Reference Material: Note: Exam may contain "accepted practice" type questions not found in the reference material listed below

NFPA 1900 **Standard for Aircraft Rescue and Firefighting Vehicles, Automotive Fire Apparatus, Wildland Fire Apparatus, and Automotive Ambulances** , 1901section Chapters 18, 19 and appropriate annex
NFPA 1910 ***Standard for Inspections, Maintenance, Refurbisment, Testing and Retirement of In-Service Emergency Vehicles and Marine Firefighting Vessels,*** 1911 section, Chapters 3, 6, 12, 13, 23, 24, 26 and appropriate annex
IFSTA ***Principals of Foam Firefighting*** 2nd edition Chapters 2, 3, 4, 5, glossary and appendix
IFSTA Pumping Apparatus, ***Driver/Operator Handbook***, 3rd edition Chapters 14, 15, glossary and appendix.
Contact IFSTA at 800-654-4055

Fire pump manufacturer's operations manual
Hale FoamLogix Rotary Gear Manual 3.3/5.0/6.5
https://smhttp-ssl-61500.nexcesscdn.net/media/pdf/FoamLogix_Digital_3.3-5.0_Manual.pdf
Hale Smart CAFS Troubleshooting Guide b
https://smhttp-ssl-61500.nexcesscdn.net/media/pdf/FSG-MNL-00177_SmartCAFS_Troubleshooting_Guide-A.pdf
Waterous "Eclipse" CAFS System Operation and Maintenance Form F1031 Section 2412
https://www.waterousco.com/media/pdfs/F1031-2412.pdf
Waterous 200P PTO Driven Compressor Kit Installation (3036) and Operations (2422) Instructions.
https://www.waterousco.com/media/pdfs/F1031-3036.pdf
https://www.waterousco.com/media/pdfs/F1031-2422_200-P_.pdf
FoamPro Form 829 Installation and Operation Manual
http://fireresearch.com/foampro-lit/manuals/Form-829.pdf
FoamPro Power Fill Form 809 https://fireresearch.com/foampro-lit/manuals/Form-809.pdf
VFIS.com Firefighting Foam https://www.vfis.com/Portals/vfis/fire-and-ems-operations/Firefighting-Foam-VFIS.pdf
FFFC.org Best Practice Guidance for use of Class B Firefighting Foams
https://www.fffc.org/_files/ugd/331cad_188bf72c523c46adac082278ac019a7b.pdf
Manufacturer's web sites
www.waterousco.com/ www.wsdarley.com https://www.fireresearch.com/foampro www.haleproducts.com

LEARNING OBJECTIVES FOR THE F7 EXAM

1. **Principals of Foam**: The Fire Apparatus Technician should understand the principals of foam firefighting
   - a. Foam Types
   - b. Characteristics
     - (1) Expansion
     - (2) Safety
       - (a) environmental impact
       - (b) personal impact
     - (3) Benefits
     - (4) Concentrate Properties
     - (5) Adding Foam to Tank
       - (a) viscosity
       - (b) drainage
     - (6) Freezing and Thawing
   - c. Application/Uses
     - (1) Induction
     - (2) Injection
     - (3) Pre-mix
     - (4) Batch-mix
   - d. Limitations
   - e. Storage
   - f. Definitions
     - (1) Proportioning
     - (2) Scrubbing
     - (3) Foam Generators
       - (a) low energy
       - (b) high energy
     - (4) Mixing Chamber/Static Mixer
     - (5) Foam Solution
     - (6) Surfactant
     - (7) Milspec
     - (8) CAFS
     - (9) Slug Flow
     - (10) Eduction
     - (11) Venturi Principal
     - (12) PFAS-Per & polyfluoroalkyl substances

2. **Foam Systems and Operations**: The Fire Apparatus Technician should understand the requirements for foam systems and operations
   - a. Systems
     - (1) Eductor Type
       - (a) Characteristics
       - (b) Requirements
     - (2) Installed In-line Eductor System
     - (3) Around the Pump Proportioners
     - (4) By-pass Balanced Pressure Proportioners
       - (a) Requirements
     - (5) Variable Flow - Demand Type Pressure Proportioner
     - (6) Variable Flow - Variable Rate Direct
     - (7) C.A.F.S.
       - (a) Compressor Engagements
       - (b) Operation & Schematics
         - (i) Air Flow
         - (ii) Hydraulic
     - (8) Direct injection
   - b. Operations
     - (1) Cleaning and Flushing
     - (2) Labeling
     - (3) Safety
     - (4) Proportioning
       - (a) mixing proportions
       - (b) Injections rates
     - (5) Pressure
   - c. Foam Concentrate Storage

3. **Mechanical Components**: The Fire Apparatus Technician should understand the requirements for mechanical components
   a. Nozzles
      (1) Poor foam solution
   b. Tanks
      (1) Atmosphere
      (2) Pressure
      (3) Fill tower opening
      (4) Foam fill system
   c. Hose
   d. Strainers
   e. Check Valves
   f. Flow Meters
   g. Controllers
      (1) Electronics
   h. Proportioners
      (1) Eductors
         (a) inline
         (b) installed
         (c) foam class
      (2) Venturi
      (3) Flush Line
   i. Manifolds
   j. Water Filters
   k. Oil Separators
   l. Compressors
   m. Injectors
   n. Pressure Indicating Devices & Gauges
   o. Compressor control circuit
   p. Pressure vessel tank
      (1) Fill cap
   q. Foam pump
   r. Air control circuit
   s. Compressor Hydraulic Circuit
   t. Valves

4. **Maintenance and Testing**: The Fire Apparatus Technician should understand the proper maintenance and testing procedures
   a. Maintenance
      (1) Air Compressor Systems
         (a) Frequency
         (b) Filters/Strainers
         (c) Fluids
         (d) Adjustments
         (e) Compressor Drives
      (2) Proportioning System
         (a) Flushing
         (b) Calibration
         (c) Strainers
         (d) Frequency
   b. Testing
      (1) Air Compressor Systems
         (a) Air Flow
         (b) Pressure Balance
         (c) Frequency
         (d) Methods
      (2) Proportioning Systems
         (a) Test Methods
         (b) Concentration Flows
            (i) accuracy
         (c) Flow Meters
      (3) Gauges
      (4) Performance Test
         (a) Engine Driven Accessories
   c. Troubleshooting Guides
      (1) Air compressor systems
      (2) Proportioning systems
      (3) Foam Solutions
      (4) Contaminated Foam
   d. Repairs
      (1) Air compressor drives
      (2) Proportioning systems
      (3) Out of service criteria

F7 SAMPLE QUESTIONS

Answer key is at bottom of page

1. Technician A says: Batch mixing is the simplest method of mixing foam. Technician B says: If the batch mixing is to be done directly in the apparatus water tank, the tank should be circulated for a few minutes before discharging foam. Who is correct?
A. Technician A
B. Technician B
C. Both A and B
D. Neither A nor B

2. An apparatus has a variable flow-variable rate injection foam system. Technician A says: The system is only accurate at a specific water pressure. Technician B says: The injection rate is controlled by water flow. Who is correct?
A. Technician A
B. Technician B
C. Both A and B
D. Neither A nor B

3. Any type of nozzle may be used with any eductor.
A. true
B. false

4. The foam tank level gauge reads 3/4 full. The foam proportioner indicates low concentrate. Technician A says: There must be a problem with the foam proportioner. Technician B says: The foam proportioner has a separate low level sensor and the tank level gauge could be malfunctioning. Who is correct?
A. Technician A
B. Technician B
C. Both A and B
D. Neither A nor B

5. Which of the following is the correct procedure to test the accuracy of a foam proportioning system?
A. volume test
B. by refractometer
C. by conductivity meter
D. all of the above

Answer Key
1. c 2. b 3. b 4. b 5. d

July 5, 2020

Class A Foam for Wildland Fire Management

Qualified by US Forest Service in Accordance with Forest Service Specification 5100-307a as Amended

These products are evaluated, qualified, and approved for use only at the specified mix ratio range with the indicated application equipment.

Consult individual agencies for specific policies relating to wildland fire foam use.

Definition: Foams contain foaming and wetting agents that affect how the product clings to surfaces and penetrates fuels. They depend on the water they contain for their effectiveness.

Chemical	Mix Ratio	Qualified Applications [1]				
		Fixed-Wing		Helicopter		Ground Applied
		Water Scooper	SEATS [2]	Fixed-Tank	Bucket	
FireFoam 103B	0.1–1.0%	●	●	-	●	●
Phos-Chek WD881	0.1–1.0%	●	●	●	●	●
Pyrocap B-136	0.1–1.0%	-	●	-	●	●
Phos-Chek WD881C	0.1–1.0%	●	●	●	●	●
National Foam KnockDown	0.1–1.0%	●	●	-	●	●
FlameOut	0.1–1.0%	-	-	-	●	●
Angus Hi-Combat A	0.1–1.0%	●	●	-	●	●
Buckeye Platinum Class A Foam	0.1–1.0%	●	●	-	●	●
Solberg Fire-Brake 3150A	0.1–1.0%	●	●	-	●	●
First Response	0.1–1.0%	●	●	●	●	●
Ansul Silv-Ex Plus Class A Also sold as Chemguard DirectAttack	0.1–1.0%	●	●	●	●	●
1% Bushmaster "A" Class Foam	0.1–1.0%	●	●	-	●	●
Phos-Chek WD881A	0.1–1.0%	●	●	●	●	●
Fomtec Enviro Class A Also sold as FireIce Polar EcoFoam	0.1-1.0%	●	●	-	●	●
Bio-Ex Ecopol-F Also sold as BIO FOR N+	0.1-1.0%	●	●	●	●	●

1 – Qualification Notes

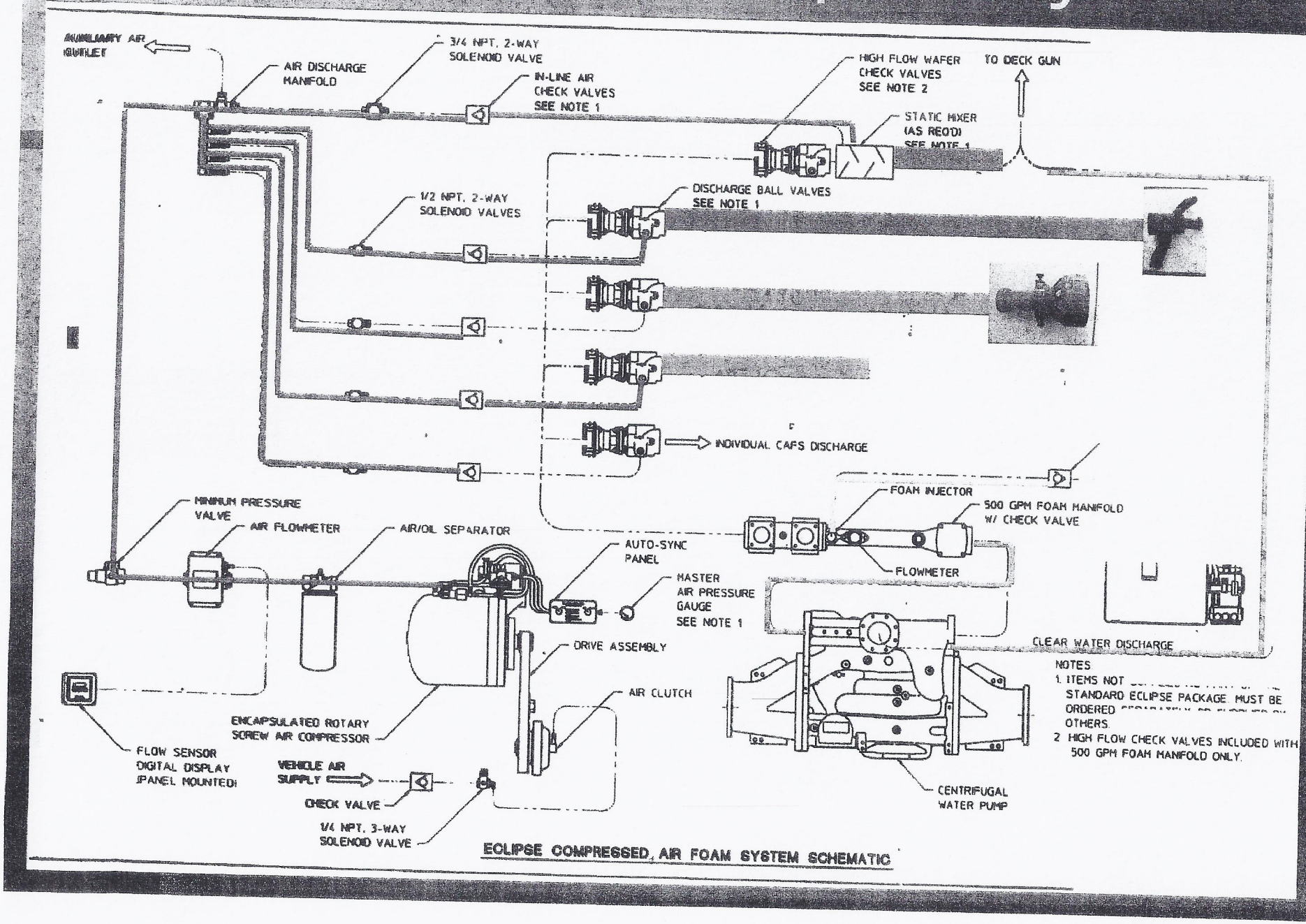
● Fully Qualified – Product complies with all requirements of a formal specification.

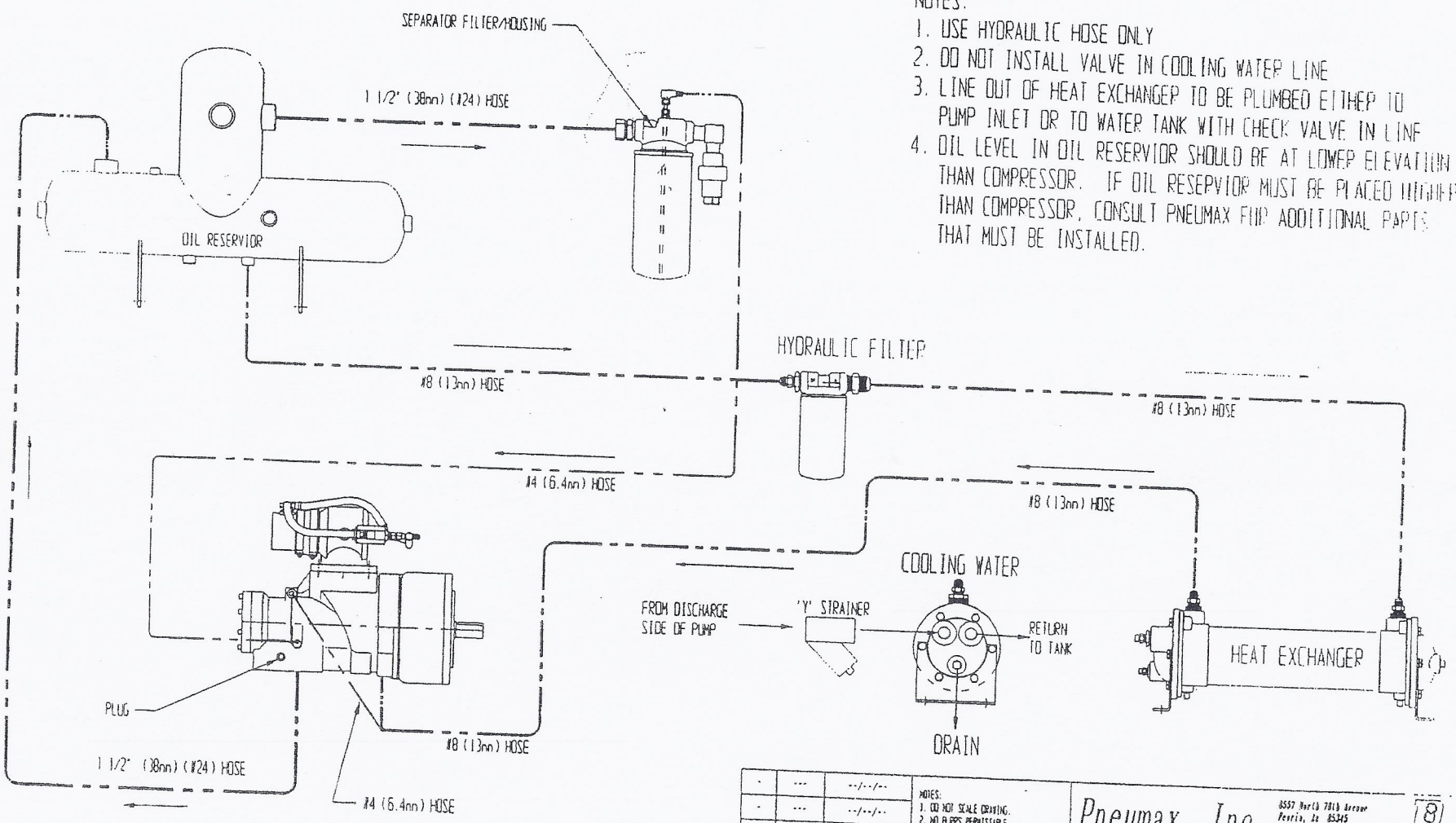
o Conditional Approval – Product complies with all requirements in the specification for laboratory evaluation; a field evaluation is required for full qualification.

- Not qualified for this application.

2 – Within Canada, the wildland fire management agencies apply foam from land-based fixed-wing airtankers (single or multi engine). The presence of a dot in this column indicates approval in Canada for application from aircraft of either type.

CAFS Diagram – Multi point injection





NOTES:

1. USE HYDRAULIC HOSE ONLY
2. DO NOT INSTALL VALVE IN COOLING WATER LINE
3. LINE OUT OF HEAT EXCHANGER TO BE PLUMBED EITHER TO PUMP INLET OR TO WATER TANK WITH CHECK VALVE IN LINE
4. OIL LEVEL IN OIL RESERVIOR SHOULD BE AT LOWER ELEVATION THAN COMPRESSOR. IF OIL RESEPVIOR MUST BE PLACED HIGHER THAN COMPRESSOR, CONSULT PNEUMAX FOR ADDITIONAL PARTS THAT MUST BE INSTALLED.

-	---	--/--/--	
-	---	--/--/--	
-	---	--/--/--	
-	---	--/--/--	
-	---	--/--/--	
ORIG	DRB	10/23/2001	
REV.	BY	DATE	

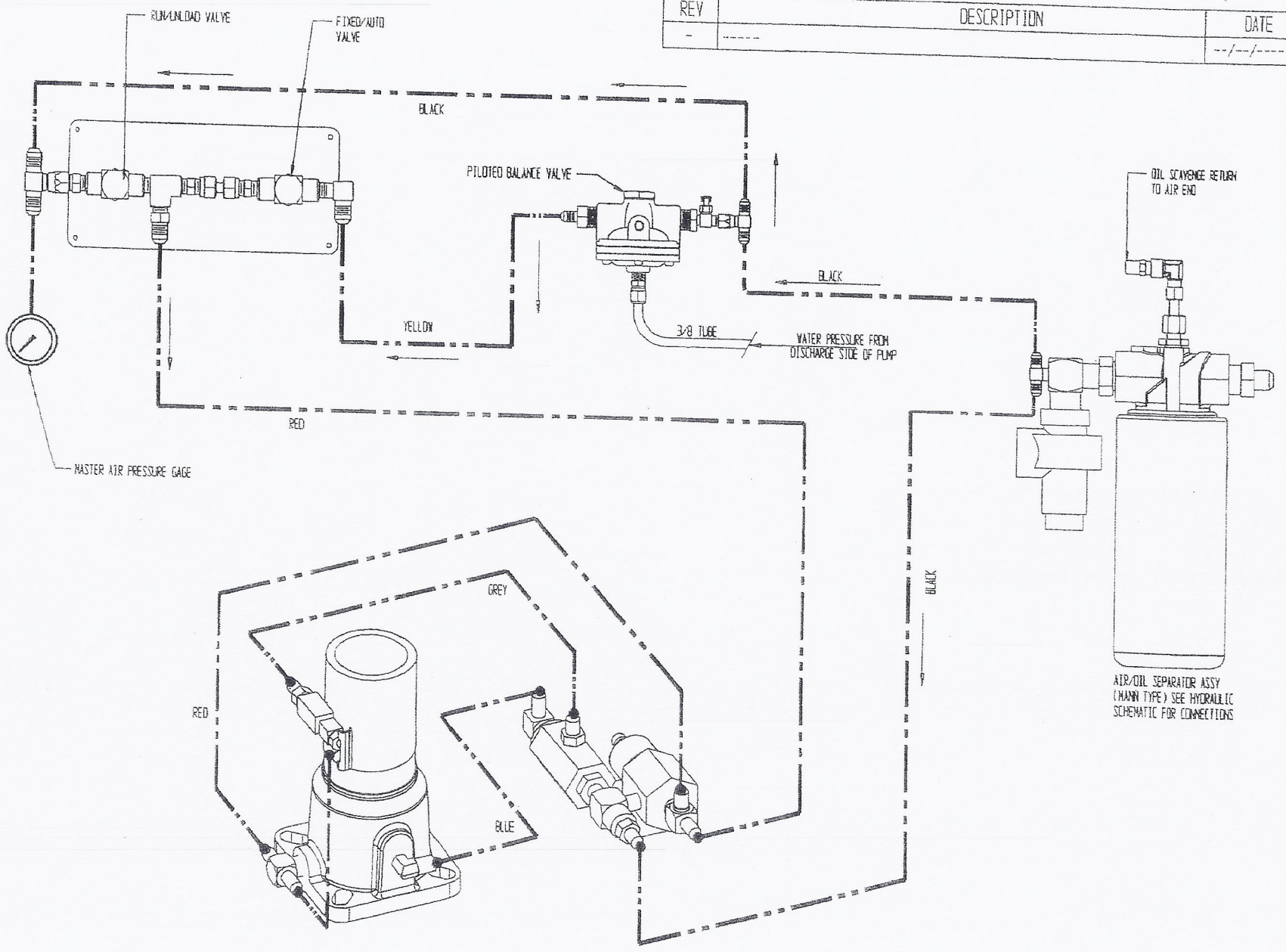
NOTES:
1. DO NOT SCALE DRAWING.
2. NO BURRS PERMISSABLE
3. DECIMAL TOLERANCE +/- .063
4. ANGLE TOLERANCE +/- 500

Pneumax, Inc.
8557 North 78th Avenue
Peoria, Az 85345
(602) 979 - 3288

HYDRAULIC SCHEMATIC

SIZE	FSCM NO.	DWG NO.	REV
B		314014	A
SCALE 1/8		SHEET 1 of 1	

REV	DESCRIPTION	DATE	ECR #
-	-----	--/--/----	------



PNEUMAX
8557 N. 78TH AVE.
PEORIA, AZ 85345
623-979-3398
FAX: 623-979-6949

DO NOT SCALE DRAWING
TOLERANCE UNLESS OTHERWISE SPECIFIED
.XX +/- 0.030 1/X +/- 1/16
.XXX +/- 0.010 ANGLES +/- 0.5°

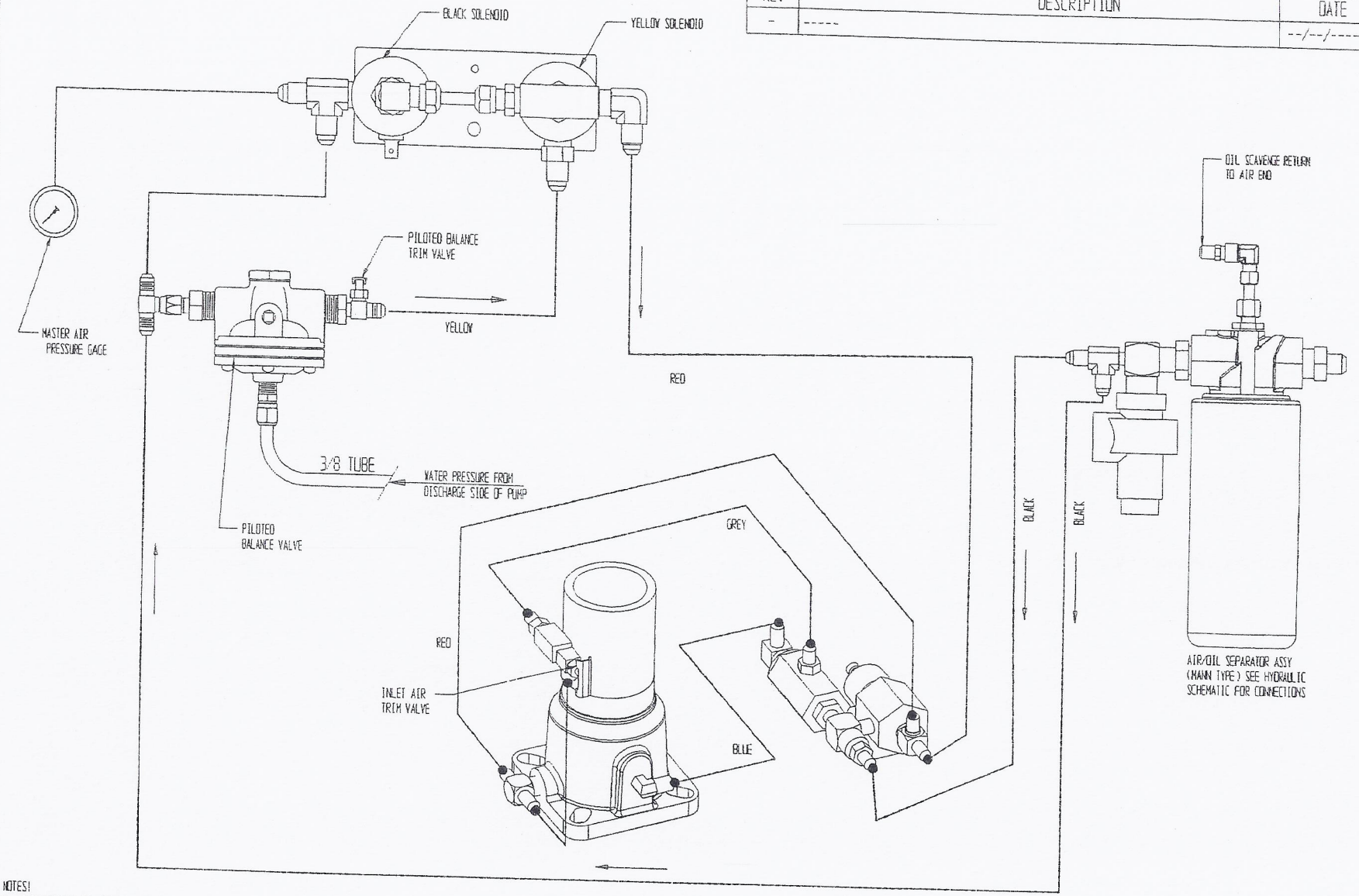
SIZE	WEIGHT	SHEET	DRAWN
A	--- LBS	1 of 1	12/17/2002 DRB

USED ON: 80-P

AIR SCHEMATIC
CE55G SYSTEMS

DWG NO.
314035

REV	DESCRIPTION	DATE	ECR #
-	-----	--/--/----	------



NOTES!
1. FITTINGS MAY CHANGE PER APPLICATION
2. FITTINGS MAY HAVE BEEN TURNED FOR DRAWING CLARITY

PNEUMAX
8557 N. 78TH AVE.
PEORIA, AZ 85345
623-979-3398
FAX: 623-979-6949

DO NOT SCALE DRAWING
TOLERANCE UNLESS OTHERWISE SPECIFIED
.XX +/- 0.030 1/X +/- 1/16
.XXX +/- 0.010 ANGLES +/- 0.5°

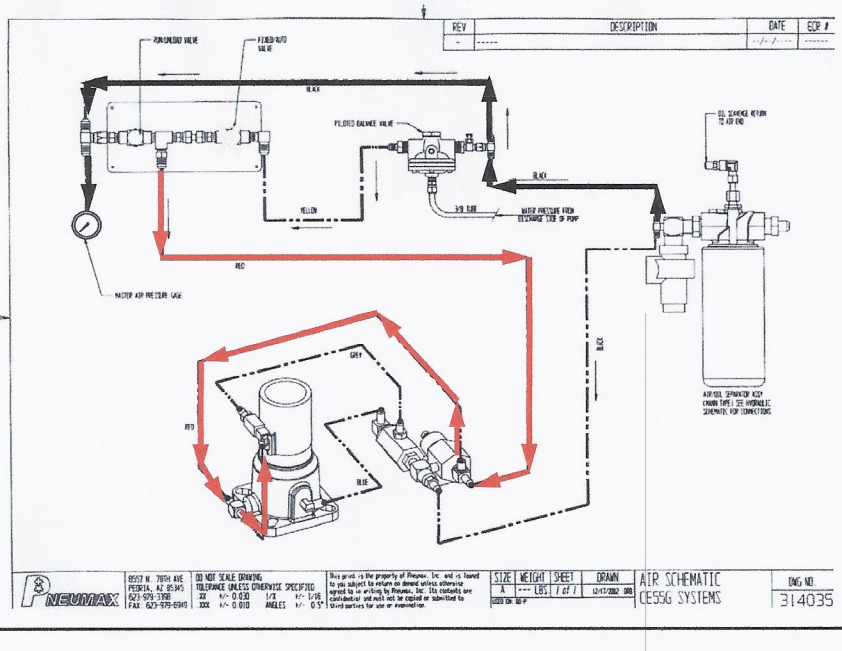
SIZE	WEIGHT	SHEET	DRAWN
A	--- LBS.	1 of 1	10/19/2004 RC

USED ON:

AIR SCHEMATIC ELECTRIC AUTO-SYNC

DWG NO. 314057

Air control circuit – Unload

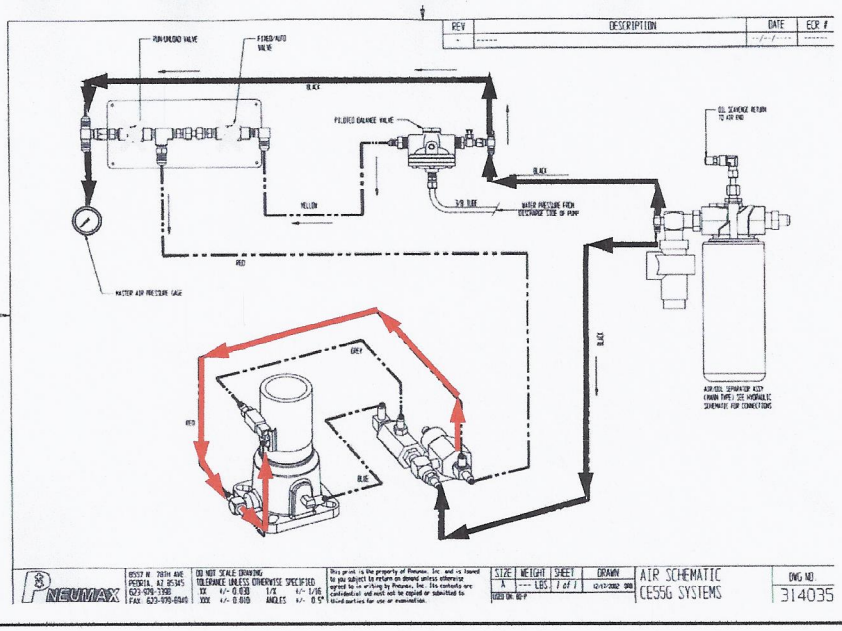


9-26-06

1

1

Air control circuit – Fixed

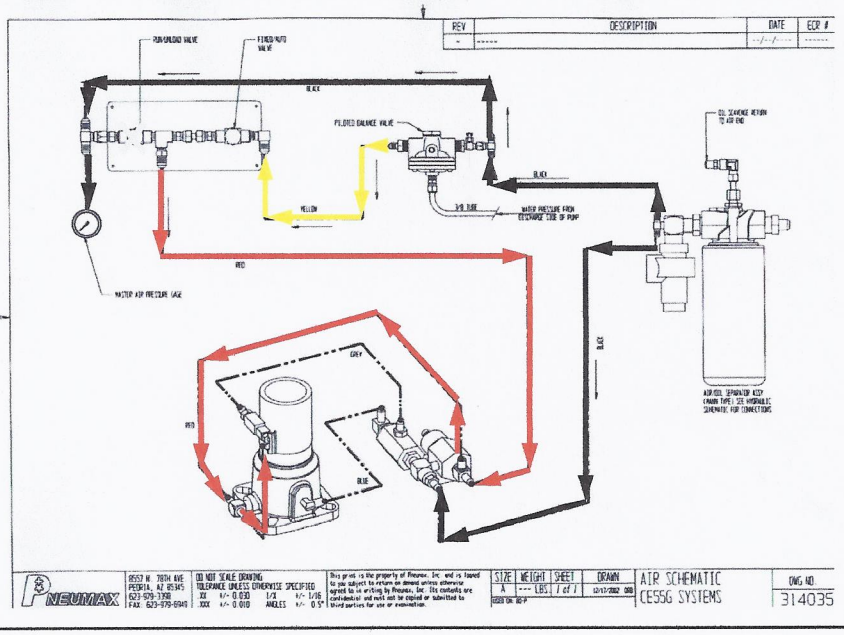


9-26-06

2

2

Air control circuit – Automatic Balance

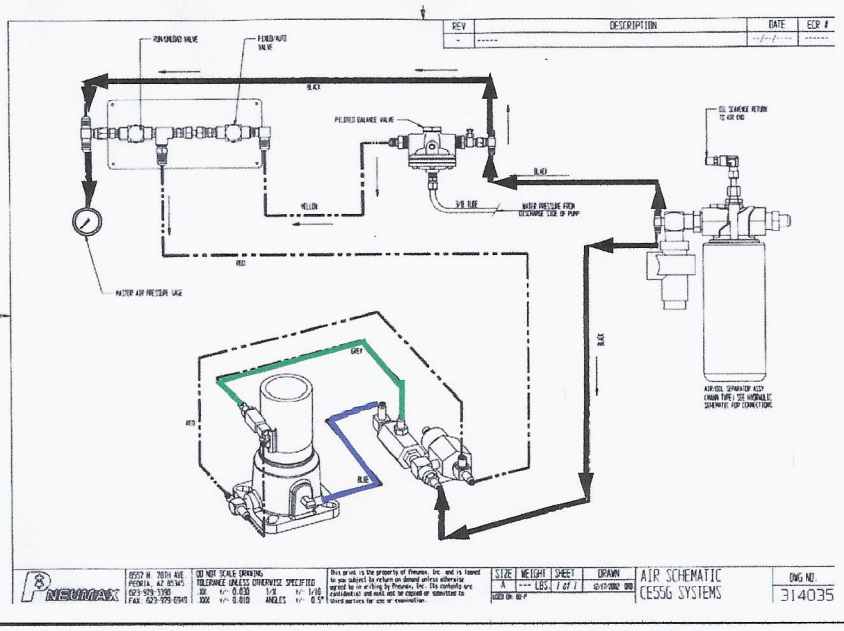


9-26-06

3

3

Air control circuit – Bleed Down



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4

4

CAFS Maintenance and Adjustment

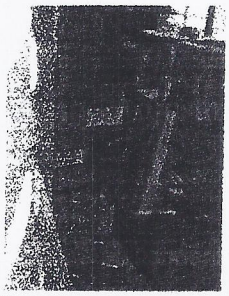
- Maintenance
- Adjustments
  - –Air circuit fixed pressure adjustments
  - –Air circuit auto balance trim adjustments

Flushing system

- Flush all discharges, lines, appliances and nozzles used with foam immediately after use
  - – Turn off off foam proportioner
  - – Flow water until clear water at nozzle
  - – Foam concentrate can remain in electronic direct injection systems
  - – Refer to manufacture instructions for other proportioners

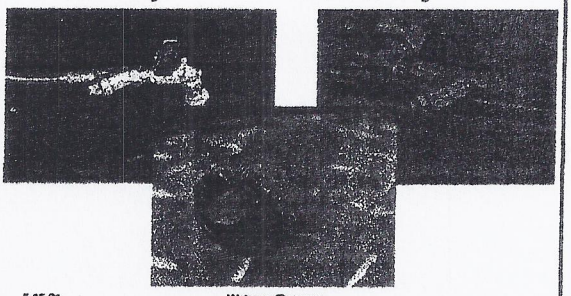
Fluid level checks and daily system checks

- compressor oil
- proportioner oil level
- engine fluids if auxiliary powered
- foam concentrate level
- run system
  - – flow air only



Strainers

- Foam y-
- Cooler y-



Filter service intervals

- air filter
  - – as needed depending on conditions
- hydraulic oil filter
  - – annually
- separator filter
  - – bi annually
- engine filters if auxiliary powered
  - – as recommended by engine manufacturer

Fluid types and changes

- compressor
  - – ISO 68 hydraulic low foaming oil
  - – check with system manufacturer on specific compressor types
- proportioner
  - – 30W non detergent

Air Circuit

Fixed and Auto Pressure Final Adjustments

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 psi. The AUTO air operation is set (or trimmed) to match 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 Inlet Air Trim Valve (IATV) by closing the valve, than opening it 3 turns.
2. Preset the Piloted Balance Trim Valve PBTV) to full open.
3. Start the fire pump and at idle establish water flow either through a discharge or tank recirculation.
4. The Auto Sync Control Panel should be in the FIXED – UNLOAD mode and all air discharges closed.
5. Start the air compressor by placing the compressor engage switch to "ON".
6. The main air pressure gauge should read 40-50 psi. In the UNLOAD mode, this minimum pressure is always present to provide compressor oil circulation.

We are ready to proceed with final adjustments for the FIXED and AUTO modes.

FIXED air mode.

1. To set the pressure for FIXED operation first location the "Fixed Pressure Regulator". The regulator has an adjustment screw with lock nut.
2. Loosen the regulator's lock nut.
3. Go to the Auto Sync Panel and place controls to the FIXED – RUN positions. The compressor will build pressure to some valve and hold (regulate).
4. While monitoring the air pressure gauge, adjust the screw on the Fixed Pressure Regulator until the desired pressure is reached. Turning the screw IN will INCREASE pressure and turning the screw OUT will DECREASE pressure.
5. Once the desired regulated pressure is achieved, tighten down the lock nut.
6. Verify the fixed regulator is performing by varying the compressor speed and monitoring the air pressure gauge. The pressure should remain steady at your fixed pressure setting.

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

AUTO air mode.

1. With the fire pump operating at 100 psi main discharge and minimal flow, place the Auto Sync controls to the AUTO – RUN position.

2. Monitor main water discharge pressure gauge and the air pressure gauge. The pressure readings should be the same. If not, proceed to step 3.
3. The Air Inlet Trim Valve (AITV) is the first valve to adjust. If the air pressure is too high, close the trim valve in half turn increments, monitoring both water and air pressure gauges, until the pressures match. Once the pressures match, no further adjustments are needed and proceed 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, again open the trim valve a half turn. If your air pressures match, no further adjustments are needed and proceed to step 5. However if your air pressure is still too low proceed to step 4.
4. Your 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. So to extend its range, go to the Piloted Balance Trim Valve (PBTV). From the fully open position, close the PBTV one turn then check water and air pressure gauges. If air still too low, again close the PBTV one turn and check gauges. Keep repeating this process until the air pressure matches or is slightly higher than water pressure. The final adjustment can be done using the AITV and step 4.
5. Verify the piloted balance valve is performing by varying the fire pump discharge pressure and monitoring the water and air pressure gauges. The air pressure should follow the water pressure and match it. If not, repeat final adjustment procedure.

Troubleshooting Guide

Symptom	Possible Cause	Solution
The compressor is working, but no air is supplied to the discharges.	The auto-sync switch is not in the correct position.	• Make sure that the air pressure produced in unload mode is between 25 to 40 psi. • Make sure that the air pressure produced in auto mode is 50 psi or more and changes with water pressure. • Make sure that the air pressure produced in fixed mode is between 145 to 150 psi.
	The air discharge solenoid is not working.	Verify that the air discharge solenoid has power and is operational—repair or replace the solenoid.
	There is a leak in the air solenoid or in the tubing between the solenoid and discharge.	Repair or replace the leaking components.
	The air check valve is defective or mounted backwards.	Replace the air check valve or mount it correctly.
	The trim valve is out of adjustment.	Adjust the trim valve.
	The minimum pressure valve is stuck.	• Disassemble and clean the minimum pressure valve, then assemble the minimum pressure valve with moly grease. • Replace the minimum pressure valve.
	The air lines were plumbed prior to the discharge valve seal.	Relocate air lines to the discharge side of discharge valve.
The air supply is insufficient.	The compressor speed (rpm) is too low.	Increase the compressor speed (rpm).
	The air lines are the wrong size.	Replace the lines with the correct size.
	The minimum pressure valve is restricted.	Clear any debris hindering valve operation.
	The throttle valve is closed (if the system uses a throttle valve to control air flow).	Make sure that the throttle valve is open and properly adjusted.
The system is functional, but the pressure gauge is not indicating the correct pressure.	• The gauge is malfunctioning. • The air line has detached or is leaking. • The air line is restricted.	• Check the components for air leaks. • Reattach, repair, or replace the malfunctioning components. • Make sure that the air line is not kinked or obstructed—clear any obstructions.
Air pressure is produced in fixed mode, but no pressure is produced in auto mode.	• The balance valve is malfunctioning. • Water is not being supplied to the balance valve.	• Make sure that the balance valve tubing is installed properly. • Make sure that the balance valve tubing is not leaking, kinked, or obstructed—clear any obstructions.
Air pressure is produced in auto mode, but it remains at the fixed pressure.	The balance trim valve is closed.	Make sure that the trim valve is open and properly adjusted.
	The balance valve is malfunctioning.	• Make sure that the balance valve tubing is installed properly. • Make sure that the balance valve tubing is not leaking, kinked, or obstructed—clear any obstructions.
	The balance trim valve is closed.	• Make sure that the trim valve is open and properly adjusted. • If the trim valve is already open, make sure that it is not obstructed—clear any obstructions.

Symptom	Possible Cause	Solution
The air discharge pressure is too high.	The red auto-sync tube has detached or is leaking.	Reattach, repair, or replace the tubing.
	The trim valve is out of adjustment—the air inlet trim valve is too far open, the balance trim valve is closed.	Adjust the trim valve.
	The PMC valve is out of adjustment.	Adjust the system to approximately 150 psi in fixed mode.
The system is overheating (air/oil cooling).	The electric cooling fan is malfunctioning.	• Make sure that the fan control wiring and motor are not damaged—repair or replace damaged components. • Make sure that no fuses or breakers are blown or tripped—replace or reset blown fuses and breakers.
	Not enough air is flowing through the cooler.	• Make sure that there is no debris obstructing the cooling fins on the fan—clear any obstructions. • Make sure that there is adequate space in front of and behind the cooler for air to flow through the fan. • Repair or replace the cooler.
The system is overheating with adequate flow to the cooler (liquid shell/tube cooling).	The compressor oil level is too low.	• Add the appropriate amount of oil—the proper oil level is halfway up the sight window when the apparatus is on level ground. • Make sure that the lines are not kinked or obstructed—clear any obstructions. • Replace the oil filter.
	The temperature sending unit and/or temperature gauge is malfunctioning.	• Check the wire connections at the sending unit. • Make sure that the wiring is not damaged or corroded—repair or replace any damaged or corroded wiring. • Make sure that the components are not malfunctioning or corroded—repair or replace worn or corroded components.
	The water being recirculated through the system has become saturated with heat.	Introduce cool water to the tank or stop operation until the system is no longer overheating.
	The cooler is partially restricted.	Check the cooler for debris—clear any debris hindering the flow and determine where debris entered the cooler.
	The wye strainer or panel strainer is plugged with debris.	Clean the wye strainer or panel strainer.
	There is a hole in the wye strainer.	Replace the wye strainer.
	There is a buildup of material in the cooling tubes.	Clean the cooler as needed and clear any obstructions in the tubing.
The air flow meter is not reading correctly (stuck at 0 cfm).	The magnetic coupler has decoupled.	Turn the air flow off and then on to reset the air flow meter.
	There is debris on the magnet.	Disassemble and clean the magnet, then assemble the magnetic coupler.
	The magnet is loose and sliding off of the piston.	Remove the magnet, then securely attach the magnet to the piston.
	The air flow meter is malfunctioning.	Replace the air flow meter.
The air flow meter is not reading correctly (stuck at a high cfm).	The magnetic coupler has decoupled.	Allow excess air (pressure) in the compressor to bleed off, then turn the air flow off and then on to reset the air flow meter.
	The air flow meter is malfunctioning.	Replace the air flow meter.

Symptom	Possible Cause	Solution
The oil consumption is high.	The compressor oil level is too high.	Remove the appropriate amount of oil—the proper oil level is halfway up the sight window when the apparatus is on level ground.
	The compressor oil is not suitable for your system.	Switch to low- or non-foaming compressor oil.
	The separator filter is damaged.	Replace the separator filter.
	There is water in the separator filter.	Remove the water or replace the separator filter.
	An incompatible separator filter is being used.	Replace the separator filter with another separator filter from the factory-recommended brand.
	Air flow exceeds the system's cfm.	• Check the maximum cfm of the system and test again. • Lower the engine speed and flow CAFS to relieve pressure. • Replace the separator filter.
	The scavenge tube is restricted.	Make sure that the tube is not kinked or obstructed—clear any obstructions.
	The scavenge tube is sitting too high in the separator filter.	Adjust the height of the scavenge tube.
	There is an oil leak in the system.	Repair or replace the leaking components.
The engine stalls when the compressor is engaged.	The compressor was engaged while under load.	Allow the air (pressure) in the compressor to bleed off before engaging the compressor.
	The compressor is flooded with oil.	Allow the air (pressure) in the compressor to bleed off, then start the compressor and flow air.
	The engine horsepower was underrated.	Increase the engine speed (rpm) before engaging the compressor—do not engage the compressor when the engine speed is over 1000 rpm.
	The auto-sync system is in fixed mode.	Engage the compressor in auto or unload mode, then switch to fixed mode.
	The compressor oil level is too low.	Add the appropriate amount of oil—the proper oil level is halfway up the sight window when the apparatus is on level ground.
	The compressor oil level is too high.	Remove the appropriate amount of oil—the proper oil level is halfway up the sight window when the apparatus is on level ground.
	The compressor is locked up.	Replace the compressor.
	The sump is positioned too high above the compressor.	Lower the sump or install a check valve into the oil line between the oil cooler and compressor.
	There is a dome on the compressor discharge hose.	Reroute the hose per the requirements of your application.
The compressor is locked up.	The oil level is too high and the compressor is flooded.	Remove the appropriate amount of oil—the proper oil level is halfway up the sight window when the apparatus is on level ground.
	There was a sump fire.	Check the system and repair the damaged components. Contact Waterous for more information.
	The oil level is low or there is no oil.	• Add the appropriate amount of oil—the proper oil level is halfway up the sight window when the apparatus is on level ground. • Check the system and repair the damaged components. Contact Waterous for more information.

Symptom	Possible Cause	Solution
The air pressure is appropriate but the system produces poor quality foam.	The foam system has not been calibrated or is out of calibration.	Make sure that the foam system has been calibrated—recalibrate the system.
	You are using a wetting agent, not foam concentrate.	Use foam concentrate rated for CAFS.
	The foam proportioning control is too low.	Increase the amount of concentrate to the manufacturer's recommended percentage.
	The air supply is restricted.	Make sure that the lines are not kinked or obstructed—remove any obstructions.
	The air/water volume was not adjusted properly.	Adjust the air/water volume to achieve the proper mixture for foam.
	The air/water pressure is not balanced.	Adjust the trim valve.
	The foam proportioning control is too low or disabled, or the foam tank is empty.	Make sure that the proportioner is turned on, the foam supply valve is open, the foam tank has concentrate, the wye strainer is clear, and the supply line is connected to the injector.
The foam pump is disabled and there is foam in the water system.	Foam concentrate was poured into the on-board water tank.	Flush the tank and pump with clean water, then refill.
	The foam manifold drain line is not isolated from the water drain lines.	Isolate to a separate drain valve.
	The cooler line is plumbed from the foam manifold.	Relocate the cooler line to the discharge side of the fire pump.
	The foam concentrate inject check valve is defective.	Repair or replace the check valve.
	There is a leak between the water and foam tanks.	Repair or replace the tanks.
	The dry vacuum test forces foam concentrate into the foam manifold.	Set the proportioner to flush during the test.
Water is in the compressor oil/air.	The air check valves are malfunctioning.	Repair or replace the check valves.
	Check valves were not installed on the discharges.	Install check valves on the discharges.
	Condensation has built up in the oil/air mixture.	Flow air once per week at a minimum, more often if operating in high humidity.
	The system was exposed to cold temperatures without the oil cooler being drained.	Test the oil cooler for internal leaks from the water side to the oil side—replace the cooler.
The air flow meter is not reading correctly.	The magnetic coupler has decoupled.	Turn the air flow off and then on to reset the air flow meter.
	The meter is malfunctioning.	Replace the air flow meter.

Symptom	Possible Cause	Solution
The safety pop-off valve is opening at a low pressure or opening repeatedly.	The auto-sync system is out of balance.	Adjust the auto-sync system—make sure to not open the compressor trim valve more than 3 turns.
	A sump fire damaged the pop-off valve.	Check the system for other damaged components, then replace the pop-off valve.
	The trim valve or inlet is completely open.	Adjust the trim valve.
	The red tube circuit has detached or is leaking.	Reattach, repair, or replace the red tubing.
	The black tube circuit is restricted.	Make sure that the black tubing is not kinked or obstructed—clear any obstructions.
	Operating in high humidity has trapped water vapor in the compressor oil.	Operating the system at the boiling point of water allows the water vapor to escape as steam.
The bleed-down time seems too long during system operation.	The bleed-down time varies between systems.	If the auto-sync system is working properly and the compressor output is within spec, the bleed-down time is normal.
	The trim valve or inlet is too far closed.	Adjust the trim valve.
	The air inlet trim valve is restricted.	Clear any debris hindering the trim valve operation.
The bleed-down time seems too long during system shutdown.	The bleed-down time varies between systems.	If the auto-sync system is working properly and the compressor output is within spec, the bleed-down time is normal.
	There is a plugged restrictor jet at the air inlet trim valve tee.	Remove and discard the restrictor jet at the tee fitting.
	The green/gray air-brake tube is restricted.	Make sure that the green/gray tubing is not kinked or obstructed—clear any obstructions.
	The shuttle valve is stuck.	Disassemble and clean the shuttle valve, then install it back into the PMC. ***Note:*** *Because it is easy to reverse the shuttle valve connections, make sure to note how the shuttle valve is connected during disassembly.*
The clutch is smoking.	The auto-sync system is engaged in the wrong mode.	Engage the system in auto or unload mode.
	The clutch solenoid has an air leak.	Repair the air leak or replace the solenoid.
	The clutch disc is contaminated.	Clean or replace the clutch disc.
	The clutch is engaged at a high engine speed.	Only engage the clutch at a lower engine speed.
	The clutch is engaging the system when the compressor has not had adequate bleed-down time.	Allow the air (pressure) in the compressor to bleed off before engaging the compressor.
	The air supply for the clutch does not have an isolated air line.	Plumb an air line exclusively for clutch operation.

Symptom	Possible Cause	Solution
The discharge hose is shaking (slug flow).	The foam proportioner is on, the setting is correct, and the tank has concentrate, but it is not providing foam solution.	Refer to foam proportioner instructions for detailed calibration and troubleshooting instructions.
	Foam concentrate is not being injected into the foam manifold.	Make sure that the foam system is turned on.
	The discharge has low water flow and the foam concentrate is not being injected into the foam manifold.	• Increase water flow. • Raise the foam percentage. • Make sure that the flow meter is the correct size. • Make sure that the foam system has been calibrated—recalibrate the system.
	Poor quality foam concentrate is being used.	• Make sure that the foam system is calibrated correctly. • Raise the foam percentage until slug flow stops.
	The wye strainer is plugged with debris.	Clean the foam tank and wye strainer, then open the foam concentrate shut-off valve.
	The foam concentrate shut-off valve is closed.	Open the shut-off valve.
	The foam concentrate inject check valve is in the bypass position.	Move the check valve to the inject position.
The compressor is producing no air pressure.	The clutch is not engaging.	• Make sure that the clutch is operating properly—check air clutch systems for leaks. • Make sure that the *OK TO PUMP* light is illuminated. • Check the wire connections at the clutch or PTO. • Make sure that the wiring is not damaged or corroded—repair or replace any damaged or corroded wiring. • Make sure that the PTO is not malfunctioning—repair or replace any damaged components.
	The auto-sync system is not engaged in fixed mode.	• Make sure that the air pressure produced in unload mode is between 25 to 40 psi. • Make sure that the air pressure produced in auto mode is 50 psi or more and changes with the water pressure. • Make sure that the pressure produced in fixed mode is between 145 to 150 psi.
The compressor is producing low air pressure.	The clutch is not engaging.	• Make sure that the clutch is operating properly—check air clutch systems for leaks. • Make sure that the *OK TO PUMP* light is illuminated. • Check the wire connections at the clutch or PTO. • Make sure that the wiring is not damaged or corroded—repair or replace any damaged or corroded wiring. • Make sure that the PTO is not malfunctioning—repair or replace any damaged components.
	The auto-sync system is not engaged in fixed mode.	• Make sure that the air pressure produced in unload mode is between 25 to 40 psi. • Make sure that the air pressure produced in auto mode is 50 psi or more and changes with the water pressure. • Make sure that the pressure produced in fixed mode is between 145 to 150 psi.

FOAM PROPORTIONING SYSTEM PERFORMANCE TEST

Apparatus no. or designation _____ Year manufactured _____

Manufacturer _____ Model _____

Serial no. _____ Vehicle identification no. _____

Foam proportioner make _____ Model _____

Foam proportioner type _____ Serial no. _____

Foam proportioner specifications:

Flow range	Min _____	Max _____
Pressure range	Min _____	Max _____
Percentage range	Min _____	Max _____
Foam concentrate viscosity	Min _____	Max _____
Power requirements	Min _____	Max _____

Test conditions: Proportioning ratio _____ Waterflow _____ Water Pressure _____

Test method used:

- ❑ Substituting water for foam concentrate
- ❑ Measuring foam concentrate pump output directly
- ❑ Determining foam percentage by use of a refractometer
- ❑ Determining foam percentage by use of a conductivity meter

Calibration accuracy _____ Within minimum requirements? ❑ Yes ❑ No

Comments on foam proportioning system performance test _____

_____

_____

_____

_____

_____

Tested by _____ Date _____

FIGURE C.3(g) Foam Proportioning System Performance Test Form.

CAFS COMPRESSOR PERFORMANCE TEST

Apparatus no. or designation _____ Year manufactured _____

Manufacturer _____ Model _____

Serial no. _____ Vehicle identification no. _____

Compressor make _____ Model _____

Compressor rate capacity at 125 psi (862 kPa) _____ SCFM

Compressor drive ☐ Belt ☐ Engine ☐ PTO ☐ Hydraulic

If engine, make _____ Model _____

Test device _____ Airflow meter _____ Fixed orifice _____ (size)

Compressor Run Test

Time	Air Pressure	Airflow (SCFM)	Compressor Temperature
Start			
5 minutes			
10 minutes			
15 minutes			
20 minutes			

Maximum air pressure: psi _____

Pressure Balance Test

Time	Water Pressure	Air Pressure	Percent Difference
At test start			
With air flowing			
After 5 minutes			

Comments on CAFS compressor performance test _____

Tested by _____ Date _____

FIGURE C.3(h) CAFS Compressor Performance Test Form.

PSI Across Orifice	Orifice Diameter, in inches										
	1/64	1/32	1/16	1/8	1/4	3/8	1/2	3/4	3/4	7/8	1
5	.062	.249	.993	3.97	15.9	35.7	63.5	99.3	143	195	254
7	.073	.293	1.17	4.68	18.7	42.2	75.0	117	168	260	300
9	.083	.331	1.32	5.30	21.2	47.7	84.7	132	191	260	339
12	.095	.379	1.52	6.07	24.3	54.6	97.0	152	218	297	388
15	.105	.420	1.68	6.72	26.9	60.5	108	168	242	329	430
20	.123	.491	1.96	7.86	31.4	70.7	126	196	283	385	503
25	.140	.562	2.25	8.98	35.9	80.9	144	225	323	440	575
30	.158	.633	2.53	10.1	40.5	91.1	162	253	365	496	648
35	.176	.703	2.81	11.3	45.0	101	180	281	405	551	720
40	.194	.774	3.10	12.4	49.6	112	198	310	446	607	793
45	.211	.845	3.38	13.5	54.1	122	216	338	487	662	865
50	.229	.916	3.66	14.7	58.6	132	235	366	528	718	938
60	.264	1.06	4.23	16.9	67.6	152	271	423	609	828	1082
70	.300	1.20	4.79	19.2	76.7	173	307	479	690	939	1227
80	.335	1.34	5.36	21.4	85.7	193	343	536	771	1050	1371
90	.370	1.48	5.92	23.7	94.8	213	379	592	853	1161	1516
100	.406	1.62	6.49	26.0	104	234	415	649	934	1272	1661
110	.441	1.76	7.05	28.2	113	254	452	705	1016	1383	1806
120	.476	1.91	7.62	30.5	122	274	488	762	1097	1494	1951
130	.494	1.98	7.90	31.6	126	284	503	790	1138	1549	2023

Values calculated based on dry air at atmospheric pressure of 14.7 psia, 70°F.