



**Operation Guide
Applies to Waterous Model**

**70-35-GP Rotary
Rev 5**

Unit Serial Number _____

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Warnings, Cautions, and Notes

Warning A warning alerts you to a procedure, practice or condition that may result in death or long term injury to personnel or destruction of equipment.

Caution. A caution alerts you to a procedure or condition that may result in serious damage to equipment or its failure to operate as expected

Note: A note points out important information. Failure to read the note may not result in physical harm to personnel or equipment. It may waste time and money.

Revision History

Revision	Date Issued	Comments
---	04/2005	Original Release
1	9/29/2006	Logo chg, reformatted, T/S guides added, added Manual Auto-sync pic,
2	9/6/2007	Updated Service parts list
3	5/20/10	Updated per ECR 136
4	5/26/10	Compressor changed

Disclaimer: These instructions are guidelines only and in no way meant to be definitive. During installation, standard safety precautions and equipment should be used where appropriate. Because the tools used and the skill/experience of the installer can vary widely, it is impossible to anticipate all conditions under which this installation is made, or to provide cautions for all possible hazards. Proper installation is the responsibility of the purchaser. All bolts, setscrews, and belts must be checked prior to start-up AND after the initial operation. Damages due to poor installation are the responsibility of the installer.

Waterous reserves the right to make modifications to the system without notice

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SECTION 1. OPERATING INSTRUCTIONS

Check the following fluid levels daily or prior to starting unit:

- Engine oil
- Compressor oil
- Foam concentrate
- Onboard water supply

A. Multiple Uses

The Waterous portable compressed air foam unit can be operated in several pumping modes: water only, foam solution without compressed air and compressed air foam.

NOTE: Monitor compressor instruments during any and all operations.



Figure 1 Manual Auto-sync Controls

B. Water Pumping Operations

All unit operations begin with pumping water. These steps must be followed for operations involving pumping water, foam solution or compressed air foam.

Connect the hose to the discharge port.

Prior to starting the engine, the Auto-Sync control should be in the UNLOAD, a position which allows the air compressor to "free wheel" without pumping air.

- If pumping water from an onboard booster tank, fully open the tank to pump valve. If pump from an overboard source, the tank to pump valve should be fully closed.
- If so equipped, turn on the main electrical power switch to the CAFS unit.
- To start the engine, open the throttle to approximately 1/4, close the choke if necessary, move the ignition switch to the "ON" position, then to the start position to crank the engine until it starts.
- Throttle-up to desired pressure. If pump pressure is absent, it will be necessary to prime the pump utilizing the Waterous Manual Primer.
 - To prime,
 - a) Open the 1/4 turn Priming valve.
 - b) Pump primer until water comes out of the outlet hose
 - c) When the water discharge pressure gauge rises, the pump is primed.
 - d) After prime is achieved, close the Primer valve.
- Open the discharge valve and throttle-up to desired pressure.

CAUTION: Running the unit for extended periods with a dry fire pump can cause damage to the pump.

C. Foam Solution Operations

Follow the instructions above for water pumping operations.

- a) Attach the foam concentrate supply line to the FPS and foam pail, then open the concentrate metering valve in the supply line.
- b) Set the pump to the desired pressure (approximately 125psi).
- c) Water and foam concentrate will now exit the FPS into the hose line. Foam concentrate will be less than 1.0% under normal operating conditions.
- d) If the foam produced is too dry, slowly close the metering valve towards 0 (0 equals fully closed and 5 equals fully open).
- e) Following any use of the FPS with foam concentrate, and prior to shut down for any extended period, the foam concentrate metering valve should be closed, and clean water should be allowed to flow through the FPS to clean itself. The check valve in the foam concentrate supply line should be periodically removed and rinsed to insure proper foam concentrate flow.

D. Compressed Air Foam Operations

Follow the instructions above for foam solution operations. Safe operations dictate the presence of foam concentrate in the water stream prior to the injection of compressed air. If foam concentrate is not present, a condition known as "slug flow" will occur. This is where unmixed water and air is discharged through a nozzle in an erratic manner.

Discharge pressures for compressed air foam operations typically range between 80 and 100 PSI in a flow state. Set water discharge pressure at the desired level.

NOTE: Compressed air foam does not have the hydraulic characteristics of plain water or foam solution. Therefore, standard pump hydraulics practices do not apply to CAFS operations.

1. Move Auto-Sync control to the AUTO position. Air pressure as shown on the air pressure gauge should rise to within plus or minus 5% of the water discharge pressure. The Auto Sync system will balance the air and water pressures throughout a range of 40 PSI up to 120 PSI. Optimal compressed air foam system performance occurs at discharge flow pressures of 80-100 PSI.
2. Open the discharge gate valve approximately 1/4 to 1/2 open. The foam expansion ratio is set by controlling the amount of foam solution entering the discharge stream. High solution flows restrict the amount of air admitted and result in lower expansion or "wet" foam. To produce higher expansion or "drier" foam, simply gate back the amount of solution admitted.
3. Fully open the air valve to admit compressed air into the discharge, then adjust the solution flow to produce the desired foam consistency.

Foam is formed during the transition through the hose. To produce acceptable finished foam, sufficient hose length must be provided on the discharge. Refer to Section on "Suggested Guidelines for the Production of Mid-Range Compressed Air Foam" for minimum hose lengths for CAFS operations.

WARNING Nozzle reaction force is significantly increased at the time the nozzle valve is opened in compressed air foam operations. OPEN CAFS NOZZLES SLOWLY!

SECTION 2. SHUT-DOWN PROCEDURE

1. Close air valve(s)
2. Turn off Foam proportioner by moving the selector handle to zero
3. Flow clear water through discharge hose(s) until no bubbles are present
4. Close discharge valve
5. Move Auto Sync control to UNLOAD
6. Shut engine down

WARNINGS:

- Compressed air can be dangerous. Read and understand the operating instructions for the Waterous compressed air foam unit and individual components prior to operating.
 - DO NOT use the compressed air foam unit as an air source for SCBA or any breathing air supply.
 - Discharge outlets that are capped, hose lines that are valved and charged may contain compressed air. Relieve all pressure BEFORE attempting to remove any caps, fittings, nozzles, or to perform maintenance to prevent serious personal injury.
 - Nozzle reaction force is significantly increased at the time the nozzle valve is opened in compressed air foam operations. OPEN CAFS NOZZLES SLOWLY!
 - Operating the compressed air foam unit with water and compressed air pumped through a discharge without foam concentrate will create a potentially dangerous condition known as "slug flow"; where unmixed pockets of water and air are passed through the nozzle, causing erratic nozzle reaction.
 - For compressed air foam operations, use only fire hose that is rated at 200 PSI or higher working pressure.
 - The unit operator should have a thorough understanding of "Boyle's Law" (The law of compressed gases) prior to operating the compressed air foam unit.
 - It is recommended that the operator wear/use full safety equipment (i.e. gloves, eye protection) on the fire grounds and when operating this system.
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SECTION 3. SERVICE AND MAINTENANCE

Refer to the included manuals for service and maintenance information on the following individual components:

- Engine
- Air Compressor
- Foam Proportioner

A. Maintenance Schedule

	Check oil level and for oil leaks	Change Oil Filter
Daily or After Each Use	X	
Annually	X	X
Every 24 Months	X	X

B. Maintenance Items

COMPRESSOR		
		Part#
AIR FILTER:	CO45002 ⁽¹⁾	2030040
COMPRESSOR OIL		
ISO 68 Non-foaming		
ENGINE		
(refer to Engine Manual for Maintenance Schedule)		
		Part#
AIR PRE-FILTER:	692520 ⁽⁴⁾	6030037
AIR FILTER:	692519 ⁽⁴⁾	6030036
OIL FILTER:	492932 ⁽⁴⁾	6030038
FUEL FILTER:	691035 ⁽⁴⁾	6030039
SPARK PLUGS	491055 ⁽⁴⁾	6030040
ENGINE OIL:	Refer to Engine Manual	
BELTS		
		Part#
PUMP:	8MGT-1120-12 ⁽³⁾	1030027
COMPRESSOR:	8MGT-896-12 ⁽³⁾	1030024

(1) = Donaldson (2) = Mann & Hummel (3) = Gates
 (4) = Briggs & Stratton

SECTION 4. CAFS NOZZLE / FLOW RATE / HOSE COMBINATIONS

A. Nozzles

Compressed air foam can be discharged through various types and sizes of nozzles. Fog nozzles break-down the bubble structure of the foam, resulting in "wetter" or reduced expansion foam. The preferred way to make foam is utilizing smooth bore nozzles with a given hose diameter. Smaller tips will discharge "wetter" foam.

B. Foam Concentrate Ratios

Proportioner settings of 0.2% and 0.6% are typically adequate to produce compressed air foam that is formed in a hose line and used on Class A combustibles. Higher settings will result in "drier" appearing foam. Lower settings may result in "slug flow" or discharge pulsation caused by insufficient foam concentrate in solution to form foam in the hose line.

C. Hose

Utilize fire hose that is rated by the hose manufacturer for use with CAFS. Since the foam is formed during its transition through the hose line, it is important to utilize the minimum recommended hose lengths, unless a static mixer is utilized. There is significantly less friction and head loss with compressed air foam as compared to water or foam solution. Hence, effective fire streams can be achieved with longer hose lays. Refer to the Suggested Guidelines for the Production of Mid-Range Compressed Air Foam.

NOTE: Compressed air foam systems have the ability to produce foam of shaving cream consistency. While this type of foam is highly stable and possesses a long drain time, it is essential to ensure that the foam will release sufficient water to extinguish a fire in a direct attack situation. This type of foam is typically suited for defensive operations such as exposure protection, barriers or fuels pre-treatment.

SECTION 5. SUGGESTED GUIDELINES FOR THE PRODUCTION OF MID-RANGE COMPRESSED AIR FOAM

A. 1" Hose Diameter Jacketed

1 GPM to 1 CFM

½" Tip Solution Flow: 15 GPM (56.78 LPM)

Air Flow: 15 CFM (0.42 m³/min)

Disch. Pressure: 100-150 PSI (6.804 - 10.206 BAR) (689.5 - 1034.25 KPA)

Min/Max Hose Length: 35' to over 400' (10.668 – 121.92 meters)

2 GPM to 1 CFM

½" Tip Solution Flow: 30 GPM (113.56 LPM)

Air Flow 15 CFM (0.42 m³/min)

Disch. Pressure: 100-150 PSI (6.804 - 10.206 BAR) (689.5 - 1034.25 KPA)

Min/Max Hose Length: 35' to over 400' (10.668 – 121.92 meters)

1 GPM to 1 CFM

¾" Tip Solution Flow: 20 GPM (75.71 LPM)

Air Flow: 20 CFM (0.56 m³/min)

Disch. Pressure: 100-150 PSI (6.804 - 10.206 BAR) (689.5 - 1034.25 KPA)

Min/Max Hose Length: 35' to over 200' (10.668 – 60.96 meters)

2 GPM to 1 CFM

¾" Tip Solution Flow: 40 GPM (151.41 LPM)

Air Flow: 20 CFM (0.56 m³/min)

Disch. Pressure: 100-150 PSI (6.804 - 10.206 BAR) (689.5 - 1034.25 KPA)

Min/Max Hose Length: 35' to over 200' (10.668 – 60.96 meters)

B. 1-1/2" Hose Diameter

1 GPM to 1 CFM

1" Tip Solution Flow: 30-40 GPM (113.56 – 151.41 LPM)

Air Flow: 30-40CFM (0.84 – 1.12 m³/min)

Disch. Pressure: 100-150 PSI (6.804 - 10.206 BAR) (689.5 - 1034.25 KPA)

Min/Max Hose Length: 100' to over 800' (30.48 – 243.84 meters)

2 GPM to 1 CFM

1" Tip Solution Flow: 60-80 GPM (227.12 – 302.82 LPM)

Air Flow: 30-40CFM (0.84 – 1.12 m³/min)

Disch. Pressure: 100-150 PSI (6.804 - 10.206 BAR) (689.5 - 1034.25 KPA)

Min/Max Hose Length: 100' to over 800' (30.48 – 243.84 meters)

1 GPM to 1 CFM

1-3/8" Tip Solution Flow: 50-60 GPM (189.27 – 227.12 LPM)

Air Flow: 50-60 CFM (1.4 – 1.68 m³/min)

Disch. Pressure: 100-150 PSI (6.804 - 10.206 BAR) (689.5 - 1034.25 KPA)

Min/Max Hose Length: 100' to over 800' (30.48 – 243.84 meters)

2 GPM to 1 CFM

1-3/8" Tip Solution Flow: 90-120 GPM (340.68 – 454.24 LPM)

Air Flow: 50-60 CFM (1.4 – 1.68 m³/min)

Disch. Pressure: 100-150 PSI (6.804 - 10.206 BAR) (689.5 - 1034.25 KPA)

Min/Max Hose Length: 100' to over 800'(30.48 – 243.84 meters)

C. 1-3/4" Hose Diameter**1 GPM to 1 CFM**

1" Tip Solution Flow: 30-40 GPM (113.56 – 151.41 LPM)

Air Flow: 30-40 CFM (0.84 – 1.12 m³/min)

Disch. Pressure: 100-150 PSI (6.804 - 10.206 BAR) (689.5 - 1034.25 KPA)

Min/Max Hose Length: 100' to over 1400' (30.48 – 426.72 meters)

2 GPM to 1 CFM

1" Tip Solution Flow: 60-90 GPM (227.12 – 340.68 LPM)

Air Flow: 30-50 CFM (0.84 – 1.4 m³/min)

Disch. Pressure: 100-150 PSI (6.804 - 10.206 BAR) (689.5 - 1034.25 KPA)

Min/Max Hose length: 100' to over 1400' (30.48 – 426.72 meters)

1-3/8" Tip Solution Flow: 50-90 GPM (189.27 – 340.68 LPM)

Air Flow: 50-80 CFM (1.4 – 2.24 m³/min)

Disch. Pressure: 110-150 PSI (7.4844- 10.206 BAR) (758.45- 1034.25 KPA)

Min/Max Hose Length: 100' to over 700' (30.48 – 213.36 meters)

NOTE: With 1-3/4" hose lengths of 100'-250' (30.48 – 76.2 meters), up to 90-120 GPM (340.68 – 454.24 LPM) of water and 40-100 CFM (1.12 – 2.8 m³/min) of air may be utilized as a highly effective initial attack flow.

D. Master Stream

1" Tip Solution Flow:

90-120 GPM (340.68 – 454.24 LPM)

Air Flow: 60-80 CFM (1.68 – 2.24 m³/min)

1-3/8" Tip Solution Flow:

100-150 GPM (378.53 – 567.80 LPM)

Air Flow: 70-100 CFM (1.96 – 2.8 m³/min)

1-1/2" Tip Solution Flow:

120-200 GPM (454.24 – 757.06 LPM)

Air Flow: 80-120 CFM (1.68 – 3.36 m³/min)

1-3/4" Tip Solution Flow:

180-250 GPM (681.35 – 946.33 LPM)

Air Flow: 120-150 CFM (3.36 – 4.2 m³/min)

2" Tip Solution Flow:

250-450 GPM (946.33 – 1703.39 LPM)

Air Flow: 200 CFM (5.6 m³/min)

Disch. Pressure: 120-150 PSI (8.1648 – 10.206 BAR) (827.4 – 1034.25 KPA)

SECTION 6. TROUBLESHOOTING – CAFS

The following instructions may refer to options or equipment that you may not have purchased with your system.

Observed Symptom	Probable Cause	Suggested Remedy
Lack of air pressure from compressor	Lack of air supply to clutch (for air-clutch systems)	Repair air leak or re-establish air supply
Compressor not engaging	No PTO engagement	Confirm OK TO PUMP light is on, if not check wiring for damage or disconnected wire, check PTO.
Compressor engaging. No air supply to discharges or insufficient air supply.	Auto-Sync switches not in correct position.	Confirm 40 PSI in UNLOAD position (200 CFM systems) and 50+ in run position. Smaller compressors have lower UNLOAD pressures. Verify when in FIXED/RUN whether pressure reflects 145-150 PSI
	(electric valves) Verify there is power to the air solenoid and check operation of solenoid.	Air discharge solenoid not working. Repair/replace solenoid Air solenoid working - leak between solenoid and discharge. Repair leak.
	Air check valve defective	Replace or correct installation.
	Trim valve out of adjustment	Refer to trim valve instructions
	Restricted minimum pressure valve	Clean rust or debris from valve
	Air plumbed before discharge valve seal	Relocate to discharge side of discharge valve
	Incorrect air line size	Size according to discharge and replace line with correct size.
System functioning correctly, pressure gauge reading obviously incorrect.	Gauge malfunction, air line detached	Check for air leaks, replace gauge
FIXED has pressure but AUTO has no pressure	No water supply to balance valve.	Check line for proper installation, with no kinks or obstructions. Refer to trim valve instructions.
Air discharge pressure too high	Red hose circuit (compressed air control) has leak or is disconnected.	Repair leak or attach hose

Observed Symptom	Probable Cause	Suggested Remedy
System overheating	Inadequate water flow through cooler	Ensure adequate water flow through pump. Check Y strainer for obstruction, clean and reinstall Drain and flush cooler water tubes
	Adequate water flow through cooler.	On-board tank used for cooling for a prolonged period - water too hot to effectively cool the compressor. Locate source of lower temperature water. Check oil level - Adjust level to half of the sight glass on level surface.
	Low compressor oil level:	Check the hydraulic lines for kinks Change oil filters
	Temperature sending unit and or gauge circuit malfunction.	Check wire connections at sending unit
High Oil Consumption	Overfull compressor oil	Adjust level to half of the sight glass on level surface.
	Excess of 200 CFM air flow (on 200 CFM systems)	Back down RPM's and flow CAFS to relieve pressure, then recheck Replace Air/Oil Separator Filter
	Air/oil Separator Filter torn or damaged (could be caused by air flow of higher than 200CFM)	System being operated at higher than capacity
"Excessive" compressor bleed down time on shutoff	Systems vary in bleed down time.	If Auto-Sync is operating correctly, and compressor output is within spec, do nothing.
Engine stalls upon compressor engagement	Engaging compressor while under load	Allow compressor to bleed down before re-engagement
	Running system without flowing air causes oil to accumulate in compressor acting like hydraulic pump	Bleed down air, restart compressor, and move air
	Underrated engine horsepower	Raise engine RPM
	Auto-Sync in FIXED / RUN setting	Engage in AUTO/UNLOAD, then switch to FIXED/RUN
	High oil level	Check oil level, adjust level to half of the sight glass with vehicle parked on a level surface
	Compressor locked up	Repair/replace compressor

Observed Symptom	Probable Cause	Suggested Remedy
Compressor locked up	High oil level (compressor is flooded)	Check oil level, adjust level to half of the sight glass with vehicle parked on a level surface
	Sump fire	Check system and repair
	Low oil level or no oil	Check system and repair
Air flow meter stuck at "0" CFM	Magnet uncoupled in meter	Turn air flow on and off to re-couple
Air flow meter stuck at high CFM		Move large amounts of air out discharge and turn air flow on and off to re-couple
Poor foam (wet or dry) or no foam (assuming air pressure to discharges is OK)	Using wetting agent and not foam concentrate.	Use foam concentrate
	Foam proportioning control turned too low.	Increase amount of concentrate delivered to manufacturer recommended amount.
	Foam proportioning control OFF or turned too low, foam tank empty.	Make sure proportioner is turned on, foam supply valve is open, foam tank has concentrate, Y strainer is clean, and supply line is connected to injector.
Discharge hose shaking (slug flow)	Foam proportioner ON, setting correct, and tank has foam concentrate, but not providing foam solution.	Refer to foam proportioner manufacturer's instructions for detailed calibration and troubleshooting instructions
Foam in the water system (when proportioner turned off)	Foam concentrate was poured into the on-board water tank	Flush tank and pump with clean water, refill
	Foam manifold drain lines not isolated from water drain lines	Isolate to separate drain valve
	Cooler line plumbed from foam manifold	Relocate line to discharge side of pump
	Foam manifold check valve defective	Rebuild/replace check valve
Water in compressor oil/air	Leaking inside cooler Freeze damage	Isolate cooler and check for leaks, replace if needed, check drain
	Defective air check valves	Replace or check
	Missing air check valves for discharges	Install check valves

Observed Symptom	Probable Cause	Suggested Remedy
Clutch smoking	Engaging in RUN position	Engage in AUTO/UNLOAD only
	Slight air leak from solenoid to clutch	Repair air leak
	High RPM engagement	Engage in lower RPM
	Not allowing compressor to bleed down before engaging clutch again	Allow for bleed down
	Contaminated clutch disc	Clean or replace
Safety pop off valve opening at low pressure	Auto-Sync system out of balance	Adjust the Auto-Sync system, making sure to not open the trim valve on the compressor more than 3 turns.
	Sump fire damaged pop off valve	Check system for other damage and replace valve
Safety pop off valve repeatedly opening	Trim valve or inlet completely open	Refer to trim valve instructions

SECTION 7. TROUBLESHOOTING – PUMP

The following instructions may refer to options or equipment that you may not have purchased with your system.

Observed Symptom	Probable Cause	Suggested Remedy
Pump fails to prime or loses prime	Air leaks	<p>Clean and tighten all Intake connections. Make sure intake hoses and gaskets are in good condition.</p> <p>Use the following procedure to locate air leaks:</p> <ol style="list-style-type: none"> 1. Connect Intake hose to pump and attach Intake cap to end of hose. 2. Close all pump openings. 3. Open priming valve and operate primer until vacuum gage Indicates 22 in. Hg/.735 atmospheres. (If primer fails to draw specified vacuum, it may be defective, or leaks are too large for primer to handle.) 4. Close priming valve and shut off primer. If vacuum drops more than 10 in. Hg/.334 atmospheres In 5 minutes, serious air leaks are indicated. With engine stopped, air leaks are frequently audible. If leaks cannot be heard, apply engine oil to suspected points and watch for break in film or oil being drawn into pump.
		<ol style="list-style-type: none"> 1. Completely fill water tank (if so equipped). 2. Connect intake hose to hydrant or auxiliary pump. 3. Open one discharge valve and run in water until pump is completely filled and all air is expelled. 4. Close discharge valve, apply pressure to system and watch for leaks or overflowing water tank. A pressure of 100 psi is sufficient. <p style="text-align: center;">DO NOT EXCEED RECOMMENDED PRESSURE.</p>
		<ol style="list-style-type: none"> 1. If pump has not been operated for several weeks, packing may be dried out. 2. Close discharge and drain valves and cap intake openings. 3. Operate primer to build up a strong vacuum In pump. 4. Run pump slowly and apply oil to Impeller shaft near packing gland. 5. Make sure packing is adjusted properly.
	Dirt on Intake strainer	Remove all leaves, dirt and other foreign material from Intake strainer.
		<p>When drafting from shallow water source with mud, sand or gravel bottom, protect intake strainer In one of the following ways:</p> <ol style="list-style-type: none"> 1 Suspend Intake strainer from a log or other floating object to keep It off the bottom. Anchor float to prevent it from drifting Into shallow water. 2. Remove top from a clean barrel. Sink barrel so open end is below water surface. Place Intake strainer Inside barrel. 3. Make an Intake box, using fine mesh screen. Suspend intake strainer Inside box.
	No oil In priming tank	With rotary primer, oil is required to maintain a tight rotor seal. Check priming tank oil supply and replenish, if necessary.

Observed Symptom	Probable Cause	Suggested Remedy
Pump fails to prime or loses prime (cont'd)	Defective priming valve	A worn or damaged priming valve may leak and cause pump to lose prime. Consult primer Instructions for priming valve repair.
	Improper clearance in rotary gear or vane primer	After prolonged service, wear may increase primer clearance and reduce efficiency. Refer to primer Instructions for adjusting primer clearance.
	Engine speed too low	Refer to Instructions supplied with primer for correct priming speeds. Speeds much higher than those recommended do not accelerate priming, and may actually damage priming pump.
	Bypass line open	If a bypass line is installed between the pump discharge and water tank to prevent pump from overheating with all discharge valves closed, look for a check valve in the line. If valve is stuck open, clean it, replace it or temporarily block off line until a new valve can be obtained.
	Lift too high	Refer to your pump specifications to determine its lift capabilities.
	End of Intake hose not submerged deep enough	Although Intake hose might be immersed enough for priming, pumping large volumes of water may produce whirlpools, which will allow air to be drawn into intake hose. Whenever possible, place end of Intake hose at least two feet below water source.
	High point in Intake line	If possible, avoid placing any part of Intake hose higher than pump inlet. If high point cannot be prevented, close discharge valve as soon as pressure drops, and prime again. This procedure will usually eliminate air pockets in intake line, but it may have to be repeated several times.
	Primer not operated long enough	Refer to Instructions supplied with primer for required priming time. The maximum time for priming should not exceed 45 seconds.
Insufficient capacity A. Engine and pump speed too low at full throttle (continued)	Insufficient engine power	Engine requires maintenance. Check engine in accordance with manufacturer's instructions supplied with truck.
		Engine operated at high altitudes and/or high air temperatures. Engine power decreases with an increase in altitude or air temperature, except for turbo charged engines. Adjusting carburetor or changing carburetor jets (or injector nozzles) may improve engine performance. Consult with engine manufacturer.
	Discharge relief valve set improperly	If relief valve is set to relieve below desired operating pressure, water will bypass and reduce capacity. Adjust relief valve in accordance with instructions supplied with valve.

Observed Symptom	Probable Cause	Suggested Remedy
Insufficient capacity A. Engine and pump speed too low at full throttle (continued)	Transfer valve set Improperly (Does not apply to single stage pumps.)	Place transfer valve in VOLUME (parallel) position when pumping more than two thirds rated capacity. When shifting transfer valve, make sure it travels all the way into new position. Failure of transfer valve to move completely into new position will seriously impair pump efficiency.
	Truck transmission in too high a gear	Consult vehicle instructions for correct pump gear. Pump usually works best with transmission in direct drive. If truck is equipped with an automatic transmission, be sure transmission is in pumping gear.
Insufficient capacity B. Engine and pump speed higher than specified for desired pressure and volume (continued)	Transfer valve set Improperly (Does not apply to single stage pumps.)	Place transfer valve in VOLUME (parallel) position when pumping more than two thirds rated capacity. When shifting transfer valve, make sure it travels all the way into new position. Failure of transfer valve to move completely into new position will seriously impair pump efficiency.
	Pump Impeller(s) or wear rings badly worn	Install undersize wear rings if Impeller to wear ring clearance is within limits indicated in MAINTENANCE INSTRUCTIONS. If not, install new impeller(s) and wear rings.
	Intake strainer, Intake screens or impeller vanes fouled with	Remove intake strainer and hose, and clear away all debris. Pressure backwash (preferably in parallel or "volume" position) will usually clear impeller vanes when pump is stopped.
	Intake hose defective	On old intake hoses, the inner liner sometimes becomes so rough it causes enough friction loss to prevent pump from drawing capacity. Sometimes, the liner will separate from the outer wall and collapse when drafting. It is usually impossible to detect liner collapse, even with a light. Try drafting with a new intake hose; if pump then delivers capacity, it may be assumed that previous hose was defective.
	Intake hose too small	When pumping at higher than normal lifts, or at high altitudes, use a larger or additional intake hoses.
Insufficient capacity C. Engine speed higher than specified for desired pressure and volume	Truck transmission in too low a gear	Consult vehicle instructions for correct pumping gear. Pump usually works best with transmission in direct drive. (Check both engine and pump speed, if possible, to be sure transmission is in "direct".)

Observed Symptom	Probable Cause	Suggested Remedy
Insufficient pressure	Pump speed too low	<p>In general, the above causes and remedies for low pump capacity will also apply to low pump pressure.</p> <p>Check pump speed with a tachometer. If pump speed is too low, refer to engine manufacturer's instructions for method of adjusting engine speed governor.</p>
	Pump capacity limits pump pressure	<p>Do not attempt to pump greater volume of water at the desired pressure than the pump is designed to handle. Exceeding pump capacity may cause a reduction in pressure. Exceeding maximum recommended pump speed will produce cavitations, and will seriously impair pump efficiency.</p>
	Flap valve stuck open	<p>When pump is in PRESSURE (series), discharge will bypass to first stage intake. Operate pump at 75 psi/52 bar, and rapidly switch transfer valve back and forth between positions. If this fails, try to reach valve with a stick or wire and work it free.</p>
Relief Valve Malfunction A. Pressure not relieved when discharge valves are closed	Sticky pilot valve	Disassemble and clean. Replace noticeably worn parts.
	Plugged tube lines	Disconnect lines and inspect.
Relief Valve Malfunction B. Pressure will not return to original setting after discharge valves are reopened	Sticky pilot valve	Disassemble and clean. Replace noticeably worn parts.
	Sticky main valve	Disassemble and clean. Replace noticeably worn parts.
	Incorrect installation	Check all lines to be sure installation instructions have been followed.
Relief Valve Malfunction C. Fluctuating pressure	Sticky pilot valve	Disassemble and clean. Replace noticeably worn parts.
	Water surges (relief valve)	<p>Pressure fluctuation can result from a combination of intake and discharge conditions involving the pump, relief valve and engine. When the elasticity of the intake and discharge system and the response rate (reaction time) of the engine, pilot valve and relief valve are such that the system never stabilizes, fluctuation results. With the proper combination of circumstances, fluctuation can occur regardless of the make or type of equipment involved. Changing one or more of these factors enough to disrupt this timing should eliminate fluctuation.</p>
Relief Valve Malfunction D. Slow response	Plugged filter or line	Clean lines and filter.

SECTION 8. TROUBLESHOOTING – BASIC ENGINE

The following instructions may refer to options or equipment that you may not have purchased with your system.

Problem	Corrective Action
1. The engine fails to crank.	<ul style="list-style-type: none"> a. Release the clutch (if so equipped). b. Clean and tighten the positive (+) and negative (–) battery cable connections at the battery and the engine. c. Recharge the battery. Refer to the equipment or battery manufacturer's recommendations.
2. The engine cranks slowly.	<ul style="list-style-type: none"> a. Release the clutch (if so equipped). b. Clean and tighten the positive (+) and negative (–) battery cable connections at the battery and the engine. c. Recharge the battery. Refer to the equipment or battery manufacturer's recommendations. d. Change engine oil to oil having the proper viscosity for the ambient temperature.
3. The engine cranks but fails to start.	<ul style="list-style-type: none"> a. Check the fuel tank and fill if necessary. b. Open any closed fuel shut off valve. c. Check engine oil level and add oil as necessary. d. Reconnect and re-clamp the choke cable (manual-choke gasoline engines only). Re-adjust as necessary. e. Service the air cleaner. f. Replace the fuel filter (if provided on gasoline engine). g. Replace the spark plugs.
4. The engine runs and then stops.	<ul style="list-style-type: none"> a. Check the fuel tank and fill if necessary. b. Check the engine oil level and add oil as necessary. Drain excess oil if the level is above the dipstick Full mark. c. Reconnect and re-clamp the choke cable (manual-choke gasoline engines only). Re-adjust as necessary.
5. The engine exhausts black (dark) smoke.	<ul style="list-style-type: none"> a. Service the air cleaner. b. Reconnect and re-clamp the choke cable (manual-choke gasoline engines only). Re-adjust as necessary.
6. The engine misfires.	<ul style="list-style-type: none"> a. Replace the spark plugs.

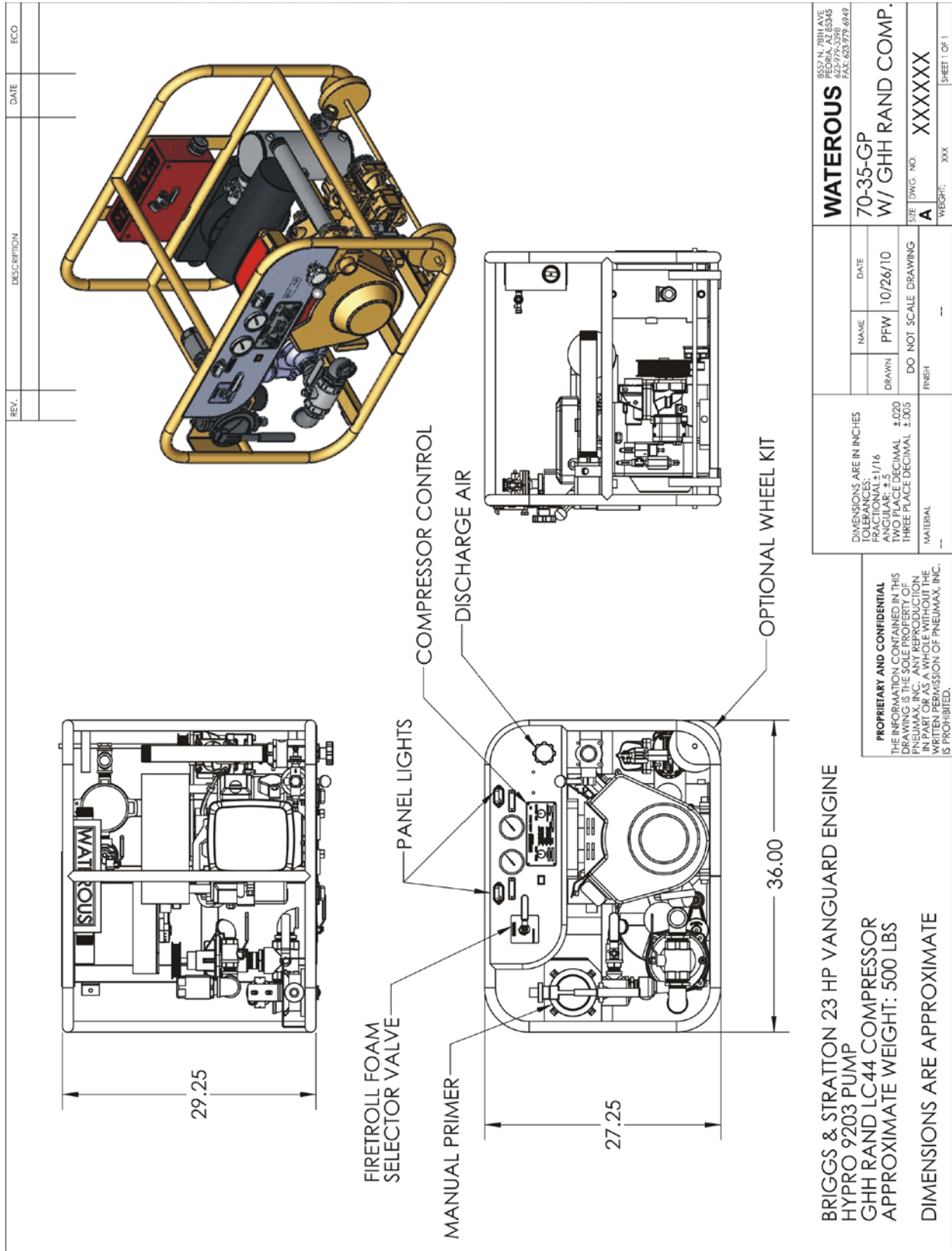


Figure 2 Unit Dimensions and Controls

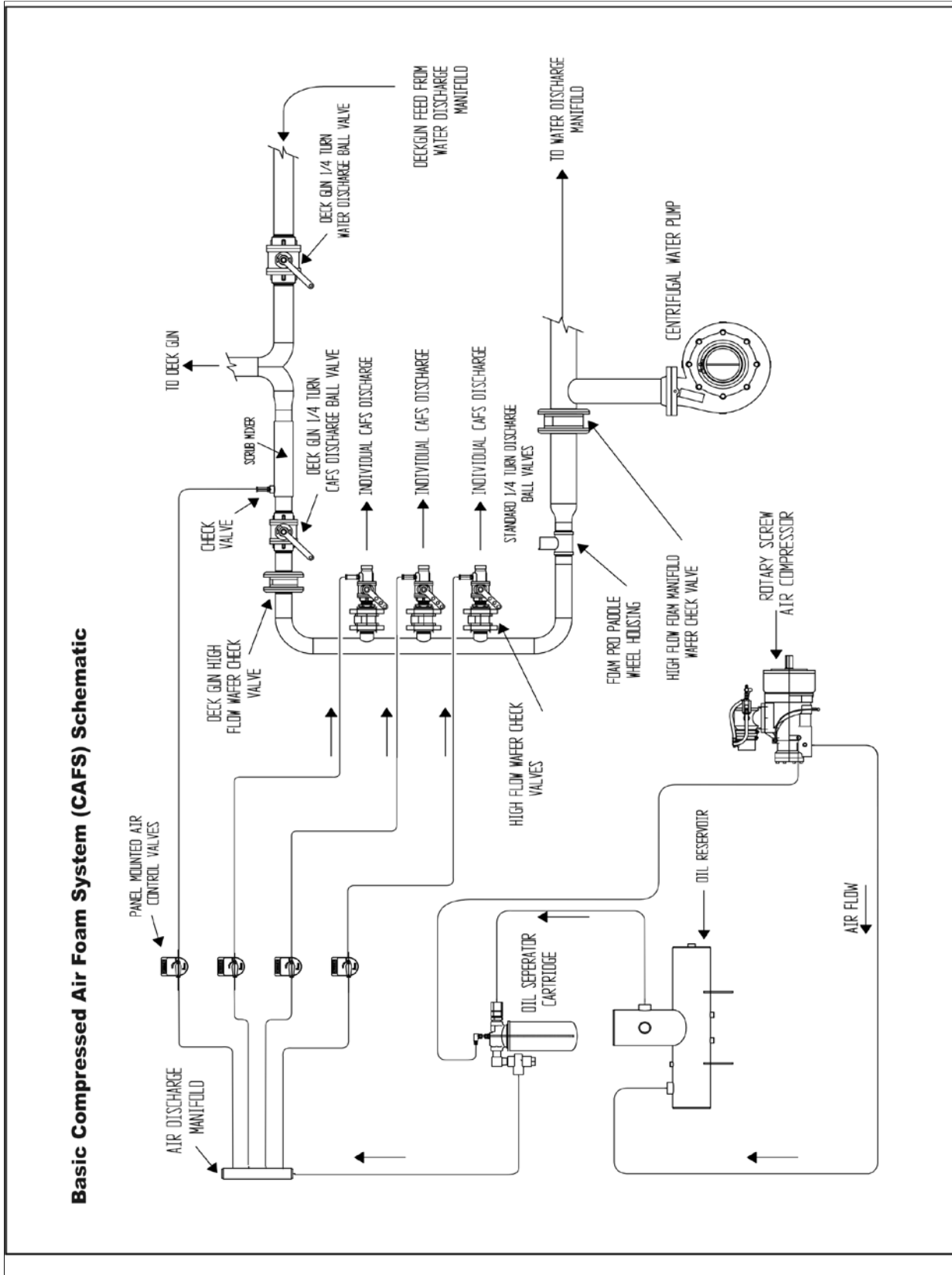


Figure 3 Basic CAFS Schematic

SECTION 9. CONDITIONAL 5-YEAR WARRANTY POLICY

WATEROUS warrants, to the original Buyer only, that products and parts manufactured by WATEROUS will be free from defects in material and workmanship under normal use and service for a period of five (5) years from the date the product is first placed in service, or five and one-half (5-1/2) years from the date of shipment by WATEROUS, whichever period shall be the first to expire; provided the Buyer notifies WATEROUS, in writing, of the defect in said product within the warranty period, and said product is found by WATEROUS to be nonconforming with the aforesaid warranty. When required in writing by WATEROUS, defective products must be promptly returned by Buyer to WATEROUS, or at such other place as may be specified by WATEROUS, with transportation and other charges prepaid. A Returned Material Authorization (RMA) is required for all products and parts and may be requested by phone, fax or mail. The aforesaid warranty excludes any responsibility or liability of WATEROUS for:

- a) damages or defects due to accident, abuse, misuse, abnormal operating conditions, negligence, accidental causes, or improper maintenance, or attributable to written specifications or instructions furnished by Buyer;
- b) defects in products manufactured by others and furnished by WATEROUS hereunder, it being understood and agreed by the parties that the only warranty provided for such products shall be the warranty provided by the manufacturer thereof which, if assignable, WATEROUS will assign to Buyer, if requested by Buyer;
- c) any product or part, altered, modified, serviced or repaired other than by WATEROUS, without its prior written consent; and
- d) the cost of dismantling, removing, transporting, storing, or insuring the defective product or part and the cost of reinstallation.
- e) normal wear items (including, but not limited to belts, hoses, check valves, packing, strainers, filters, light bulbs, anodes, intake screens, mechanical seals, etc.).

This warranty is subject to WATEROUS Conditions of Sale (detailed on WATEROUS Invoice) as currently in effect all of which are herein incorporated and by this reference made a part hereof

All other warranties are excluded, whether express or implied by operation of law or otherwise, including all implied warranties of merchantability or fitness for purpose. WATEROUS shall not be liable for consequential or incidental damages directly or indirectly arising or resulting from the breach of any of the terms of this limited warranty or from the sale, handling, or used of any WATEROUS product or part. WATEROUS liability hereunder, either for breach of warranty or for negligence, is expressly limited at WATEROUS option:

- a) to the replacement at the agreed point of delivery of any product or part, which upon inspection by WATEROUS or its duly authorized representative, is found not to conform to the limited warranty set forth above, or
- b) to the repair of such product or part, or
- c) to the refund or crediting to buyer of the net sales price of the defective product or part. Buyers remedies contained herein are exclusive of any other remedy otherwise available to Buyer.

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Compressed Air Foam Systems