" to 1" smooth bore nozzle.
   c. This unit will supply up to three 1" lines with CAF.

7) For a 1 ½" line.
   a. Open water control valve (15 or 17) to #3 position.
   b. Rotate air control valve (16 or 18) fully to #5 position
   c. Use ¾" to 1 ¼" smooth bore nozzle.
   d. The unit will supply one 1 ½" line with CAF.

F. Supplying Auxiliary Air (up to 40 cfm to power pneumatic tools)

1) Complete steps 1-7 "CAF Unit Starting Procedures".

2) Set controls to the following positions:

Compressor Control 1	Fixed
Compressor Control 2	Run
Foam Switch	Off
Auxiliary Air Valve	Open

3) Establish water pressure in main pump.

4) Advance throttle to desired air pressure (165 psi maximum).

5) Connect air devices to air chuck on pump panel.

6) Monitor booster tank temperature during prolonged operation to avoid overheating. Provide water supply if oil separator tank temperature exceeds 160 degrees F (an alarm sounds at 180 degrees F).

7) Check for following if alarm sounds:
   a. Water tank liquid level.
   b. Water tank temperature.
   c. Water flow through heat exchanger.
   d. Oil level in separator tank.

G. Shutdown

1) Close air flow valves
2) Switch Foam system off.
3) Flush plumbing and hoses with clean water.
4) Reduce engine RPM down to idle for 1 minute. This allows the turbo and engine to properly cool.
5) Turn ignition key to the off position.
6) Turn battery switch off.

H. Clean-up

Perform the following maintenance items following use to ensure readiness:

1) Refill water tank.
2) Refill foam cell.
3) Refill diesel fuel tank.
4) Check engine oil level.
5) Check air compressor oil level.
6) Park apparatus on an incline to drain water and prevent premature deterioration of body.