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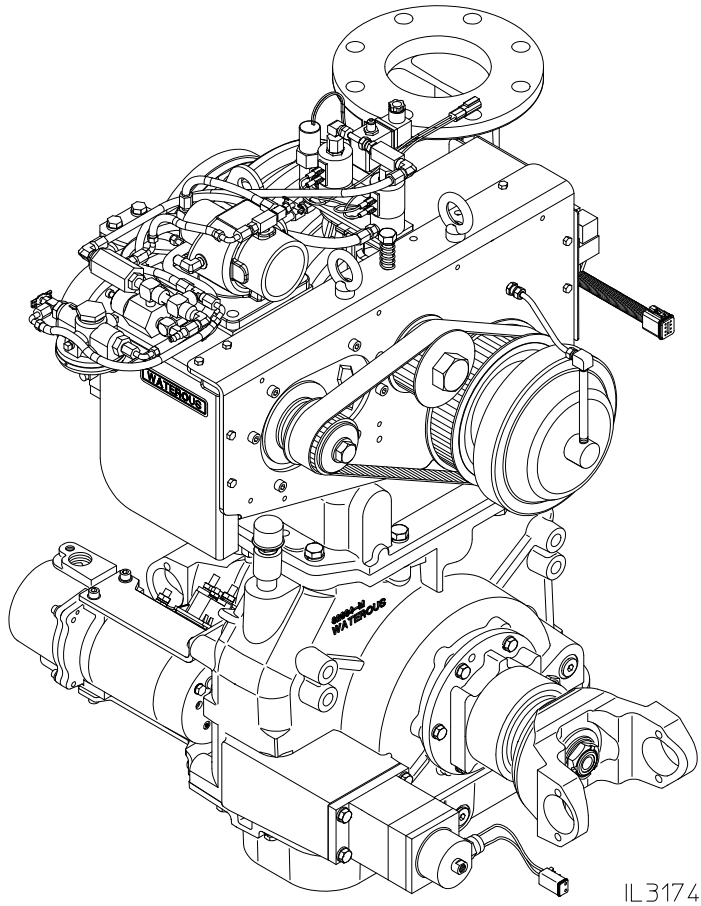


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Read through the safety information and operating instructions carefully before using your Waterous Eclipse™ CAFSystem.



Visit us at www.waterousco.com

Safety Information



Read through the safety information and operating instructions before using your Waterous Fire Pump.

WARNING

Death or serious personal injury might occur if proper operating procedures are not followed. The pump operator, as well as individuals connecting supply or discharge hoses to the apparatus must be familiar with these pump operating instructions as well as other operating instructions and manuals for the apparatus, water hydraulics and component limitation.

WARNING

Pressure Hazard. May result in personal injury.

Prior to connection or removal of hoses, caps or other closures with pump intake or pump discharge connections, relieve pressure by opening drains or bleeder valves. Bleeder valves should also be used while filling a hose connected to an intake with water.

WARNING

Scalding Water Hazard. May result in serious burns.

When operating the pump, be sure to open at least one discharge valve slightly to prevent the pump from overheating. If the pump runs for a few minutes completely closed, it may heat the water enough to scald someone when the valve is opened. Overheating can damage the packing, seals and other pump parts. If the apparatus builder has installed a by-pass system or other provision designed to prevent overheating, opening a discharge valve may be unnecessary.

WARNING

Hose Pressure Hazard. May cause serious personal injury.

Use only fire hose that is rated at 200 PSI (12.8 bar) or higher working pressure.

WARNING

Air Discharge Hose and Nozzle Heat Hazard.

May cause severe burns.

Hose and nozzle used for air discharge will become hot due to the hot air flowing through it.

Wear protective gloves. Also be prepared for nozzle reaction when air discharge and nozzle are opened.

WARNING

Air Source Hazard.

May cause serious personal injury or death.

Do not use the compressed air foam unit as an air source for any self-contained breathing apparatus (SCBA) or any breathing air supply.

WARNING

“Slug Flow” Hazard.

May cause personal injury to the hose operator.

Foam concentrate must be present before the presence of compressed air to prevent the condition known as “slug flow.” If foam concentrate is not present, unmixed water and air will be discharged through the nozzle in an erratic matter.

WARNING

Pressure Hazard.

May cause serious personal injury.

Discharge outlets that are capped, hose lines that are valved and charged and the air compressor sump may contain compressed air. Relieve all pressure before attempting to remove any caps, fittings, nozzles or to perform maintenance to prevent serious injury.

WARNING

Nozzle Reaction Force Hazard.

May cause personal injury to the hose operator.

Nozzle reaction force is significantly increased at the time the nozzle is opened in compressed air foam operation. Open CAFS nozzles slowly.

NOTICE

When towing, disconnect the drive shaft that connects the pump transmission’s rear output (coupling) shaft to the vehicles differential. Failure to do so may result in damage from lack of lubrication.

General Description

The air compressor system used by the Waterous Eclipse™ ES is a Pneumax / GHH Rand model CF75DG, oil flooded rotary screw type. Rotary screw air compressors are very common in industrial applications. This type of compressor injects oil into itself, where it lubricates, seals, cools and silences the compressor. The oil is then entrained into the air discharge from the compressor. This air/oil mixture is discharged into the sump tank where most of the oil separates from the air. The oil is then sent via hydraulic hose to a combination filter/cooler unit. It is filtered and cooled to remove compression and friction heat, and sent to the oil injection port on the compressor. The cycle is then repeated.

The oil mist that remains in the airstream is recovered by an air/oil separator system. This system recovers the oil mist in a spin-on cartridge that has a siphon tube that picks-up the recovered oil for return to the air compressor.

The compressor's air output is controlled by a modulating inlet valve. The inlet valve is opened and closed by the Auto Sync pressure control system.

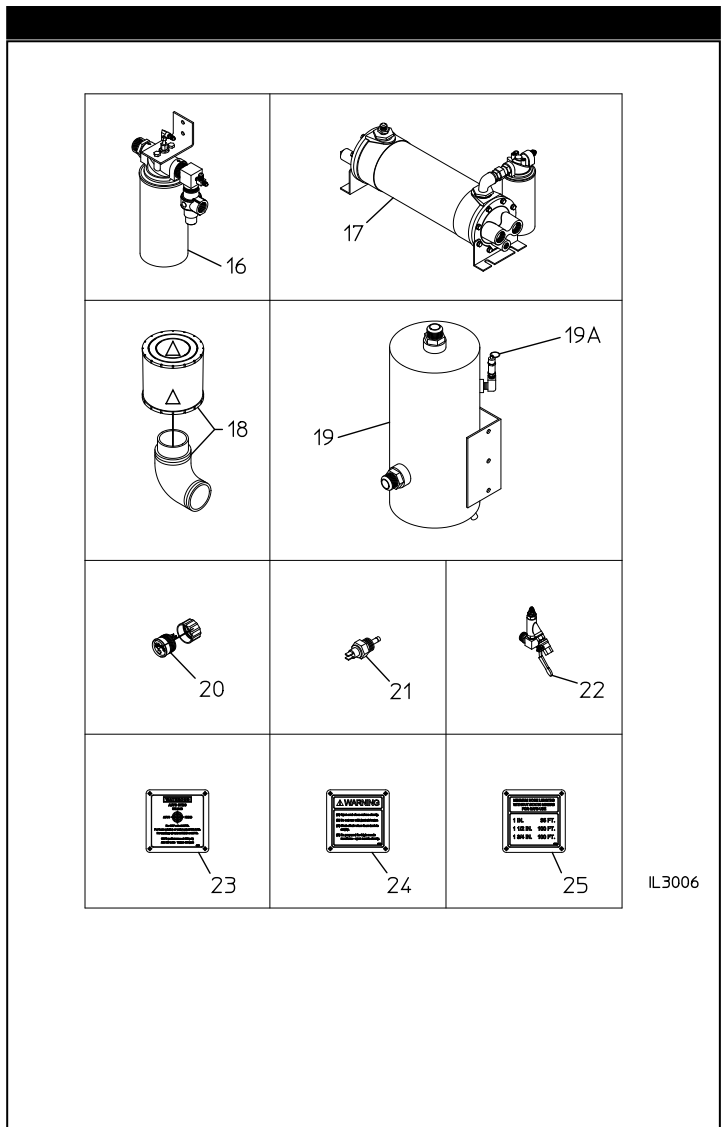
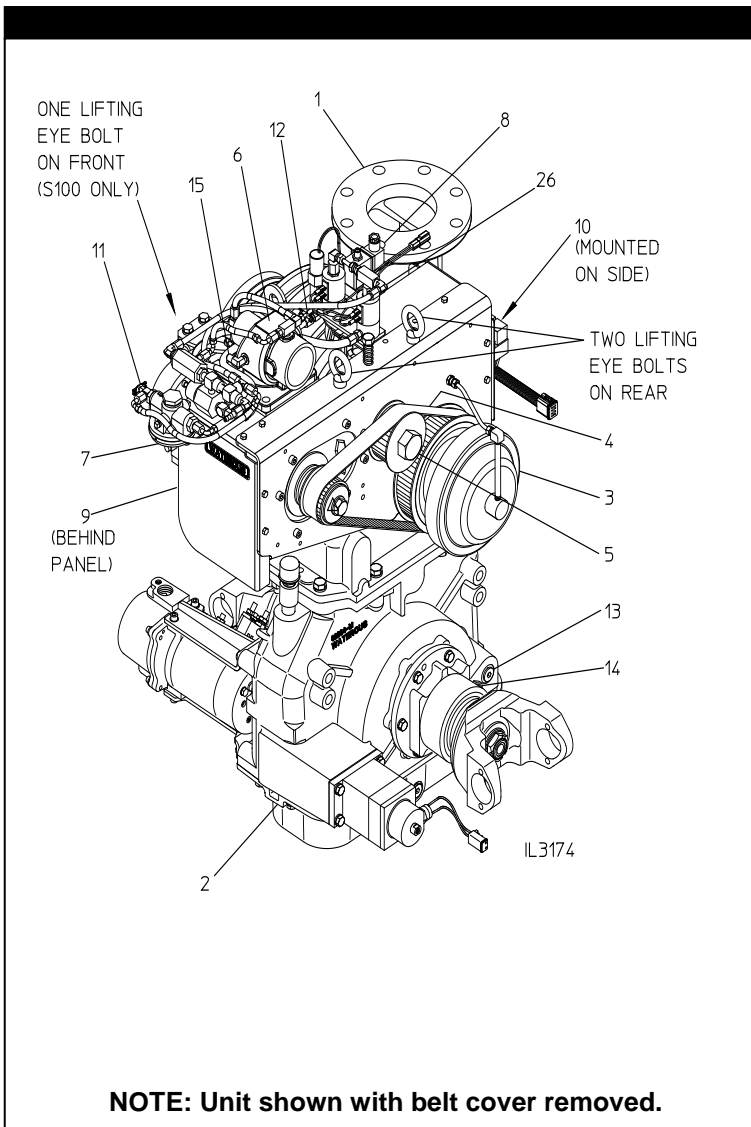
The compressor cooling system circulates water from the fire pump through the compressor oil cooler and back to the pump inlet to remove heat from the compressor oil system. The compressor oil temperature is typically in the 200 - 225°F range. Under maximum running condition, the compressor oil temperature may reach 235°F. If the oil temperature exceeds 235°F, check the water supply, water strainer, pump prime, restrictions in the cooling water system and for low oil level in the sump.

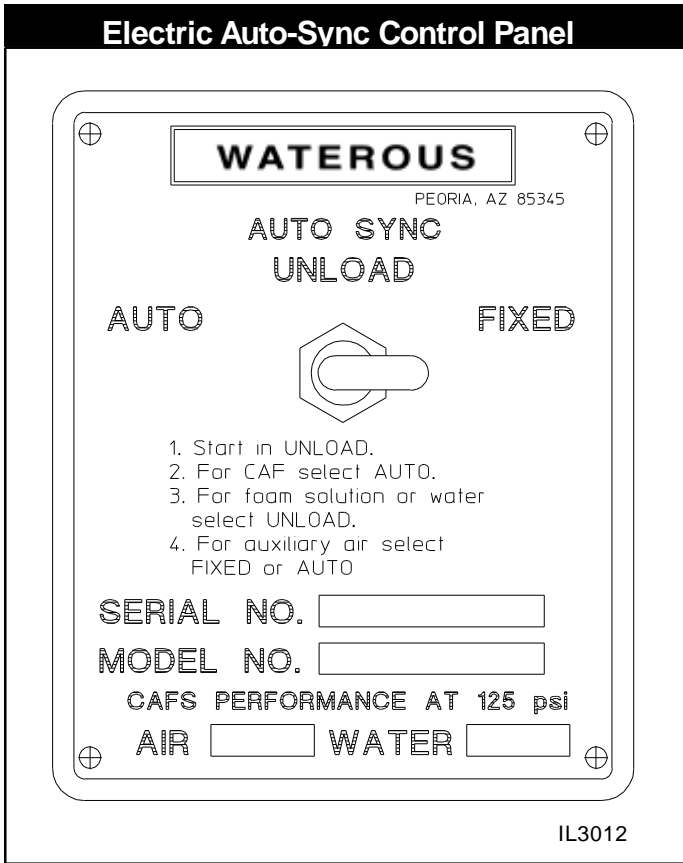
The air compressor (air end) is driven via a PolyChain® and pneumatic clutch through the pump transmission utilizing an extended impeller shaft. **It is important to ensure that there is a water supply from the fire pump whenever the compressor is running. Pump and/or compressor damage may result from running the pump without adequate water flow.**

Standard Items Furnished

Installed On Compressor	
Ref. No.	Description
1	Fire Pump (Separately Mounted for P.T.O. Applications)
2	Fire Pump Transmission or P.T.O
3	Pneumatic Clutch
4	PolyChain Belt
5	Belt Adjustment Hardware
6	Air Inlet Valve
7	Auto Balancing Valve
8	Air Clutch Solenoid
9	Air Compressor
10	Electrical Relay Panel
11	Balance Trim Valve (BTM)
12	Air Inlet Trim Valve (AITV)
15	#4 JIC Connection for Oil Scavenger Line

Components Installed Remotely from the Compressor on the Vehicle by the OEM.	
Ref. No.	Description
16	Air/Oil Separator
17	Oil Cooler
18	Air Filter and Elbow
19	Compressor Oil Sump
19A	Safety Relief Valve
20	Oil Temperature Gauge
21	Oil Temperature Sensor
22	Oil Cooler Water Strainer and Flush Valve
23	Electric Auto-Sync Control Panel
24	Air System Operation Panel Plate
25	CAFS Hose Specification Plate
26	Clutch Air Regulator (P.T.O. Applications Only)





CAFS Nozzle / Flow Rate / Hose Combinations

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 a “wetter” or reduced expansion foam. Similarly, when utilizing smooth bore nozzles with a given hose diameter, smaller tips will discharge “wetter” foam.

Foam Concentrate Ratios

Proportioner settings of 0.2% and 0.3% are typically adequate to produce compressed air foam that is formed in a hoseline and used on Class A combustibles. Higher settings will result in a “drier” appearing foam. Lower settings may result in “slug flow” or discharge pulsation caused by insufficient foam concentrate in the solution to form foam in the hoseline.

For Class B or other type foam ratio settings, follow instructions provided by the foam concentrate manufacturer.

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 hoseline, it is important to utilize the minimum recommended hose lengths, unless a static mixer is used. There is significantly less friction and head loss with compressed air foam as compared to water or foam solution; therefore, effective fire streams can be achieved with longer hose lays. Refer to the Suggested Guidelines for the Production of Mid-Range Compressed Air Foam on Page 6.


NOTE: CAFS has the ability to produce a 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 pretreatment.

Unload / Fixed / Auto Control Switch

Once the compressor’s clutch is engaged, the Unload / Fixed / Auto control switch allows the operator to select between three air compressor pressure modes:

1. Unload (Standby) - The air compressor essentially idles, producing a minimal pressure (40 PSI) to maintain compressor oil flow. The compressor’s clutch shall only be engaged when the Unload / Fixed / Auto switch is in the “Unload” position and master air pressure gauge reads “0” PSI.
2. Fixed - air pressure is maintained at a preset pressure setting (150 PSI).
3. Auto - air pressure matches water discharge pressure.

NOTE: For an explanation of Control Air Circuit function during each operation mode, see Page 16.

 WARNING
<p>Hose Pressure Hazard. May cause serious personal injury.</p> <p>Use only fire hose that is rated at 200 PSI or higher working pressure.</p>

Typical CAFS Flow - Hand Line						
Hose Diameter	Tip Size	Foam Type	Water Flow (GPM)	Air Flow (CFM)	Discharge Pressure (PSI)	Min. Hose Length
1"	1/2"	Wet	20	20	100	35'
1"	3/4"	Wet	30	20	100	35'
1"	3/4"	Fluid	15	45	100	35'
1-1/2"	15/16"	Wet	80	40	100	100'
1-1/2"	1-3/8"	Fluid	30	110	100	100'
1-3/4"	15/16"	Wet	90	50	100	100'
1-3/4"	1-3/8"	Fluid	35	130	100	100'
2-1/2"	15/16"	Wet	120	60	100	150'
2-1/2"	1-3/8"	Wet	190	90	100	150'
2-1/2"	2"	Fluid	50	155	100	150'

Typical CAFS Flow - Portable Master Stream (Fed by One 2-1/2" Line)						
Hose Diameter	Tip Size	Foam Type	Water Flow (GPM)	Air Flow (CFM)	Discharge Pressure (PSI)	Min. Hose Length
2-1/2"	1-3/8"	Wet	300	100	140	150'
2-1/2"	1-1/2"	Wet	340	120	140	150'
2-1/2"	1-3/4"	Wet	380	135	140	150'
2-1/2"	2"	Wet	400	140	140	150'

Wet Foam: Melted ice cream consistency - Fire Attack

Fluid Foam: Shaving cream consistency - Exposure Protection

Operation

A pumper equipped with an Eclipse™ ES compressed air foam unit can be operated in several pumping modes; water only, foam solution without compressed air, compressed air foam and compressed air only for support operation such as operating air tools, filling rescue air bags, etc. It is possible to pump water from one discharge, foam

solution from another discharge while pumping compressed air foam from yet another, or varying foam consistencies (expansion ratios) from different discharges simultaneously.

NOTE: Monitor compressor instruments during all operations.

Water Pumping Operations

All unit operations begin with pumping water. See the following instruction for details on how to operate and pump water from your Waterous fire pump:

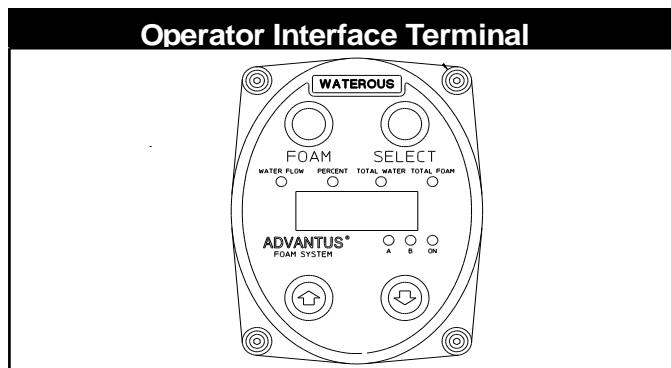
- F-1031, Section 2117, *Operation and Maintenance Instructions for Waterous S100 Series Centrifugal Fire Pumps*
- or
- F-1031, Section 2109.1, *Operation and Maintenance Instructions for Waterous CX Series Centrifugal Fire Pumps*

For water only operations, the compressor switch should be in the "OFF" position which disengages the air compressor.

CAUTION

Overheating hazard.
May cause damage to the pump and/or compressor.
 Running the unit without adequate water flow can cause damage to the pump and/or the air compressor system.

Advantus™ Foam Pump Operation (Optional)



Upon power up, the software revision number will be displayed. The unit will then display the flow rate.

Because the conductivity measurement for a given percentage mix changes with the flow rate, the calibration data is stored in an array. The array holds entries for the various parameters at several different flow rates that are in between flow rates entered in the data array.

During normal operation, the OIT will display flow rate, percent mix, total water or total product.

SELECT	<p>Selects data to display. The default is to display flow rate. Pressing the SELECT button will scroll through the list, then wrap back around to the top of the list. The associated LED will light to indicate what data is being displayed.</p> <p style="padding-left: 40px;">Flow Rate Mix Percentage Total Water Total Product</p> <p>Holding the SELECT button for more than two seconds will lock the display to the current position. Pressing the SELECT button again will unlock.</p>
UP ARROW	<p>When the Mix Percentage is displayed, the current mix setpoint will be displayed. Subsequent presses of the UP ARROW button will increase the Mix Setpoint by 0.1%. After a ten second timeout, the display will return to the Flow Rate display.</p>
DOWN ARROW	<p>When the Mix Percentage is displayed, the current mix setpoint will be displayed. Subsequent presses of the DOWN ARROW button will decrease the Mix Setpoint by 0.1%. After a ten second timeout, the display will return to the Flow Rate display.</p> <p>Pressing both UP and DOWN simultaneously when the Total Water is displayed resets the Total Water accumulator to Zero.</p> <p>Pressing both UP and DOWN simultaneously when the Total Product is displayed resets the Total Product accumulator to Zero.</p> <p>Pressing both UP and DOWN simultaneously when the Flow Rate is displayed enters the MANUAL mode of operation. See Manual Mode operation below.</p> <p>Pressing both UP and DOWN simultaneously while in Mix % will go to the default %.</p>
FOAM	<p>Pressing the FOAM key will alternately start and stop the foam operation. When the controller is running, the FOAM LED will be lit. The FOAM LED will blink when the motor control output is active. The LED will be lit and not blink during the initial pump delay, or when the system is on, but no water flow is detected.</p> <p>If flow is detected, and one or both of the sensor inputs reads full scale, an open sensor error will be flagged. The error SEn1 or error SEn2 will be displayed when the FOAM button is pressed to indicated that the system is non-functional. In this case, the Manual Mode will be functional and must be used.</p>
MANUAL MODE	<p>If the display is showing the flow rate and the two ARROW keys are pressed simultaneously, the % MIX LED will be lit and the display will show a default value of 2.0. Use the UP and DOWN arrow keys to increase or decrease this value in steps of 0.5.</p> <p>NOTE: Pump output is based on a theoretical ratio of foam to water at 50 GPM.</p> <p>Pressing both ARROW keys again exits the MANUAL mode and stops the pump.</p> <p>NOTE: Motor/Pump Assembly will operate in manual mode whether or not there is a water flow. If the INJECT/BYPASS valve is in the INJECT position, foam concentrate will be injected into the system, which will waste concentrate.</p>
AUTO RUN	<p>The system is equipped with an AUTO RUN feature. If the voltage (+12 or 24 VDC) is applied to position 1 on the terminal strip, it will have the same effect as pressing the Red FOAM button. This will start the Foam system. The system will not inject foam until water is flowing.</p>

Foam Solution Only Operation

To begin using a foam solution, follow the instructions above for Water Pumping Operations.

After the pump is operating, turn on the foam pump to inject foam concentrate into the water stream. See Page 6 for Advantus instructions or refer to *FoamPro® Systems 2001 and 2002 Installation and Operation Manual*, P/N L-0825, if equipped with a Foam Pro System.

Compressed Air Foam Operations

The Eclipse™ ES CAFS design provides a minimum air flow of 80-90 SCFM @ 125 PSI whether the pump operates from draft, tank or hydrant. At a typical engine idle speed (600-700 RPM) and a pump transmission ratio of 2.27, the air compressor is capable of delivering 80-90 SCFM of 125 PSI air.

CAUTION

Operating Speed Limit.
May cause damage to the pump and/or air compressor.

The Eclipse ES compressor has a maximum operating speed of 8950 RPM. Do not allow the compressor to run beyond 8950 RPM.

Compressor speed can be calculated by **(Engine Speed) x (Pump Transmission Ratio) x 2.5**.

CAUTION

Compressor Starting Hazard.
Starting compressor under pressure may cause damage to the clutch and/or kill the engine.

Allow ample time for the compressor to bleed down before engaging the compressor.

WARNING

“Slug Flow” Hazard.
May cause personally injury to the hose operator.

Foam concentrate must be present before the presence of compressed air to prevent the condition known as “slug flow.” If foam concentrate is not present, unmixed water and air will be discharged through the nozzle in an erratic matter.

To begin compressed air foam operations, follow the instructions above for Foam Solution Operations.

NOTE: Discharge pressure for compressed air foam operations typically range between 80 and 120 PSI in a flow state. Set the water discharge pressure at the desired level.

NOTE: Compressed air foam does not have the hydraulic characteristics of plain water or foam solution;

Compressed Air Only

For compressed air only operation, the fire pump must be equipped with a discharge bypass system designed to recirculate booster tank water through the fire pump for cooling. The bypass system must be in operation before running compressed air only.

Air compressor cooling is via water from the booster tank that is circulated by the fire pump through the compressor cooler and returned back to the pump inlet. Compressed air only operation time is limited by the amount of available cooling water. The water in the booster tank will eventually become heat saturated and ineffective at cooling the air compressor.

therefore, standard pump hydraulics practices do not apply to CAFS operations.

WARNING

Nozzle Reaction Force Hazard.
May cause personally injury to the hose operator.

Nozzle reaction force is significantly increased at the time the nozzle is opened in compressed air foam operation. Open CAFS nozzles slowly.

After the pump and foam proportioner are operating, perform the following:

1. Place the Auto Sync control in the “UNLOAD” position and check master air pressure gauge reads “0” PSI.
2. Engage the air compressor by moving the compressor switch to the “ON” position.
3. Move the Auto Sync control to the “AUTO” position. The air pressure should rise to within plus or minus 5% of the water discharge pressure. The Auto Sync system will balance the air and water pressures plus or minus 5% throughout a range of 40 PSI and up to 150 PSI.
4. Set proportioner at 0.2% - 0.4% for normal Class A combustibles. Proportioning rates are dictated by the type and brand of foam concentrate used and the tactical objective.
5. Open desired discharge valve(s) to a half-open position. The foam expansion ratio is set by controlling the amount of foam solution entering the discharge stream. High solution flows (discharge valve fully open) restrict the amount of air admitted and result in lower expansion or “wet” foam. To produce higher expansion or “drier” foam, simply reduce the amount of solution admitted by gating back the discharge valve.
6. Open the air valve(s) to the desired discharge(s). Adjust the solution flow (discharge valve setting) to produce the desired foam consistency.

CAUTION

Overheating Hazard.
May cause damage to the pump and/or compressor.

Pump water may overheat when using the Eclipse™ as an air compressor for an extended period of time. Limit the amount of time the Eclipse™ ES is used as an air compressor to prevent damage to the pump or air compressor. Monitor the compressor temperature gauge closely. Compressor system overheat is also indicated by the panel mounted warning light system.

NOTE: Extended compressed air only operations necessitate connection of an external water source to the pump inlet and closing of the tank to pump valve for proper compressor cooling.

After engaging the fire pump, ensure that the water pressure rises on the panel mounted master pressure gauge.

1. Place the Auto Sync control in the “UNLOAD” position and check master air pressure gauge reads “0” PSI.
2. Engage the air compressor by moving the compressor switch to the “ON” position.
3. Move the Auto Sync control to the “FIXED” position. Air pressure will rise to the preset pressure setting on the air compressor, approximately 150 PSI (10 bar) with the engine throttled-up.

 **WARNING**

Air Source Hazard.

May cause serious personally injury or death.

Do not use the compressed air foam unit as an air source for any self-contained breathing apparatus (SCBA) or any breathing air supply.

4. **For lower operating pressures:** Move the Auto Sync controls to the AUTO position and use the engine throttle to control the air pressure.
5. Connect the air discharge hose to the fitting on the pump operator’s panel and open the air supply valve.

Shut Down Procedure

Compressed Air Foam Operations

To shut down compressed air foam operations, follow the instructions below:

1. Close air valve(s) to the discharge(s).
2. Turn off foam proportioner.
3. Flow clear water through discharge hose(s) until no bubbles are present.

4. Close discharge valve(s).
5. Place the Auto/Sync control in the “UNLOAD” position.
6. Move the air compressor switch to the “OFF” position.

After the compressor is disengaged, the system will vent itself, creating an audible hiss as compressed air is evacuated from the pressure vessel/sump.

Compressor Auto Shut Down (Overheat)

The Eclipse™ ES air compressor is equipped with a compressor overheat auto shut down. This auto shut down is present to protect the compressor system from severe damage if such an event should occur.

Compressor Overheat

If high oil temperature (250° and above) is detected in the compressor, the compressor clutch will disengage, the *compressor will stop* and the Compressor Overheat light will illuminate. *The water pump and foam proportioning systems will continue to operate and are not affected by the compressor shut down.* To re-start perform the following:

1. Correct the fault, check oil level, cooling lines, recirculation line (if operating from tank), etc.
2. Reset auto shut down circuit by:
 3. a.Placing the Auto Sync Control to “Unload”.
 4. b.Move the compressor engage switch to the “OFF” position.

The compressor can now be restarted by following the standard instruction found in the “Operation” section. If for any reason the fault has not been corrected when turning the compressor engage switch “ON”, the auto shut down will activate immediately and the Compressor Overheat light will illuminate.

Service and Maintenance

 **WARNING**

Pressure Hazard.

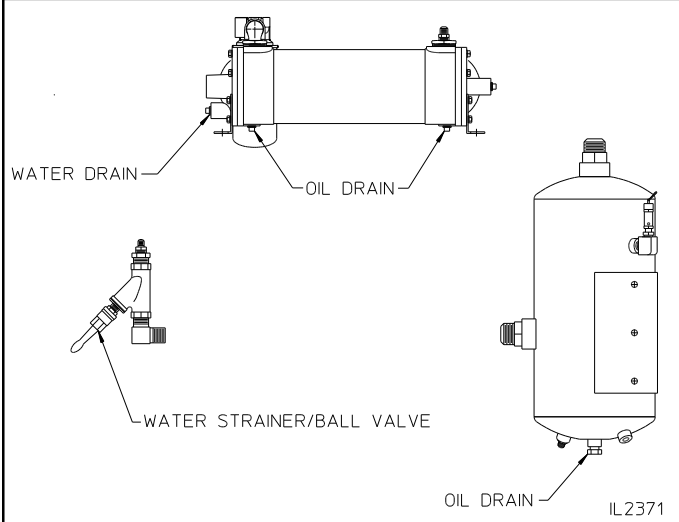
May cause serious personally injury.

Discharge outlets that are capped, hose lines that are valved and charged and the air compressor sump may contain compressed air. Relieve all pressure before attempting to remove any caps, fittings, nozzles or to perform maintenance to prevent serious injury.

Excessive heat build-up and oil system contamination are the most common causes of compressor system problems and premature wear. With proper operation and maintenance, the compressor system should far outlast the vehicle it is mounted on. Adherence to the following guidelines will prevent potentially costly damage.

1. There is a sight gauge provided on the oil reservoir/sump tank. The oil level should be at approximately half-way up the window. Check the oil on level ground, prior to system start up (system holds approximately 2 to 3 gallons of oil). If the system has recently been run, wait 10 minutes after shut-down for the oil to stabilize before checking the oil level. The compressor uses a non-foaming hydraulic oil. This oil is classified by an ISO standard as ISO 68 viscosity and is sold under various trade names. Many are sold as an “anti-wear” hydraulic oil and are available from auto parts or lubricating oil suppliers.

Oil Cooler Drain Locations



2. The compressor needs to be cycled on a regular basis. Run the compressor with air flowing, weekly for 15-20 minutes. This will insure the compressor rotors are coated with lubricant and eliminate any moisture that may be present in the compressor.
3. The oil should be changed after the first 30 hours of system operation. After that, the oil should be changed annually. There is a drain plug located at the bottom of the oil cooler (see Oil Cooler Drain

Locations). The oil fill cap is located on top of the sight gauge.

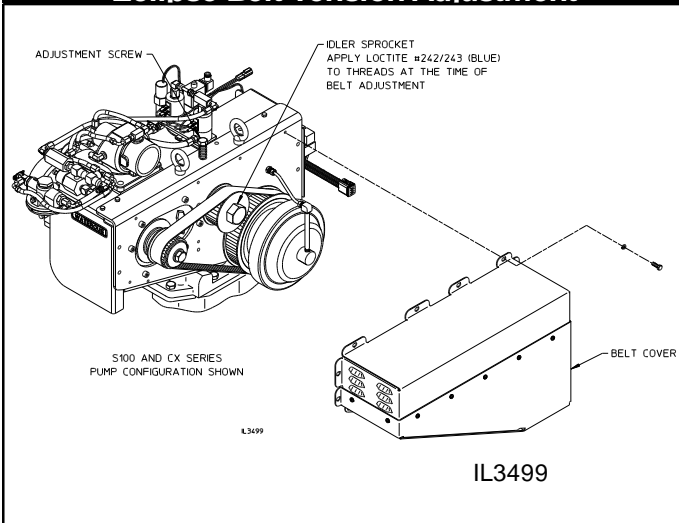
4. Change the compressor system spin-on oil filter at the same time as the oil is changed.
5. Run the compressor for two minutes after changing the oil, then re-check the oil level and add oil as necessary. **Do not overfill.**
6. Visually inspect the compressor oil system weekly for signs of leaks.
7. A water strainer is installed on the oil/water cooler inlet (see Oil Cooler Drain Locations). The water strainer should be checked and cleaned weekly. A plugged strainer will restrict cooling water and cause overheating of the compressor system.
8. Check the air compressor PolyChain® drive for damage or excessive wear semi-annually or more frequently as dictated by the amount of use. Belt tension may be checked by applying a 10-12 lb. load to the belt, mid-span between drive and driven sprocket. The belt should deflect .250 to .313".

Towing

When towing, disconnect the drive shaft that connects the pump transmission's rear output (coupling) shaft to the vehicle's differential. Failure to do so may result in damage from lack of lubrication.

Poly Chain Replacement and Adjustment

Eclipse Belt Tension Adjustment



9. The belt tension is set at the factory. No further adjustment is required unless the belt is loosened or removed to service other components.

When installing a synchronous belt, be sure it is tensioned adequately to prevent tooth jumping (ratcheting). Avoid extremely high tension which can reduce belt life and possibly damage other drive components.

- a. Remove the belt cover.
- b. Loosen idler sprocket.
- c. Turn the adjustment screw clockwise to increase the belt tension. Adjust spring height to 1-1/8 in.
- d. For a new belt, set the tension to allow 1/4 - 5/16 inch of belt deflection when 10-12 lbs of force are applied at the center of the greatest span. Do not over-tighten the belt.
- e. Apply loctite #242/243 (blue) to threads and tighten the idler sprocket. Torque to 230 ft-lbs.
- f. Install the belt cover.

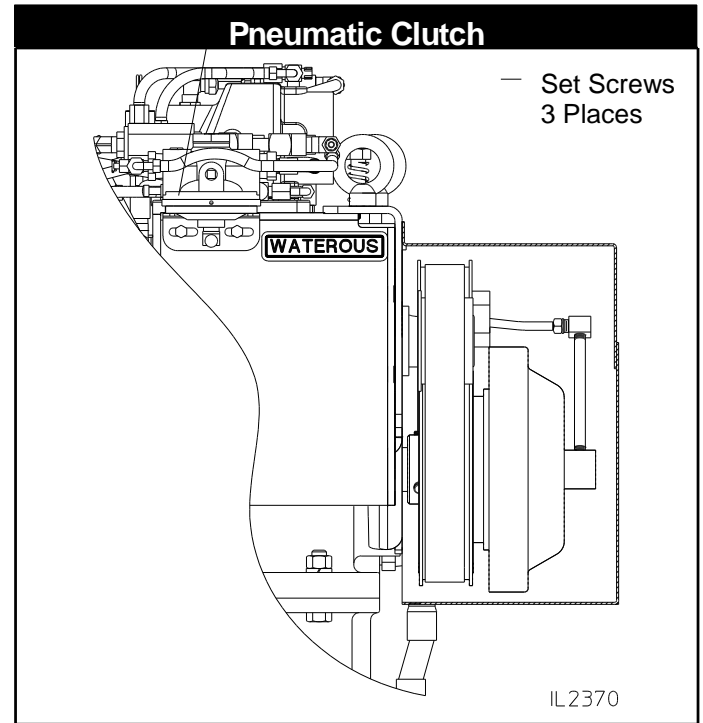
CAUTION

Belt Tightening Hazard.

May cause excessive wear or breakage.

Overtightening the belt on the Eclipse ES may result in excessive wear or breakage.

10. Whenever checking the air compressor PolyChain® also inspect the pneumatic clutch. Check that the set screws are tight and secure (See Pneumatic Clutch). These screws locate and hold the clutch to the stub shaft. If any set screw is loose, remove the screw, clean and apply Loctite 243 blue thread lock. Reinstall screw and tighten. The set screw must engage the shaft groove for proper location.



11. Inspect the compressor air intake filter and replace as necessary. The environment in which the unit operates will determine the frequency of air filter replacement. In any situation, replace at least annually.
12. Replace the air/oil separator cartridge every 24 months or if the unit's oil consumption suddenly increases. A sudden increase may be caused by a hole in the internal media of the cartridge allowing oil to carry through and discharge with the compressed air.
13. Completely drain the water from the compressor oil/water cooler in cold weather to prevent freeze damage (see Oil Cooler Drain Locations).

Maintenance Schedule

Check Oil Level/Oil Leaks	Change * Compressor Oil & Filter	Check PolyChain® & Clutch	Change Air/Oil Separator Cartridge	Check Air Intake Filter	Check & Clean Water Strainer
Daily or After Each Use	Annually	Semi-Annually	Every 24 Months	Monthly	Weekly

* Use ISO 68 Hydraulic Oil

Calibration - Control Air Circuit

NOTE: For an explanation of the Control Air Circuit function, see Page 16.

The Eclipse™ ES Air Control circuit is preset and adjusted at the factory prior to shipment. In most cases, the factory settings will provide satisfactory performance for typical CAFS and auxiliary air applications. The FIXED air operation is factory set at 145-150 P.S.I.G. The AUTO air operation is set (or trimmed) to match the fire pump discharge pressure (+/- 5%).

If the air control circuit requires changing or the circuit has lost its factory setting, the following procedure can be used to “fine tune” the system.

1. Preset the Air Inlet Trim Valve (AITV) by closing the valve, then opening the valve three turns.
2. Preset the Balance Trim Valve (BTV) to full open.
3. Start the fire pump, remaining at idle speed, and establish water flow either through a discharge or tank recirculation.
4. Set the Auto Sync Control Panel to UNLOAD mode and close all discharges.
5. Start the air compressor by placing the compressor engage switch to “ON”.
6. Read the main air pressure gauge (should read 40-50 P.S.I.G.). In the UNLOAD mode, this minimum pressure is always present to provide compressor oil circulation.

Final Adjustments for the FIXED and AUTO Modes

FIXED Air Mode

1. Locate the Fixed Pressure Regulator. Note that the regulator has an adjustment screw with a lock nut.
2. Loosen the regulator's lock nut.
3. Place the controls to FIXED position on the Auto Sync Panel. The compressor will build pressure to some value and hold (regulate).
4. Adjust the screw on the Fixed Pressure Regulator, while monitoring the air pressure gauge, until the desired pressure is reached. Turning the screw in will INCREASE the pressure. Turning the screw out will DECREASE the pressure.
5. Tighten down the locknut once the desired regulated pressure is achieved.
6. Verify the fixed regulator is performing by varying the compressor speed and monitoring the air pressure gauge. The pressure should remain steady at the fixed pressure setting.

With the final adjustments to the FIXED air mode complete, proceed with setting the AUTO air mode.

AUTO Air Mode

1. Place the Auto Sync controls to the AUTO position with the fire pump operating at 100 P.S.I.G. main discharge and minimal flow.

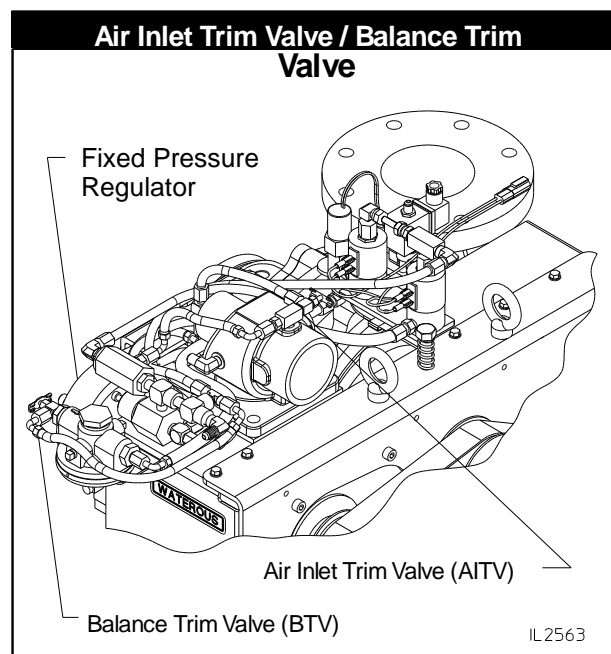
2. Monitor main water discharge pressure gauge and the air pressure gauge. The pressure readings should be the same. If not, go to Step 3.

Air Inlet Trim Valve (AITV)

3. Close the trim valve in half turn increments if the air pressure is too high. Monitor both water and air pressure gauges until the pressures match. Once the pressures match, no further adjustments are needed and go to Step 5. If the air pressure is too low, open the trim valve a half turn then check water and air pressure gauges. If the air pressure is still too low, open the trim valve a half turn. If the air pressures match, no further adjustments are needed and go to Step 5. However, if you air pressure is still too low, go to Step 4.

Note that the Air Inlet Trim Valve is now four turns open from fully closed. It is not desirable to have the trim valve open more than four turns. To extend the trim valve's range, use the Balance Trim Valve (BTV).

4. Close the BTV one turn from the fully open position. Check the water and air pressure gauges. If the air is still too low, again close the BTV one turn and check the gauges. Keep repeating the process until the air pressure matches or is slightly higher than the water pressure. The final adjustment can be done using the AITV and Step 3.
5. Verify the balance valve is performing by varying the fire pump discharge pressure and monitoring the water and air pressure gauges. The air pressure should follow and match the water pressure. If not, repeat the final adjustment procedure.



Waterous CAFS Customer's Troubleshooting Guide

It is important to know what to do if your compressed air foam system is not operating properly. This troubleshooting guide should help you diagnose, isolate and fix the problem encountered.

Problem	Cause	Fix
Lack of air supply from air compressor		
Is the air compressor engaging?	No - Lack of air supply to air clutch (Eclipse)	Repair air leak or re-establish air supply to air clutch. Check operation of the electric 3-way solenoid valve.
	No - No PTO engagement	Confirm "OK TO PUMP" light is illuminated. If not, repair as needed.
	Yes - Confirm Electric Auto-Sync settings	Pressures should be as follows: Air PSI of 20-50 when in FIXED and UNLOAD Air PSI of 45-150 when in FIXED Air PSI to match pump discharge PSI in AUTO (+/- 5%)
Air compressor operating properly, no air supply to discharges	Malfunctioning air discharge solenoid(s)	Verify power and operation of discharge solenoid(s). Repair or replace as needed. Verify proper wiring to solenoid (polarity sensitive) - See F-1031, Section 3027 (S100 Eclipse) or F-1031, Section 3028 (CX Eclipse) for wiring schematic.
	Malfunctioning air check valve(s)	Verify direction of check valve (arrow to discharge) and correct as needed.
	Air inlet trim valve out of adjustment	Reference "Control Air Circuit Calibration Instructions" on Page 12.
	Debris in air inlet trim valve (AITV)	Clean debris from air inlet trim valve (AITV).
	Minimum Pressure Valve stuck	Disassemble and clean or replace as required.
FIXED and RUN develops PSI but AUTO and RUN fails to develop PSI	Lacking water supply to balance trim valve	Reference "Control Air Circuit Calibration Instructions" on Page 12.
Air discharge PSI does not match water PSI (+/- 5%)	Air discharge pressure higher than water discharge pressure	Circuit has an air leak or is uncoupled. Trace the red hose circuit to locate leaks and repair as needed.
	Air PSI gauge is not tapped into correct location	Verify that the air PSI gauge is tapped into the Master Air Pressure tap on the black solenoid of the Electric AUTO/SYNC control.
	Water PSI gauge is not tapped into correct location	Verify that the water PSI gauge is tapped into location shown on the dimensional assembly.
	Air inlet trim valve out of adjustment	Reference "Control Air Circuit Calibration Instructions" on Page 12.
	Air or water gauge not calibrated	Recalibrate and/or replace as required.
Safety pop-off valve opening		
	Balance trim valve completely closed	Reference "Control Air Circuit Calibration Instructions" on Page 12.

Problem	Cause	Fix
System overheating	Oil level in the air compressor is low	Check for oil leaks and repair as needed. Use ISO 68 viscosity hydraulic oil, filling to the middle of the sight glass.
	Plugged water strainer at oil cooler	Remove strainer and clean screen.
	Inadequate water supply	Verify that water is being circulated within the pump (TANK TO PUMP valve completely open with the TANK FILL valve 1/4 open).
	Overheated water supply	Supply the pump with fresh cool water and open a discharge valve or TANK FILL valve, allowing the heated water to be dumped to atmosphere.
	Compressor overspeeding in UNLOAD mode	Do not run compressor in excess of 8950 RPM. Compressor speed can be calculated as follows: drive line (engine) speed x 2.5 x gear ratio in the pump transmission.
Temperature gauge inoperative	Wires unconnected	Check wire connections at the gauge, sending unit and power supply.
	Wires improperly connected	Check wiring for proper sequence (green to large terminal; yellow to small terminal) - See F-1031, Section 3027 (S100 Eclipse) or F-1031, Section 3028 (CX Eclipse).
Excessive oil consumption	Reservoirs overfilled with oil	Check oil level while on a level surface. Reduce level to middle of the sight glass.
	Flowing in excess of 200 CFM	Reduce RPM and flow CAFS and recheck oil level.
	Oil/Air filter torn or damaged	Result of flowing air in excess of 200 CFM. Replace air filter, flow CAFS, shut down the pump for 15 minutes and check oil level.
	Oil siphon line and check valve	Check oil siphon line for obstruction and inspect check valve for operation.
Excessive compressor bleed down time (time may vary)	Inlet air trim valve closed too far	Reference "Control Air Circuit Calibration Instructions" on Page 12.
	Debris in inlet air trim valve	Clean valve and reference "Control Air Circuit Calibration Instructions" on Page 12.
Engine stalls upon compressor engagement	Electric Auto-Sync in FIXED or AUTO position	Place the Electric Auto-Sync in the UNLOAD setting.
	Engaging compressor when under load	Operating under this condition causes the compressor oil to accumulate in the compressor creating a condition similar to a hydraulic pump. To correct, allow air to bleed off, restart the compressor and immediately begin flowing air through a discharge.
	Air compressor locked up	Due to a lack of compressor oil/lubrication. Repair or replace the compressor.

Problem	Cause	Fix
Poor foam solution (wet or dry)	Using wetting agent in place of foam	Flush system and install Class "A" foam.
	Lack of foam	Check if the Foam Pro system is on. Check if there is foam in the reservoir. Make sure the foam supply valve is on and the Y strainer clean. Reference the Foam Pro instruction manual.
	Incorrect size air lines to discharges	Refer to "Air Distribution Hose Size Guidelines" in F-1031, Section 3027 (S100 Eclipse) or F-1031, Section 3028 (CX Eclipse).
Foam in water system	Foam dumped into the water tank	Flush water tank and pump until foam is cleared.
	Foam cell is leaking into water tank	Condition applies to tanks utilizing a common wall(s) between the foam tank and the water tank. If a leak is confirmed, repair the foam tank and flush the water tank and pump until foam is cleared.
	Foam proportioning manifold check valve malfunction	If the above conditions have been corrected, the final cause for foam in the water tank may be the result of a malfunctioning foam manifold check valve. To troubleshoot, cap off one foam discharge that is plumbed to the foam manifold, open that discharge valve and increase the pump discharge to 30-40 PSI. Disengage the pump and monitor the corresponding discharge PSI gauge, looking for a drop in discharge pressure. If the PSI drops, it indicates the foam manifold check valve is leaking and requires repair.
Water in compressors oil/air	Leaking oil cooler	Isolate the heat exchanger and check for leaks. Replace if necessary. (Typical cause is freezing.)
	Discharge air check valve(s) malfunctioning	Confirm direction (arrow towards discharge valve). Replace if necessary.
Clutch smoking	Engaging compressor with the Electric Auto-Sync in the FIXED or AUTO Mode.	Disengage compressor and place Electric Auto-Sync settings to UNLOAD, allow the compressor to bleed off, then engage the compressor.
	High RPM engagement	Reduce engine RPM and engage in the UNLOAD position with the Master Air Pressure Gauge reading "0".
	Not allowing for compressor to bleed down prior to re-engaging	Allow ample time for compressor to bleed down. Re-engage the compressor in the AUTO and UNLOAD settings.
	Contaminated clutch disc or plate	Inspect the clutch disc and plate for contaminants (oil, dirt, foam, etc.). Clean or replace as necessary.
	Low air pressure or supply leak to clutch	Check pressure at supply side. Check supply line for leaks.
	Compressor locked up	Check entire system and repair as needed.
	Air Regulator is Faulty (P.T.O. Applications Only)	Replace Air Regulator
Safety pop-off valve opening at low pressure	Sump fire damaged pop-off valve	Check the system and oil level. Replace the pop-off valve. Once repaired, operate the compressor watching for air or oil being discharged from the pop-off valve. One indication of a pop-off valve failure is oil present throughout the pump compartment. Check for signs of sump fire.
Compressor locked up		
	Debris in the compressor	Check entire system and repair as needed.

Control Air Circuit Function

CAFS Control Air Circuits may be operated in three (3) air compressor pressure modes: **UNLOAD**, **FIXED** and **AUTO**.

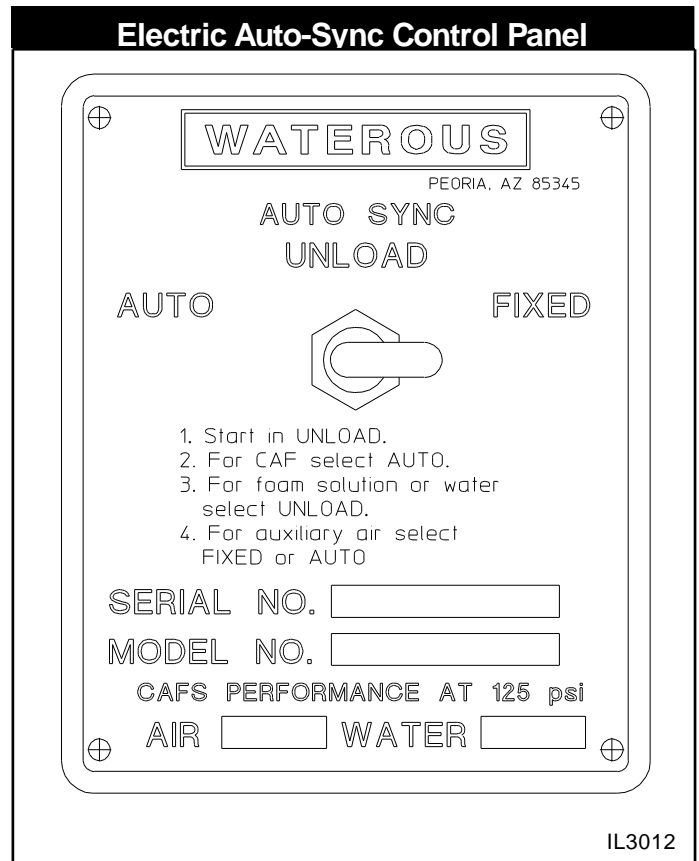
The same basic control air circuit is used on all CAFS system units including both Eclipse™ and Eclipse™ ES models.

This instruction includes descriptions and schematics showing the interaction of the control air system components in each mode as well as explanations of the workings of specific components.

The status of the control air circuit is also described when the air compressor is shutdown.

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Air Compressor Pressure Mode: UNLOAD

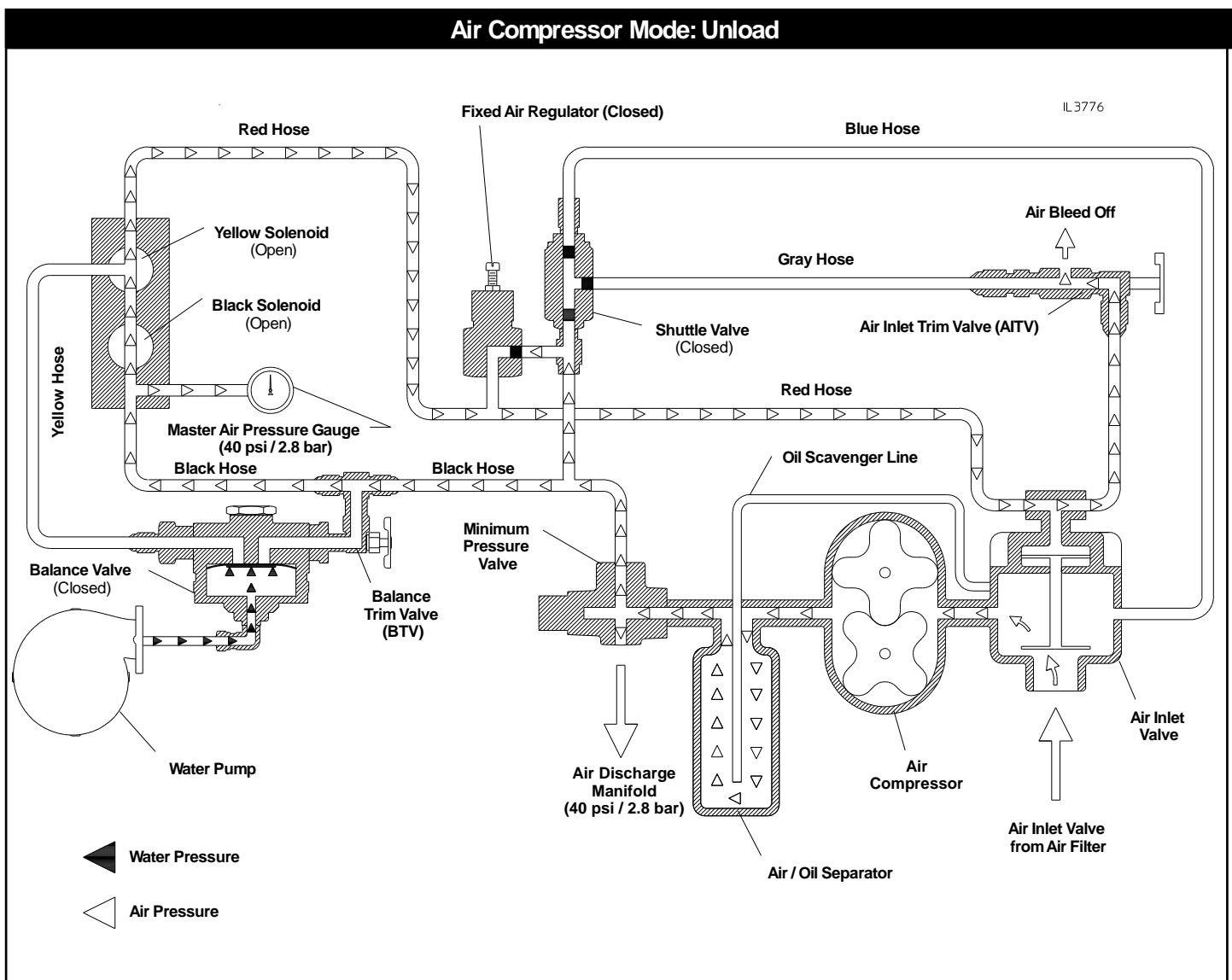
The air compressor essentially idles, producing a minimal pressure (40 psi) to maintain compressor oil flow.

NOTE: The compressor's clutch shall only be engaged when the Unload / Fixed / Auto switch is in the "Unload" position and the master air pressure gauge reads zero psi.

With the compressor engaged, running and the Auto-Sync control panel switched to "UNLOAD", the following occurs:

- The yellow and black solenoids are NOT energized and are OPEN.
- The master pressure gauge registers compressor sump tank pressure.
- The shuttle valve is closed. The compressor inlet pressure is lower than the compressor discharge pressure.
- The fixed air regulator and the balance valve are closed and do not directly influence the air circuit operation.
- The sizing of the piping and inlet valve limits the pressure produced to 40-50 psi (2.8-3.4 bar).
- If the compressor discharge air pressure is above 40-50 psi (2.8-3.4 bar), then the control air closes the air inlet valve. This causes the control air pressure to drop below 40-50 psi (2.8-3.4 bar), the control pressure is not high enough to keep the air inlet valve closed. The air inlet valve opens allowing air into the compressor raising the control air pressure above 40-50 psi (2.8-3.4 bar).

NOTE: Control air is always being released and pressure relieved through the air inlet trim valve (AITV) and out the air bleed outlet. This air release is controlled (limited) by the AITV.



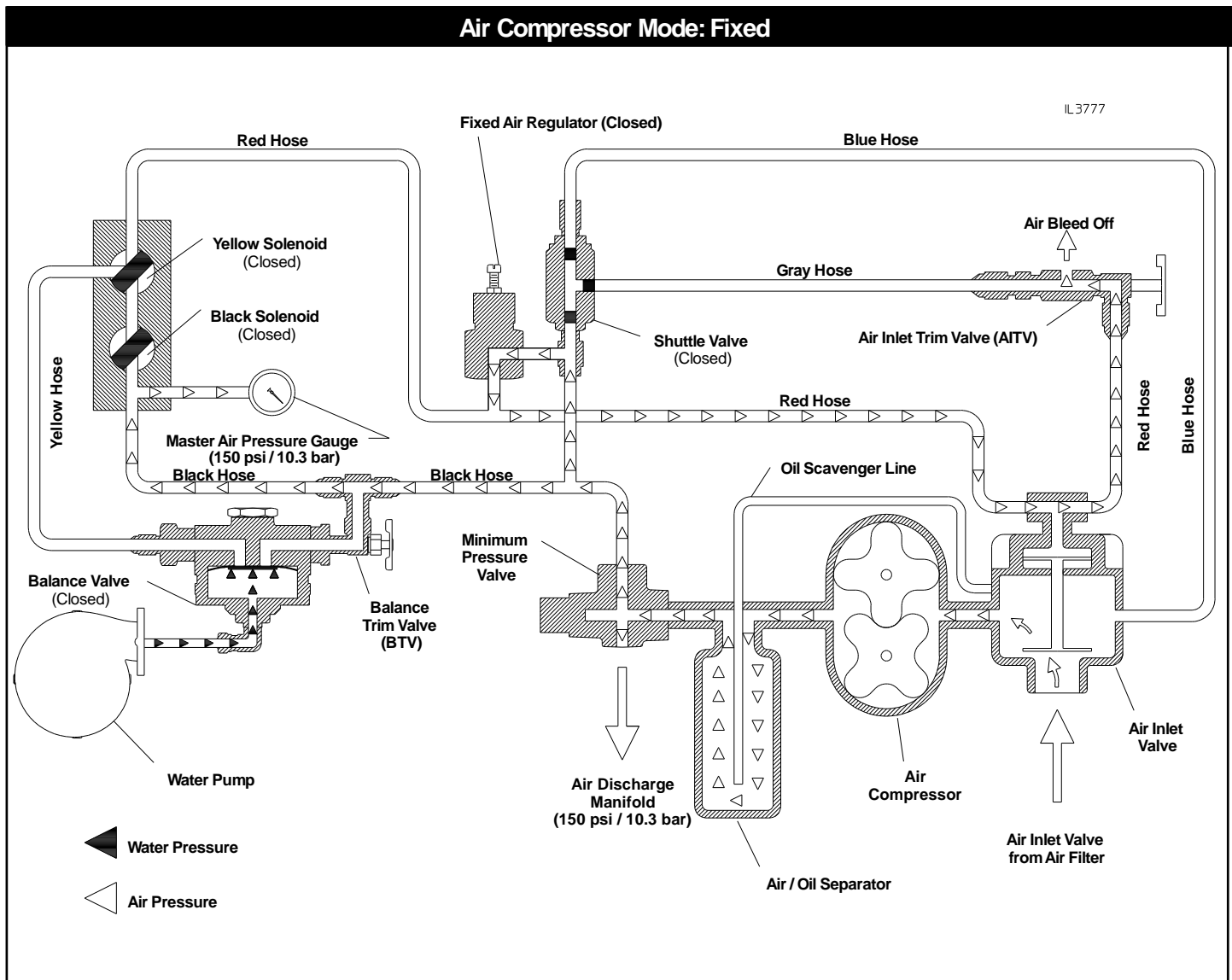
Air Compressor Pressure Mode: FIXED

Air pressure is maintained at a preset pressure setting (150 psi / 10.3 bar)

With the compressor engaged, running and the Auto-Sync control panel switched to “Fixed”, the following occurs:

- The yellow and black solenoids are energized and are CLOSED.
- The master pressure gauge registers compressor sump tank pressure.
- The shuttle valve is closed. The compressor inlet pressure is lower than the compressor discharge pressure.
- The balance valve does not directly influence the air circuit operation.
- The fixed air regulator controls the air circuit and air inlet valve (see Fixed Air Regulator Valve Function).
- If the compressor discharge air pressure is above the fixed air regulator set point (150 psi / 10.3 bar), then the fixed air regulator opens allowing the control air pressure to close the air inlet valve (see Air Inlet Valve Function). This will lower the control air pressure below 150 psi (10.3 bar). When the discharge air pressure is below the set point (150 psi / 10.3 bar), then the fixed air regulator closes. Now the control air pressure is not high enough to keep the air inlet valve closed. The air inlet valve opens allowing air into the compressor raising the control air pressure above 150 psi (10.3 bar).
- The fixed air regulator opens and closes as the air discharge pressure changes to maintain set pressure.

NOTE: Control air is always being released and pressure relieved through the air inlet trim valve (AITV) and out the air bleed outlet. This air release is controlled (limited) by the AITV.



Air Compressor Pressure Mode: AUTO

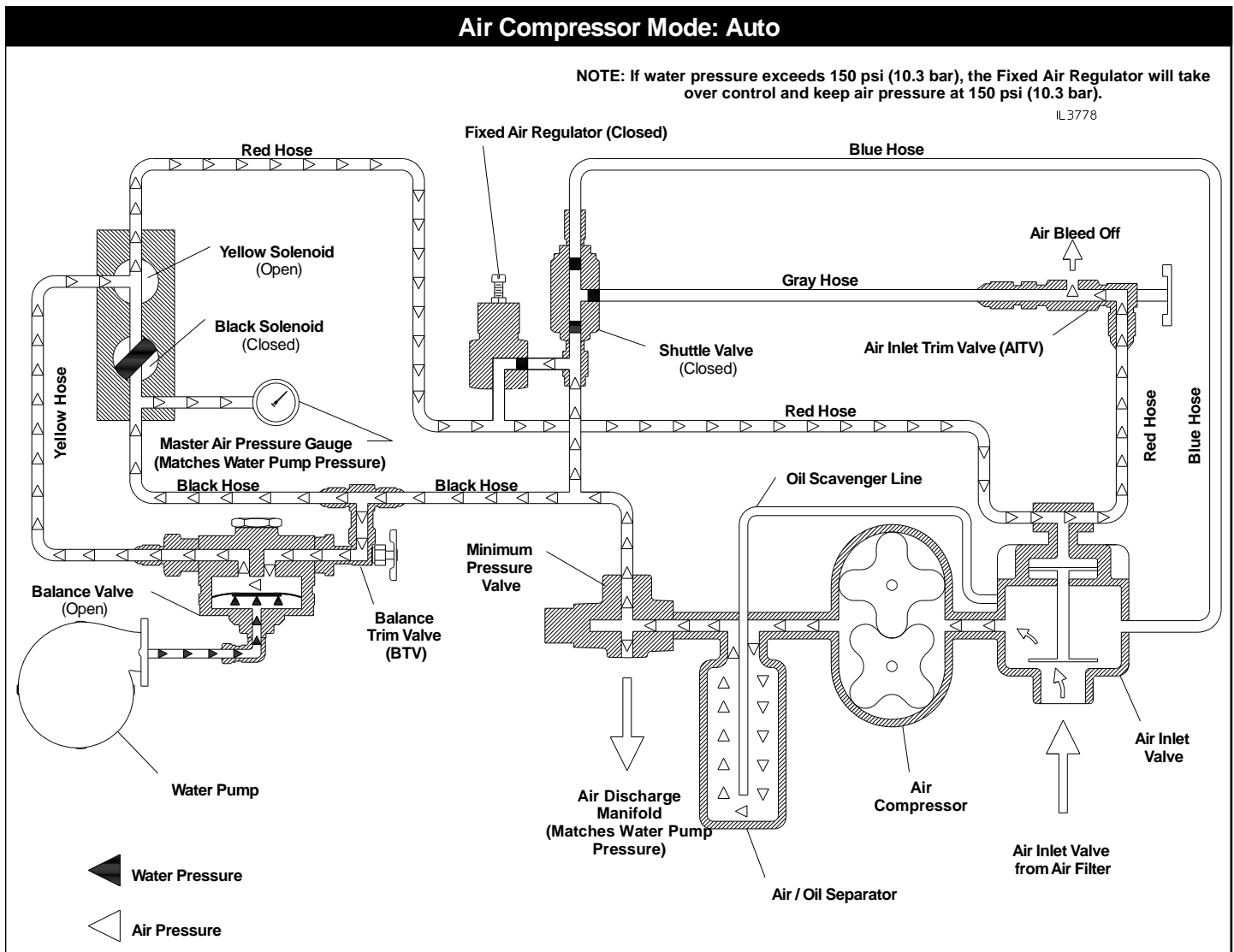
Air pressure matches water discharge pressure.

With the compressor engaged, running and the Auto-Sync control panel switched to "AUTO", the following occurs:

- The black solenoid is energized and is CLOSED and the yellow solenoid is OPEN.
- The master pressure gauge registers compressor sump tank pressure.
- The shuttle valve is closed. The compressor inlet pressure is lower than the compressor discharge pressure.
- The fixed air regulator is not the primary control device. It functions as a governor (or maximum pressure setting) in the "AUTO" mode.
- The balance valve is the primary control air regulating device in the "AUTO" mode (see Balance Trim Valve Function).
- If the compressor discharge air pressure is above water pressure (for example: 100 psi / 8.6 bar) (see Air Inlet Valve Function), then the balance valve opens allowing the control air pressure to close the air inlet valve and lowering control air pressure below 100 psi (8.6 bar). When the discharge air pressure is below the water pressure (100 psi / 8.6 bar), the balance valve closes. The control air pressure is not high enough to keep the air inlet valve closed. The air inlet valve opens allowing air into the compressor raising the control air pressure above 100 psi (8.6 bar).
- The balance valve opens and closes as needed as the air or water discharge pressure changes so the water and air pressure remain the same.

NOTE: Control air is always being released and pressure relieved through the air inlet trim valve (AITV) and out the air bleed outlet. This air release is controlled (limited) by the AITV.

NOTE: The balance trim valve (BTV) is used to calibrate the control air circuit in the "AUTO" mode. Refer to the Electric Auto-Sync calibration procedure.



Air Compressor Shutdown

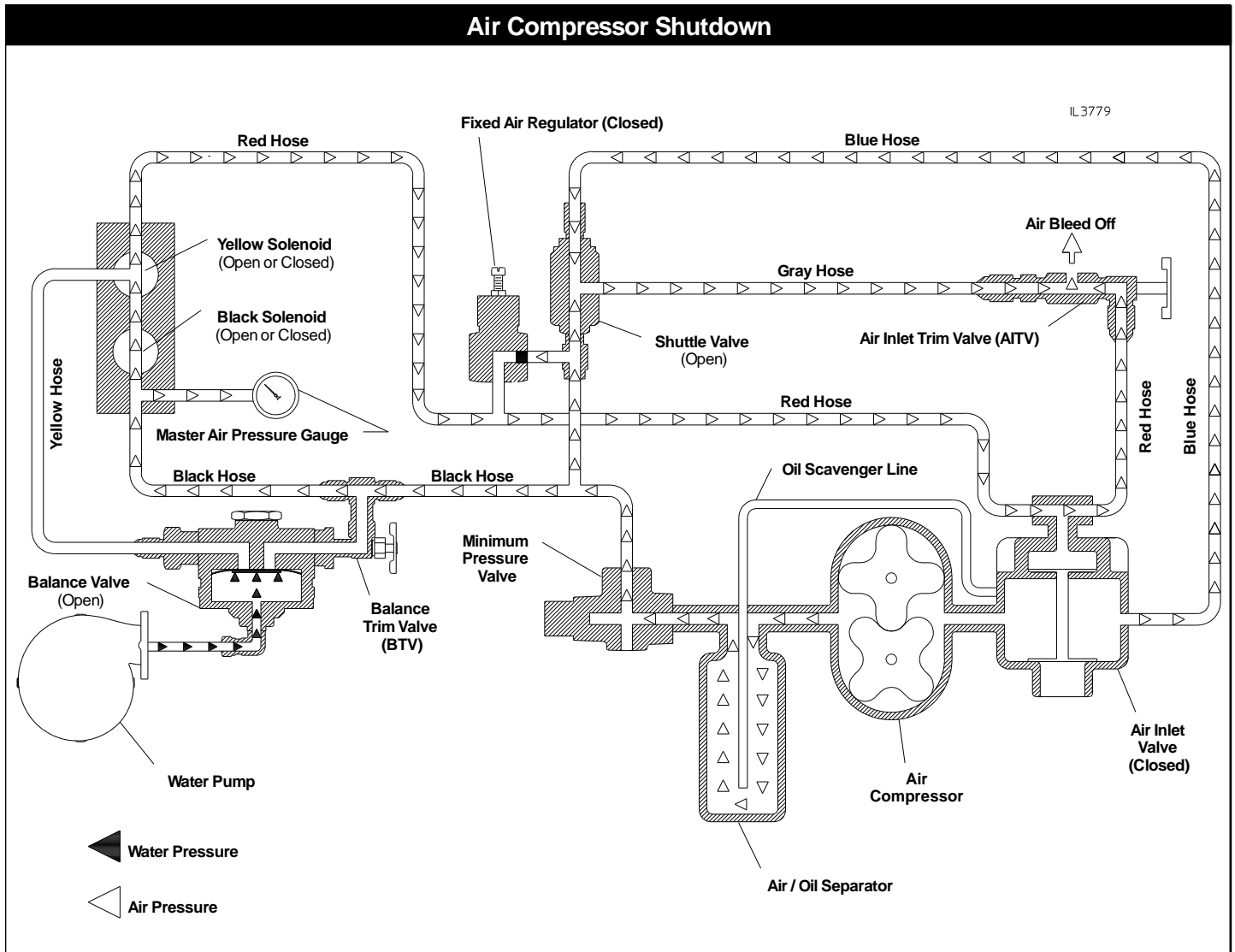
When the air compressor is shutdown or disengaged, the following occurs:

- The master pressure gauge registers compressor sump tank pressure.
- The compressor rotors stop turning and the compressor outlet and inlet pressures equalize.
- The shuttle valve sees equal pressure on the shuttle piston. Since the inlet pressure side is larger than the discharge pressure side, the shuttle valve opens (see Shuttle Valve Function).
- With the shuttle valve open, air from the compressor discharge side is allowed to exhaust through the gray air bleed outlet port. This slowly relieves all air pressure from the compressor and the sump tank.
- In shutdown, the fixed air regulator and balance valve do not control the air circuit or have any influence. They are basically bypassed.
- The auto-sync solenoids are also bypassed and it doesn't matter whether they are opened or closed. They have no influence on shutdown.

⚠ WARNING

Pressure Hazard.
May cause serious personal injury.

In shutdown, the control air circuit only relieves air stored in the compressor and sump tank. Air downstream of the minimum pressure valve is not released through the control air circuit. Pressurized air may be trapped in discharge piping and hoses.



Air Inlet Valve Function

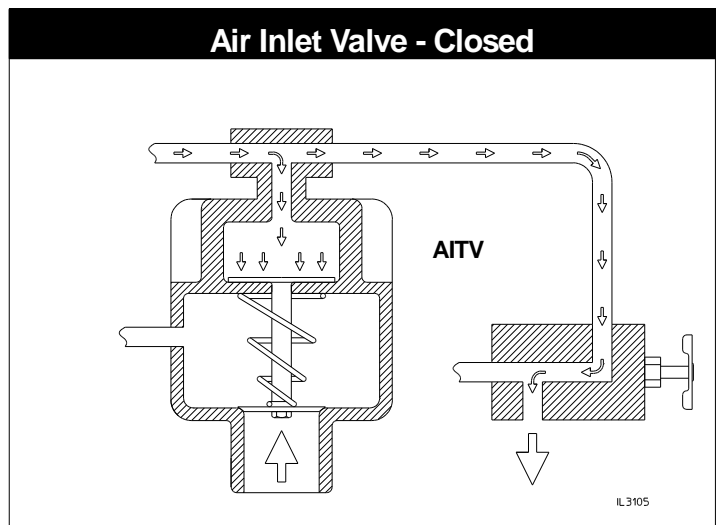
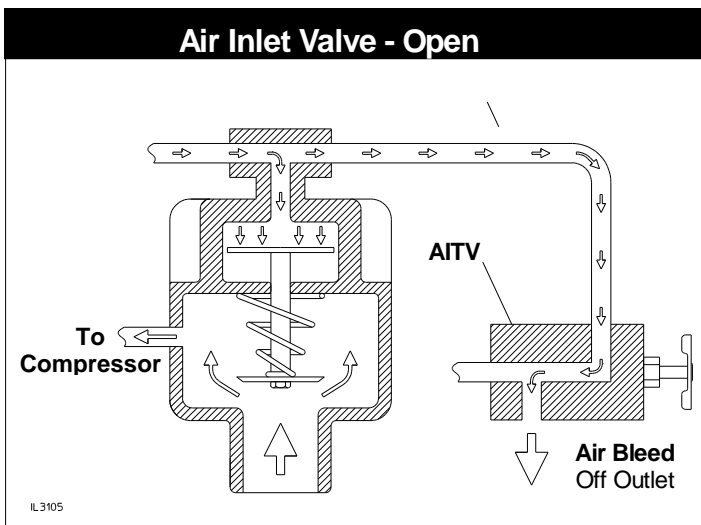
The air inlet valve is part of the control air circuit and controls the incoming air to the compressor by opening and closing. The air inlet valve operates (or follows) based on the air signal it received from the fixed regulator, the balance valve or minimum pressure valve.

The figures below show the air inlet valve in an open and closed position. Let's see how and why the valve open and closes.

When the compressor is running, there is negative air pressure behind the main valve disk, and if only a small air control pressure is on the valve's control disk, the air inlet valve opens. As long as the control air pressure is low, inlet valve remains open. With the air inlet valve open, the compressor will pull in more air resulting in more pressure and/or flow at the compressor discharge.

To stop the compressor pressure increase or restrict the compressor air flow, the air inlet valve needs to close. The air inlet valve will close when the control air pressure at the valve's control disk is high enough to overcome the inlet pressure on the main valve disk. With the air inlet valve closed, no more air can be pulled into the compressor. The discharge pressure of the compressor stabilizes and air flow stops.

In operation, the air inlet valve is constantly opening and closing (or modulating) to maintain the desired pressure called for by the control air mechanism (fixed air regulator, piloted balance valve, or minimum pressure valve). It should also be noted the air inlet valve has an air inlet trim valve (AITV) with an air bleed off outlet. This provides a means to bleed off control air continuously and at a controlled rate. The AITV is used to calibrate the air control system.



Fixed Air Regulator Function

The fixed air regulator has two primary functions in the control air circuit:

1. When the Auto-Sync is in the “**Fixed**” mode, the fixed air regulator controls the air circuit’s regulation.
2. When the Auto-Sync is in the “**Auto**” mode, the fixed air regulator acts as a governor or maximum pressure limiter for the air circuit

How does the fixed air regulator work?

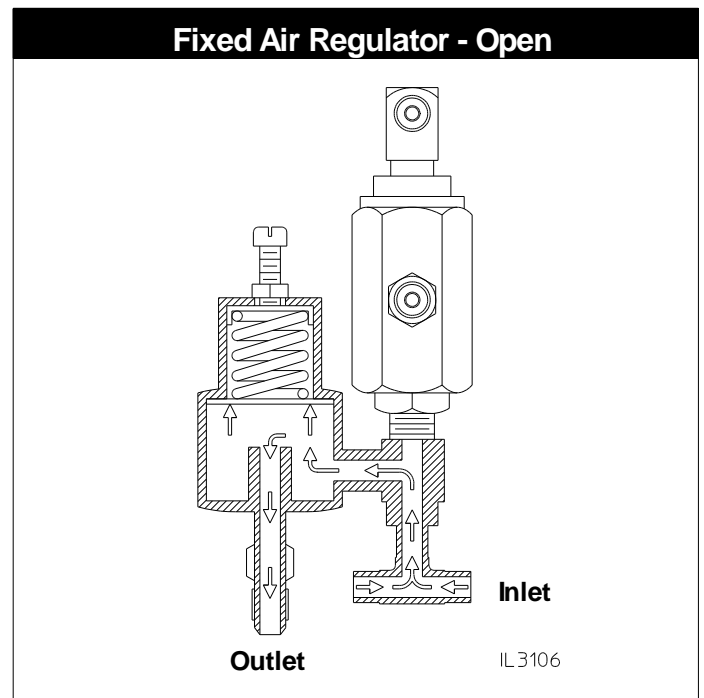
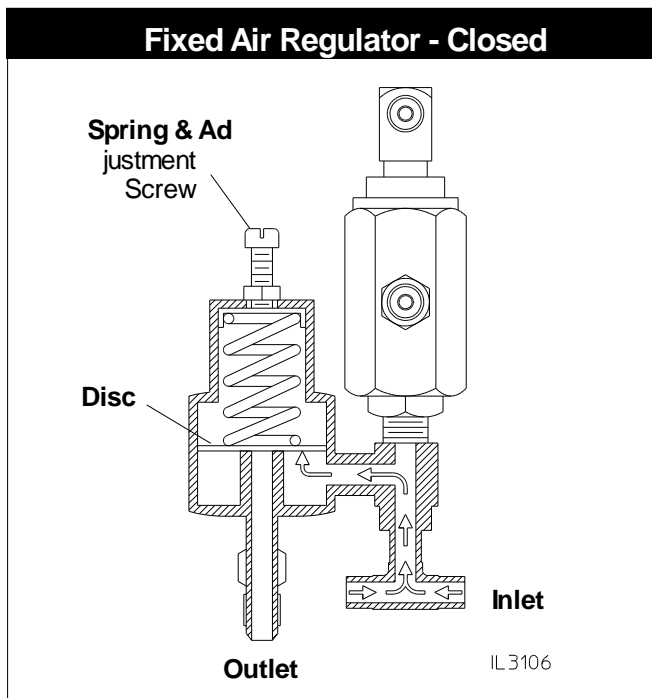
The fixed air regulator has 5 elements that work together to provide regulation: inlet, outlet, disk, spring and adjustment screw, Air enters the regulator through the inlet and applies pressure to the disk. On the backside of the disk are the spring and tension adjustment screw (the screw is used to give the spring more or less tension). The spring applies pressure to the disk and opposes the air pressure. As long as the spring tension is greater than the air pressure on the disk, the regulator stays closed and no air passes through (see Fixed Air Regulator - Closed). When the air pressure rises and becomes great enough to overcome the spring, the disk moves allowing air to pass on through the outlet (see Fixed Air Regulator - Open). Depending on how the adjustment screw is set, the spring will apply a force on the disk in which the air pressure will try to overcome and if the air pressure is high enough, air passes on through.

How does the fixed air regulator operate in the air control circuit when in the “FIXED” or “AUTO” modes?

Fixed Mode: The regulator basically operates as described above. If the compressor discharge pressure is above the fixed air regulator set point (150 psi / 10.3 bar), then the fixed air regulator opens allowing the control air pressure to close the air inlet valve. This will lower the control air pressure below 150 psi (10.3 bar). When discharge air pressure is below the set point (150 psi / 10.3 bar), then the fixed air regulator closes. Now the control air pressure is not high enough to keep the air inlet valve closed. The air inlet valve opens allowing air into the compressor raising the control air pressure above 150 psi (10.3 bar).

The fixed air regulator opens or closes as the discharge air pressure changes to maintain the desired fixed air pressure.

Auto Mode: The fixed air regulator functions as a governor (or maximum pressure limiter). The fixed air regulator is basically in parallel with the piloted balance valve. Although the piloted balance valve is the primary regulator in this operating mode, the fixed air regulator is in the background monitoring the discharge air pressure. If that discharge air pressure exceeds the fixed air regulator set point (150 psi / 10.3 bar), the fixed air regulator will open allowing control air to pass onto the air inlet valve (and closing it). This insures the compressor cannot run at pressures high than that set by the fixed air regulator.



Balance Valve Function

The balance valve's primary function is regulation of the air circuit when operating the Auto-Sync in the "AUTO" mode.

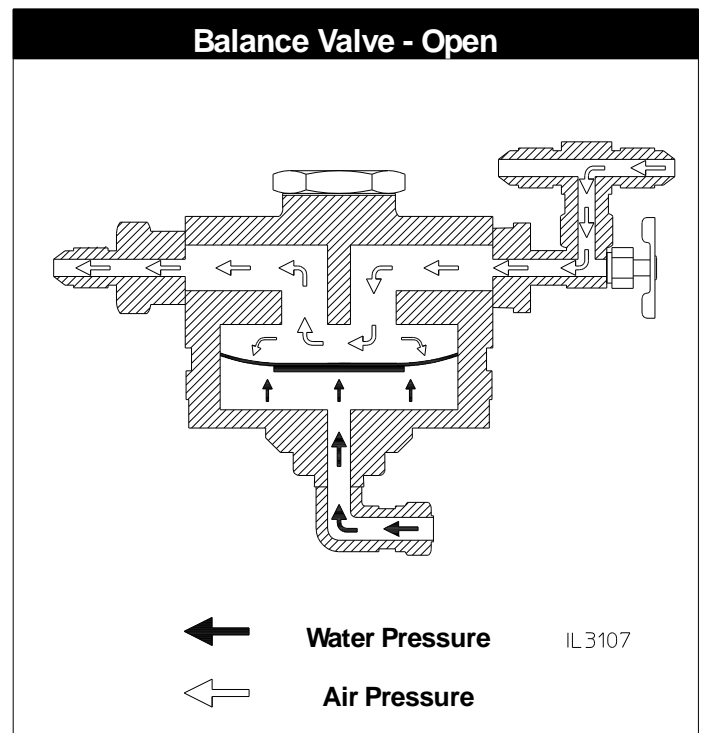
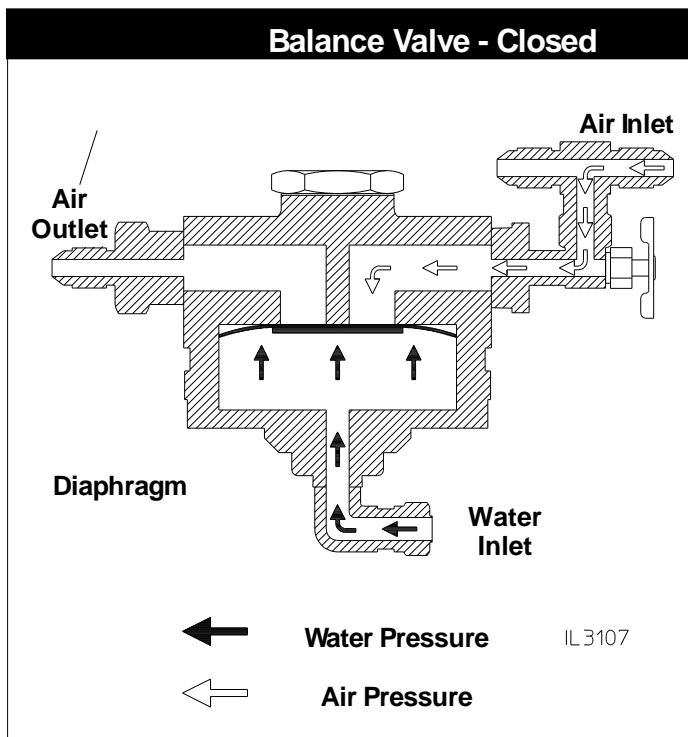
The balance valve has 5 elements that work together to provide regulation: air inlet, air outlet, diaphragm, water inlet and piloted balance trim valve (BTV) (see Balance Valve Elements)

Air enters the balance valve through the BTV and into the inlet. This applies pressure to the diaphragm. On the other side of the diaphragm is water pressure from the pump discharge. The air pressure and water pressure opposes each other against the diaphragm. As long as the water pressure is greater than the air pressure on the diaphragm, the balance valve stays closed and no air passes through. When the air pressure rises and becomes great enough to overcome the water pressure, the diaphragm moves allowing air to pass on through the outlet (see Balance Valve Open). The balance valve can be calibrated (or biased) via the BTV. See control air control circuit calibration in the maintenance manual.

How does the balance valve operate in the air control circuit when in the "AUTO" mode?

The balance valve basically operates as previously described. If the compressor discharge pressure is above water pressure (100 psi / 8.6 bar), then the piloted balance valve opens allowing the control air pressure to close the air inlet valve and lowering control air pressure below 100 psi (8.6 bar). When the discharge air pressure is below the water pressure (again 100 psi) / 8.6 bar, the piloted balance valve closes. Now the control air pressure is not high enough to keep the air inlet valve closed. The air inlet valve opens allowing air into the compressor raising the control air pressure above 100 psi (8.6 bar).

The balance valve opens and closes as needed so the discharge air pressure matches the pump discharge water pressure.



Shuttle Valve Function

The shuttle valve is part of the control air circuit and really only comes into play during a compressor shutdown. Its primary function is to provide a means (pathway) of relieving compressor air (pressure) and not allowing compressor oil to escape at the same time

Using the two figures below, let's go through how the shuttle valve works.

The figure on the left shows the shuttle valve in a closed position. This occurs when the compressor inlet air pressure (CIAP) is less than the compressor discharge air pressure (CDAP).

When the compressor is running, the CIAP is always 14.5 psia or less and the CDAP is 40 psig or greater (minimum pressure valve setting), allowing the shuttle valve to stay closed.

The figure on the right shows the shuttle valve in an open position. This occurs when the CIAP is equal or greater than the CDAP pressure (note the slightly larger piston surface on the CIAP side than the CDAP).

When the compressor shuts down and the rotors stop turning, the CIAP and CDAP equalize allowing the shuttle valve to open. With the shuttle valve open, air stored in the compressor/sump tank is allowed to escape from the air discharge through the shuttle valve and onto the air bleed off outlet where it is exhausted.

