Crimson Engine Study Guide

The purpose of this study guide is to prepare you for the process of becoming a Montgomery County Crimson Engine (aeCAFS) driver. This guide will list and explain the components of the check off process. Its purpose is to combine the multiple sources of information. This guide is mearly notes taken from the source list. If you do not fully understand a concept discussed in this guide it is imperative that you go to the source. The required information for the testing process is not limited to this guide.

The following is the source list for the Montgomery County Crimson Engine testing process:

-PSTA Engine Book (revised 2015)
-MFRI Pump Operators book 1 and 2
-Crimson Engine Study Guide (this book)
-Policy 24-07 AMII
-Policy 808
-FCGO 10-03
-FCGO 14-10
-General knowledge of the specific Crimson Engine that you drive
-Knowledge of the inventory on a Crimson Engine Company and how to use it
-Knowledge of the Pump and capabilities
-Knowledge of the capabilities of the hand lines on a Crimson Engine
-Knowledge of the capabilities of Montgomery County's CAFS systems
-Knowledge of proper preventative maintenance procedures
-Troubleshooting procedures

It is the candidate's responsibility to know what source the information came from.

The PAGS in the back of this book are the same sheets that your test evaluator will use while testing you.

Crimson Engine General Knowledge

-Stock number? _____(unit specific)

-GVW = 47,000 LBS

-Front axle weight = 20,000 LBS

-Rear axle weight = 27,000 LBS

-Vehicle height? _____(unit specific)

-Vehicle length? _____(unit specific)

-Vehicle width? _____(unit specific)

-Tire PSI: Front = 120 PSI Rear = 120 PSI

-Engine oil (type and quantity)? _____

-Antifreeze (type and quantity)? _____

-Transmission fluid (type and quantity)? _____

-Power steering fluid (type and quantity)? _____

-Hub oil front (type and quantity)? _____

-Rear axle oil (type and quantity)? _____

-Cab tilt Fluid (type and quantity)? _____

-Generator oil (type and quantity)? _____

Brakes

Rear Brakes

-S cam drum brakes
-must have at least 1/4" brake shoe
-dual chamber
-operate off primary air tank

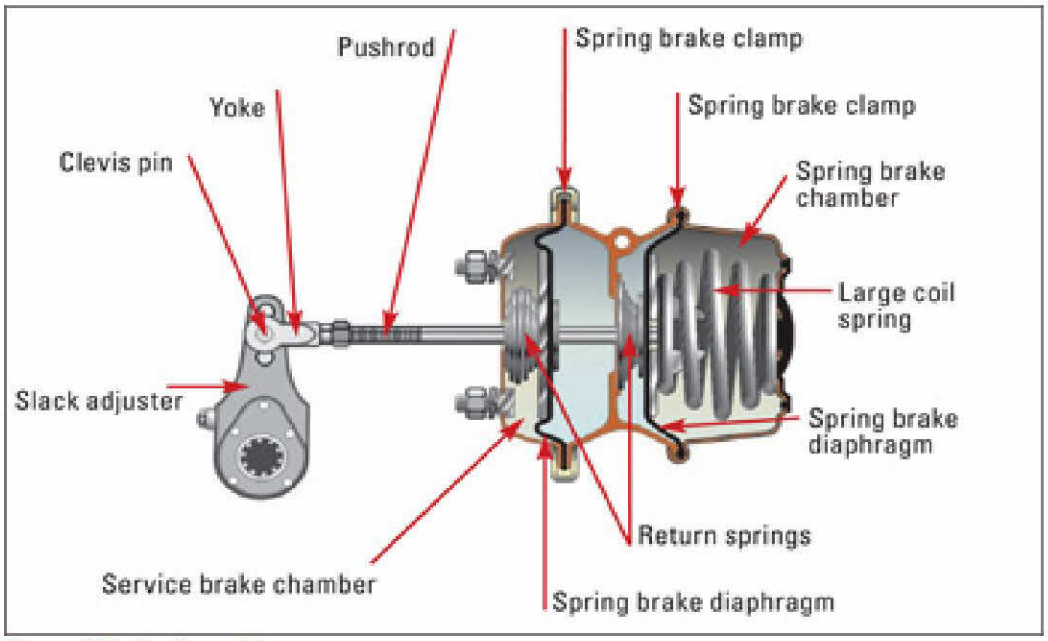


Figure 1 Brake Assembly

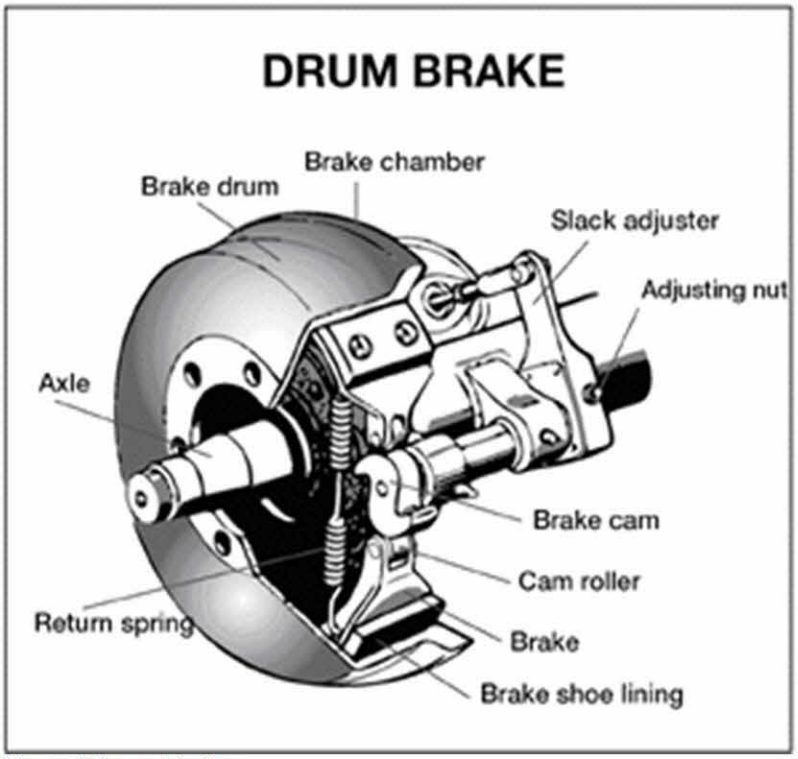


Figure 2 Drum Brake

Front Brakes

-disk brakes
-must have at least 1/8" pad each
-single chamber
-when indicator pin is flush, pads need to be replaced

Figure 3 Front Brake

Rotor

-No heat checks greater than half the diameter
-No heat checks that your fingernail will get stuck in
-Free of grease and debris

-spring brake: operates when the APV is pulled, uses air pressure to disengage brakes

-service brake: operates when you push on the brake pedal, uses air pressure to apply the brakes

Treadle Valve

-Controls the air delivered to the brake chambers
-Located on the drivers side at the very front

Figure 4 Treadle Valve

It is important to recognize the continuous braking over a period of time builds up a tremendous amount of heat. This could cause glazing of the brakes that greatly reduces the braking capacity of the system and could cause brake failure.

Air Compressor

-produces air pressue for brakes and auxiliary applications
-gear driven
-the high pressure braded air lines are a good way to identify
-located on the drivers side of the engine

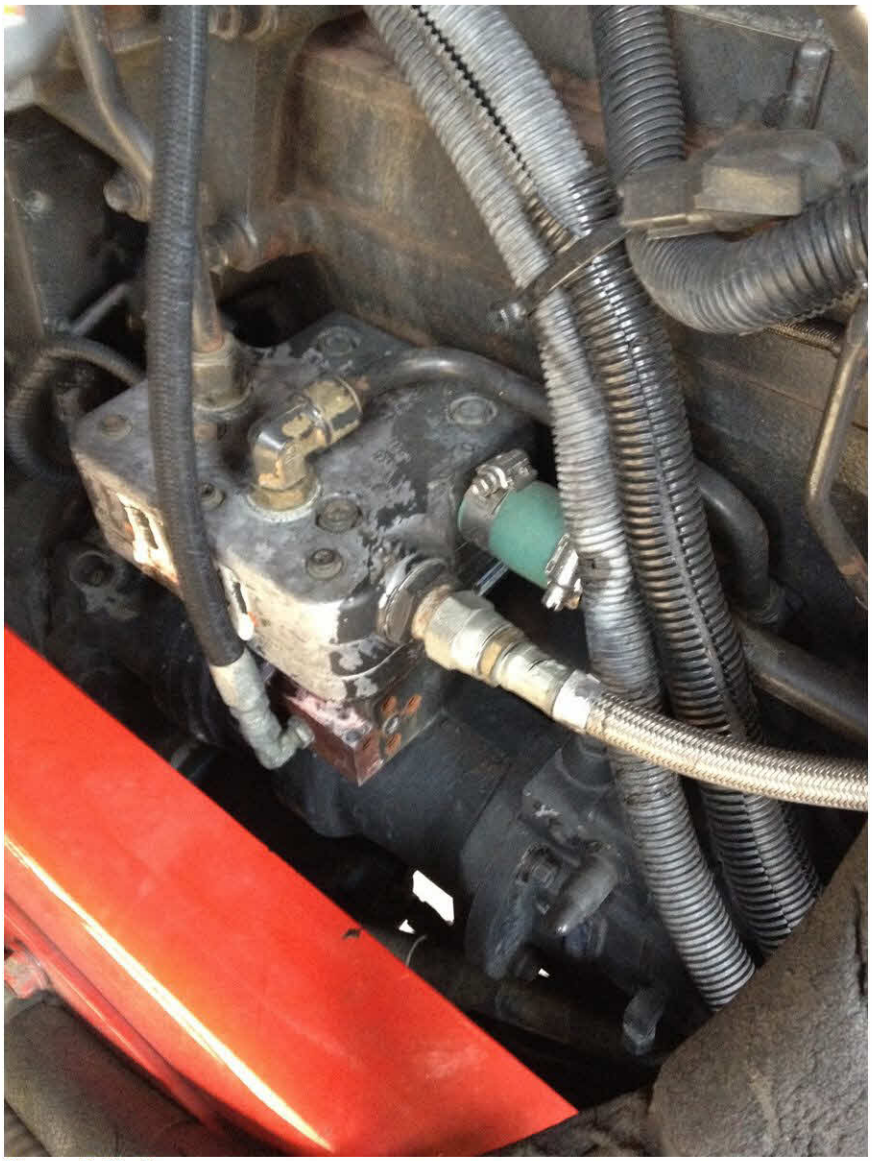


Figure 5 Air Compressor

Air Dryer

-When air is compressed it heats up. This heating up causes moisture to form. After the compressed air leaves the air compressor it goes to the air dryer where most of the water is removed.

Wet Tank

-From the air dryer the compressed air goes to the Wet Tank. It is called the Wet Tank because it is the first tank back from the Air Dryer. Most of the water from the stored air will collect in this tank.

All Air Tanks

-All air tanks need to be drained of water. This is done through the pull cord. Accumulation of water in the air tanks can cause brake malfunction if it freezes. Water in the air tanks will decrease the volume of compressed air that the tanks can hold.

ABS

-Crimson Engines are equipped with ABS
-Prevents the wheels from locking
-Sensors at each wheel sense when a wheel is about to lock up and pump the brakes to that wheel.
-Allows for steering while braking
-Produces a shorter stopping distance

Jake Brake

-The Jacobs brake is a two stage engine compression brake.
-Allows new air into the cylinders and restricts air from leaving, increasing compression and a reduction of horsepower.
-Can be set to: High, Low or Off
-Turn OFF in slippery conditions
-The Jacobs brake and the Telma retarder can be used in conjunction with each other.

Telma

-4 stage, frictionless, driveline retarder

-When you lift off the accelerator the first two stages of the Telma engage. As you depress the service brake the next two stages of the Telma engage.

-Turn OFF in slippery conditions

Figure 6 Telma

Glad Hands

-Used when the vehicle has to be towed. They allow the tow truck to run air to the brakes on the vehicle being towed.

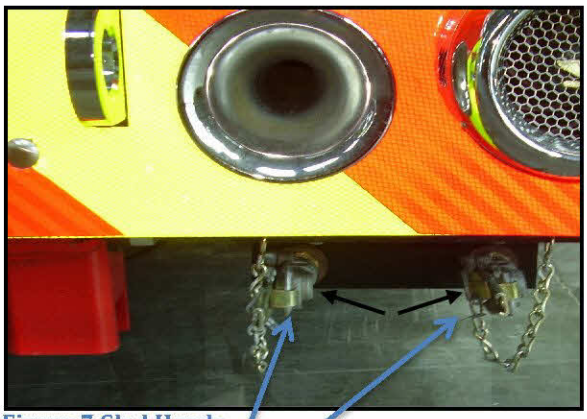


Figure 7 Glad Hands

Tow Hooks

-This is were the tow truck will hook up to the Engine

Figure 8 Tow Hooks

Suspension

-The purpose of the suspension is to keep the wheels on the road and to support the weight of the vehicle.

-Parts of the suspension system:

-Hydraulic Shocks

-U bolts- attach Leaf Springs to Axle

-Shackles- Allow for movement

-Leaf springs- Any broken or cracked Leaf Spring on a MCFRS vehicle is OOS. If the top or bottom Leaf Spring is cracked or broken The vehicle is OOS and must be towed.

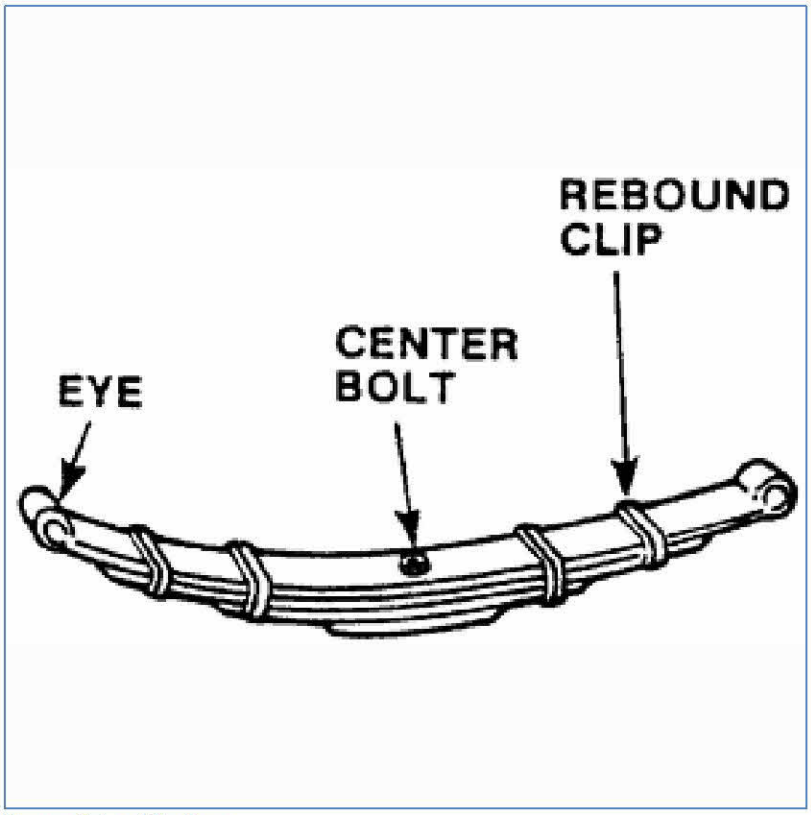


Figure 9 Leaf Springs

Front Hub Oil

-85 W 140 / 1 pint

-Do not remove plug to check, shine hand light in sight glass to check. There will be oil on the rim in the form of "spin art" if there is a leak.

Rear axle oil

-85 W 140 / 46 pints

-sealed unit

Engine oil

-15W 40 / 39 quarts

- The dipstick and oil fill is located behind the officers side front grill.
- Should not be frothy or smell like fuel

Figure 10 Oil dipstick and fill

Air Filter

- Filters the air before it goes into the engine

Figure 11 Air Filter

Engine

- 450 HP

Fuel Tank

-63 gallons
-Check for rubber bushings on hanger straps
-Note and be mindful of the location and how low the fuel tank hangs.

Starter Motor

-The starter motor engages the motor of the vehicle to get it to spin until the motor can maintain it's self to keep running. Located on the drivers side of the engine (underneath.)

Figure 12 Starter Motor

Radiator

-The Crimsons have a stacked radiator system. The top one cools is the Turbo air cooler. The middle one cools the engine. The bottom one is for the transmission cooler.

Antifreeze

-Extended Life / 41 quarts
-Check with site glass if hot
-Remove cap only if it is cool

Water Pump

-Pumps the coolant. The best way to find the water pump is to follow the large hose coming from the bottom of the radiator. In the picture below you can see the large hose coming from the radiator. Above the 90 degree bend is the water pump. It can be seen from underneath.

Figure 13 Water Pump

FAN

-Cools the radiator fluid when normal passing air is not sufficient.
-Have been retrofitted with clutches.

Transmission

-Fluid = TES-295 / 39 quarts
-Fluid can be checked by holding the up and down arrows in the cab or with the dipstick while engine is running and between 140-160 F.
-Can be checked with the dipstick while the cab is down through the access panel in the doghouse in front of the E5 position.
-Should be reddish in color, not smell burnt and no metal shavings.

Figure 14 Gear Shifter

- After the D (drive) mode has been selected and 5th gear is desired the operator must depress the mode button.

Transfer Case

Crimsons have a mid-ship split shaft pump. In this set up the fire pump is PTO driven off power delivered from the engine through the transmission, and then through the driveshaft. When you move the shifter in the cab from "road" to "pump" the Transfer Case diverts the power from the rear wheels to the fire pump. Once the transmission is the placed in "D" the pump will be turning.

Figure 15 PTO Transfer Case

Hand Throttle

-Located on the pump panel.

-Electronic hand throttle. It uses a linier potentiometer to translate mechanical position to an electrical signal in order to control the engine from a remote location.

-Equipped with a quick shut down feature. Activated by pushing the knob in. **Only use the quick shutdown when absolutely necessary**. For normal operations slowly throttle down.

-At the end of each PAG it says to turn the throttle all way down. This is extremely important. When placing the pump in gear if the hand is not turned all the way down (clockwise) the engine will not throttle up. This can be fixed one of two ways. Either push on the foot throttle to allow the RPMs to equal out or manually turn down the hand throttle, take the pump out of gear and then place back in gear.

Figure 16 Hand Throttle Assembly

Pump Cooler

-Takes water from the discharge side of the pump and returns it to the tank.
-This allows water to be continuously circulating to cool the pump. However, this alone has proven to be insufficient in cooling the pump.
-Should be kept open for normal operation.
-Keep closed when drafting.
-There are two pump cooler lines that dump back into the tank. One is operated via the valve on the pump panel. The second continuously circulates when the pump is in gear.

Engine Cooler

-When open it takes water from the pump to the engine for cooling.
-Keep closed for normal operation. Only open when engine temperature reaches 200 degrees F.
-Pictured below is where the tank water enters the upper radiator hose. This is located between the radiator and engine on the topside.

Figure 17 Tank Water to Radiator

Steering System

Figure 18 Steering Components

Power Steering Pump

-Provides power for the power steering system.

-Located on the drivers side of the oil pan.

Figure 19 Power Steering Pump

Steering Assist

- Located on the officers side in front of the axle
- Helps to turn the wheels and relieve some of the stress on the tire rod.

Figure 20 Steering Assist

Power steering fluid :

-Dextron 3 / 5 quarts

-The power steering reservoir is located on the rear of the engine.

-This fluid can be checked with the fluid being hot or cold

Power Steering Reservoir

Figure 21 Power Steering Reservoir and Fuel Water Separator

Fuel / Water Separator

Fuel / Water Separator

-Water in the fuel goes to the bottom of the separator and is drained out using the white plug on the bottom of the separator.

-This is to be done by CMF only.

AC Unit

-Located on the drivers side.

-Belt driven.

-The way to tell an AC unit from an alternator is an AC unit has hoses coming from it and an alternator has wires.

Figure 22 Air Conditioner Unit

Generator:

-Oil = 10 W 40 / 5 quarts
-Coolant = 50 / 50, 1.25 gallons
-Capacity = 7,500 watt.
-Always keep 10% in reserve.
-Volts X Amps = Watts.
-Can be started: in the cab, at the pump panel, or on the unit itself.
-To start the generator you must pre-heat the unit first.
-Hold the start switch to the stop/preheat position for 10 seconds and immediately start the generator
-Hold the start switch until the generator starts then release.
-Do not hold the start switch for longer than 15 seconds.
-When using generator power, always turn on the equipment with the highest draw first.
-When the generator is running the AC volt meter will show the electrical output. (located in the drivers compartment)

Figure 23 AC Volt Meter

-When turning off the generator remove all electrical draws first, then allow to run for 3 minuets, then turn off.
- 2014 Crimsons are equipped with an inverter instead of a generator.

Raising /Lowering The Cab

-Cab tilt Fluid = Dextron 3 / 5 quarts

-The unit must be on level ground to prevent twisting of the cab.

-The battery switch must be on, and the ignition switch off, with the parking brake set.

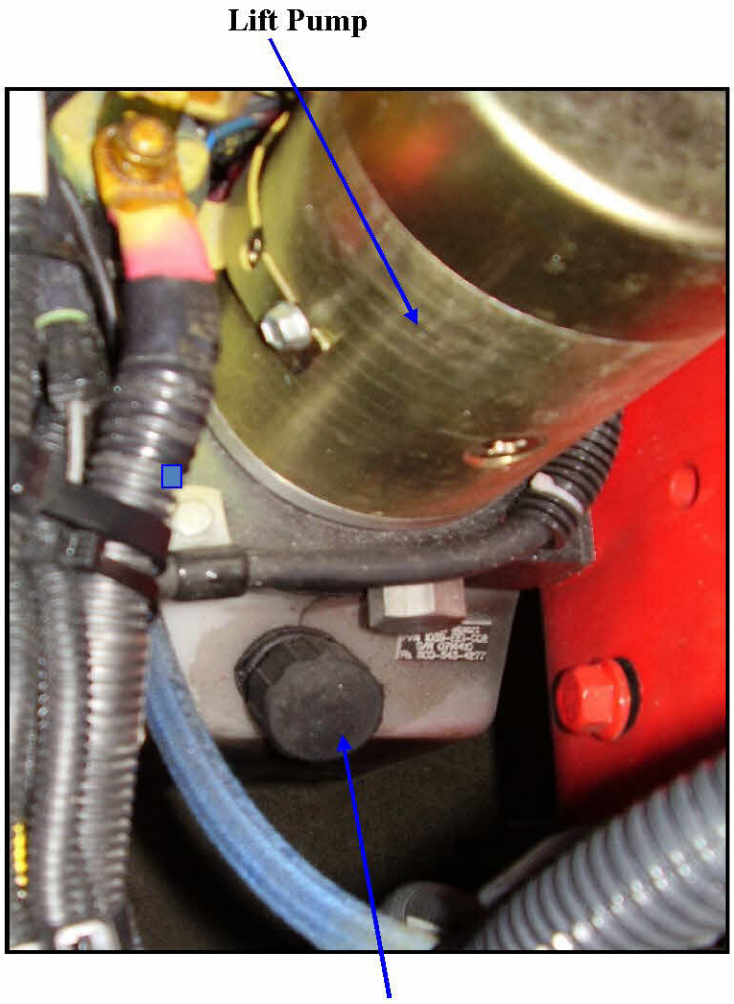


Figure 24 Cab Tilt Pump

-Raise the cab until you hear the safety fall against the cylinder and stop.

-For safety reasons remove the controller and turn the batteries off.

-DO NOT LOWER THE CAB BACK DOWN ONTO THE CYLINDER, this will cause the cab to torque.

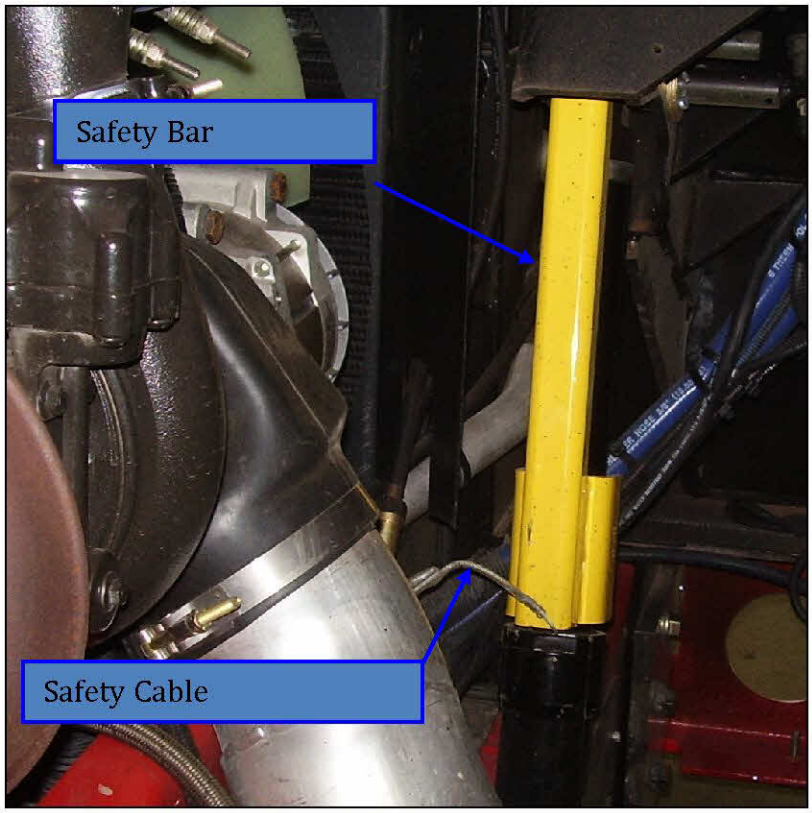


Figure 25 Cab Tilt Safety Bar and Cable

-To lower the cab: turn the batteries on and replace the controller, pull the safety release cable and depress the "down" button on the hand controller.
-Hold the safety release cable for five seconds and release.
-Depress the "down" button and hold until cab comes to a stop.
-Continue to hold the "down" button until the red light on the controller begins to blink, you will hear the locks engage, visually confirm that the locks engaged.
-The cab is now secure and you may disconnect the controller.

Cab Lift/Lower Emergency Override Procedures

-If the electric cab lift fails to raise the cab this is the emergency manual pump.
-To operate the cab lift insert jack handle and pump.

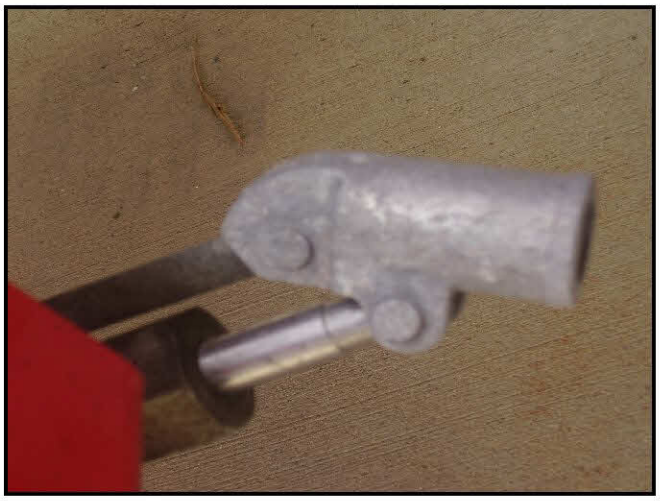


Figure 26 Cab Tilt Manual Pump

-This is located behind the drivers side batteries
-Lift cab until the safety engages on the right lift cylinder.
-When manually lowering the cab the operator must loosen this screw to allow the fluid to return to the reservoir.
-This valve is located under the body of the manual cab raise location

Figure 27 Cab Tilt Manual Hydraulic Valve

Alternator

-Charges the batteries and powers the electrical systems when the engine is running.
-320 amps
-Belt driven
-Located on the officers side of the engine

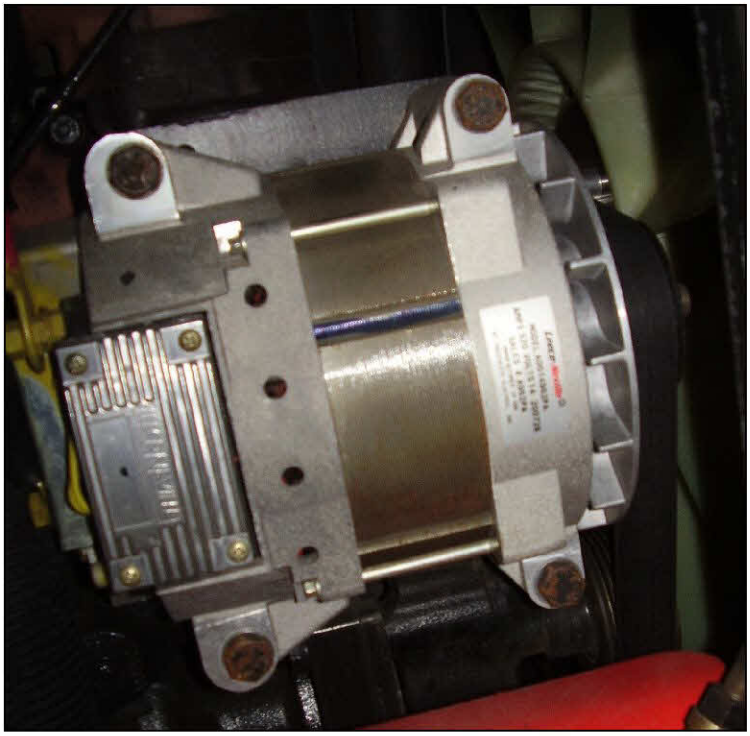


Figure 28 Alternator

Batteries

-12V jumper studs are located in the drivers step well.
-Jumper studs order of operation:
    Live red to dead red
    Dead black to a grounding point

Roll Stability

-The roll stability control is an ABS based system designed to help prevent rollover.
-The roll stability control is automatic.
-This function is controlled through the ECU.
-In a roll stability event up to three actions can occur:
Decrease in engine power
Retarder Activation
Brakes being applied

RollTek

-Designed to deploy air bags, lower air suspension seats and tighten seat belts, in a rollover situation.

Four stages of the RollTek system:

1. Sensing - As the vehicle begins to roll, the roll sensor activates the RollTek protection devices.

2. Pretensioning - The pretensioning system automatically tightens the seat belt around the occupant, preventing movement and positioning the occupant securely in the seat.

3. Positioning - The S4 seat pull-down system pulls the suspension seat to its lowest position and holds the seat in place, increasing the occupant survivable space and minimizing head contact with the interior roof.

4. Deployment - The side airbag deploys across the window, protecting the head and neck during impact.

Vogel Lube System

-The Vogel Lube system is an automatic lubrication system.
-The Vogel Lube reservoir is located behind the left battery box on the frame rail.
-At a predetermined interval it will lubricate components on the truck.
-Make sure that there is fluid above the minimum line in the reservoir

Figure 29 Vogel Lube Reservoir

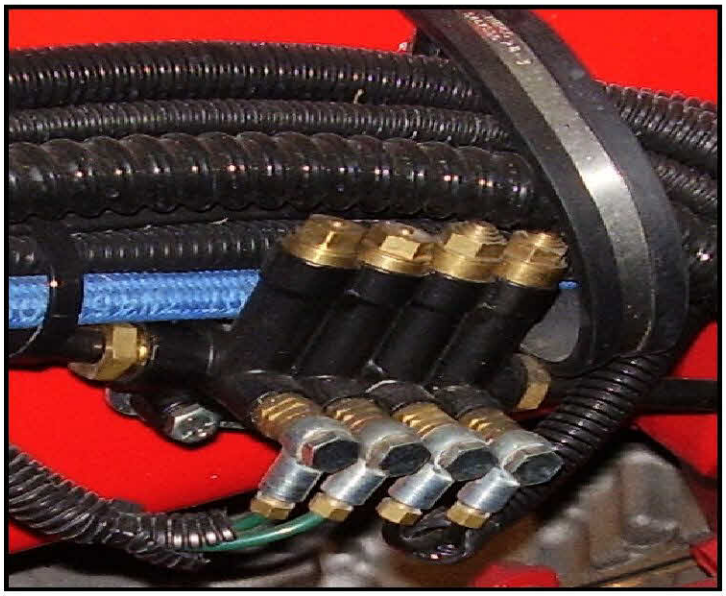


Figure 30 Vogel Lube Distribution Points

-The Vogel lube leaves the reservoir and enters distribution ports.
-The fluid then leaves the ports and is applied to the specified part.
-Check for leaks at these ports and on the hoses leading to the vehicle.

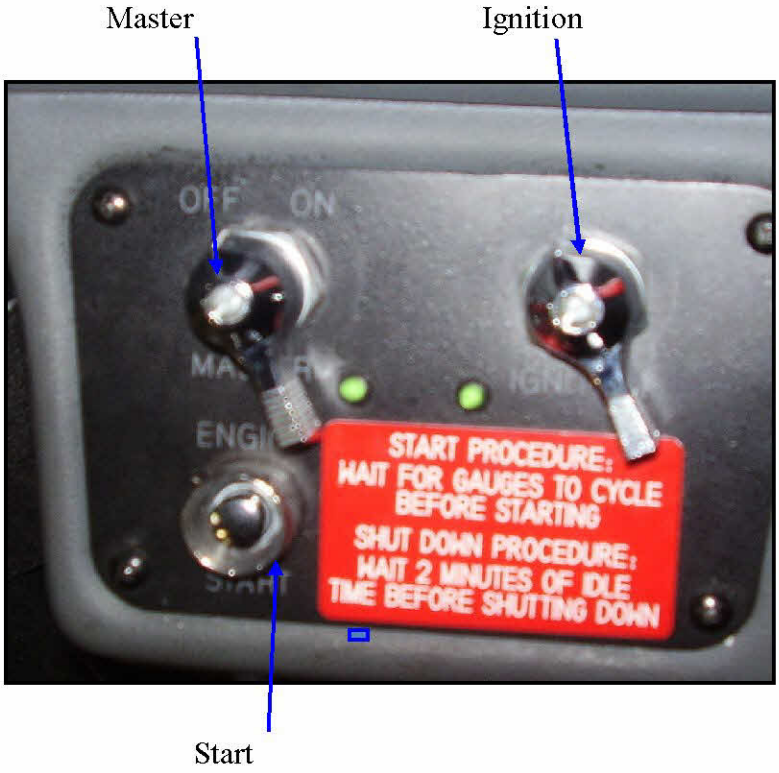
Starting / Shutting Down Procedures

-First turn the battery switch to the "on" position.

-Turn the ignition switch to the "on" position.

-Wait 5 seconds before depressing the start button.

-Before engine shutdown let the engine idle for at least 1 minute. Yes the plaque says 2 minutes. Per CMF 1 minute is acceptable. This procedure is extremely important in prolonging the life of the Turbo. When the vehicle is driving down the road the Turbo is spinning at 30,000 to 50,000 RPM. If we then stop and turn the engine off immediately the Turbo will continue to spin at approximately ¼ the running RPM with no lubrication. This is because the Turbo is cooled by engine oil and when we turn the engine off oil is no longer pumped to the Turbo.



DEF

-Diesel Exhaust Fluid

-It is a mixture of deionized water and urea

-Injected into the exhaust stream via a metering system at a rate of 2 to 6% of the diesel fuel consumption via a metering system.

-Reduces the nitrogen oxides in the exhaust

-Per CMF do not continuously top off the DEF. Allow it to run down below half a tank before refilling. If the DEF sits in the reservoir too long it will crystalize. Keep extra DEF in the pump operators compartment.

MFRI Pump Operators Book 1 and 2
(review)

-Liquids are practically incompressible.

-1 cu' of water weighs 62.5 LBS

-1 cu' of water contains 7.5gallons.

-The head pressure created by water 1' deep is .434 LBS.

-Flow = Amount

-Pressure = Force

-Static pressure = no water flowing

-Residual pressure = measured at the point of discharge with water flowing

-Bourdon tube = the tube inside the gauge that measures pressure

-Pressure gauge = measures positive pressure only, one Bourdon tube

-Compound gauge = measures pressure and vacuum, two Bourdon tubes

-Pressure is generated when water is forced into a confined area faster than it can be relieved. So when you put an additional line in service, more water is flowing and you can expect the pressure to drop.

-3 ways to generate pressure:
- Natural = gravity, 1 psi is generated for every 2.3' of fall
- Chemical = substances combine and react creating pressure
- Mechanical = created by a pump, Positive Displacement or Centrifugal

-Primer pump = reduces the atmospheric pressure inside the pump

-Atmospheric pressure at sea level is 14.7 PSI

-Cavitation = discharging water from the pump faster than it is coming in, indicated by: hose stream pressure fluctuations, pump sounds like it has gravel in it, intake hose bouncing, increased RPM does not equal an increase in discharge pressure. To stop the pump from cavitation you must: reduce flow, increase intake or both.

-Churning = This occurs when water is not moving through the pump. When water is moving through the pump it cools the pump. There is Pump Coolers on the Crimsons that move about 5 GPM of water (each) from the discharge side of the pump back into the tank. This is not enough movement to cool the fire pump. If water is not flowing through discharges you must get water flowing i.e. crack your Tank Fill. If churning continues and the water inside the pump heats up to 120 degrees F the TRV (Thermal Relief Valve) will activate. This is a wax that melts and allows water to flow from the discharge side of the pump on to the ground. The TRV will not provide sufficient cooling, this is merely a reminder to get water flowing. As the pump temperatures decreases the wax will harden and water will no longer flow through the TRV. Don't let it come to this, ensure water is constantly flowing from the beginning

-2 kinds of pumps = Positive Displacement and Centrifugal

Positive Displacement- a cretin amount of water is delivered with each revolution or stroke, cannot take advantage of incoming pressure, are self-priming

2 kinds of Positive Displacement pumps:

Piston = moves back and forth inside a cylinder

Rotary = 2 types: gear and Vein, self priming

Gear = 2 gears that rotate in a tight clearance, The 5 GPM EZFill pump is Rotary Gear

Vein = Self adjusting to maintain a tight clearance, The Primer Pump is Rotary Vein

Centrifugal- Can take advantage of incoming pressure, not self priming, the fire pump is a Centrifugal Pump, non positive displacement pump because it does not pump a definite amount of water with each revolution, water enters the pump through the eye

-Centrifugal pumps produce their highest flow capacity at 150 PSI. Any pressure above or below 150 PSI will reduce the pumping capabilities of the pump.

150 PSI = max capacity (GPM)
200 PSI = 70% capacity
250 PSI = 50% capacity

3 factors that determine the operating pressure of centrifugal pumps (Ceteris paribus- with all other factors being held constant.)

1. Speed- As the speed of the impeller increases the discharge pressure will increase.

2. Intake- Since Centrifugal Pumps can take advantage of incoming pressure, as intake pressure increases so does discharge pressure. This is seen when you switch from tank water to hydrant water. As you open the MIV you need to throttle down to maintain the same discharge pressure because you are now taking advantage if intake pressure.

3. Flow- As the amount of discharge flow increases the discharge pressure will decrease. So as more lines are put in service you need to throttle up to maintain the same discharge pressure.

<u>Flow of Dual Lines</u>

3" = 30%
4" = 70%

2.5" = 40%
3" = 60%

<u>Hose Capacity</u>

3" = 33 gal per 100'
4" = 66 gal per 100'

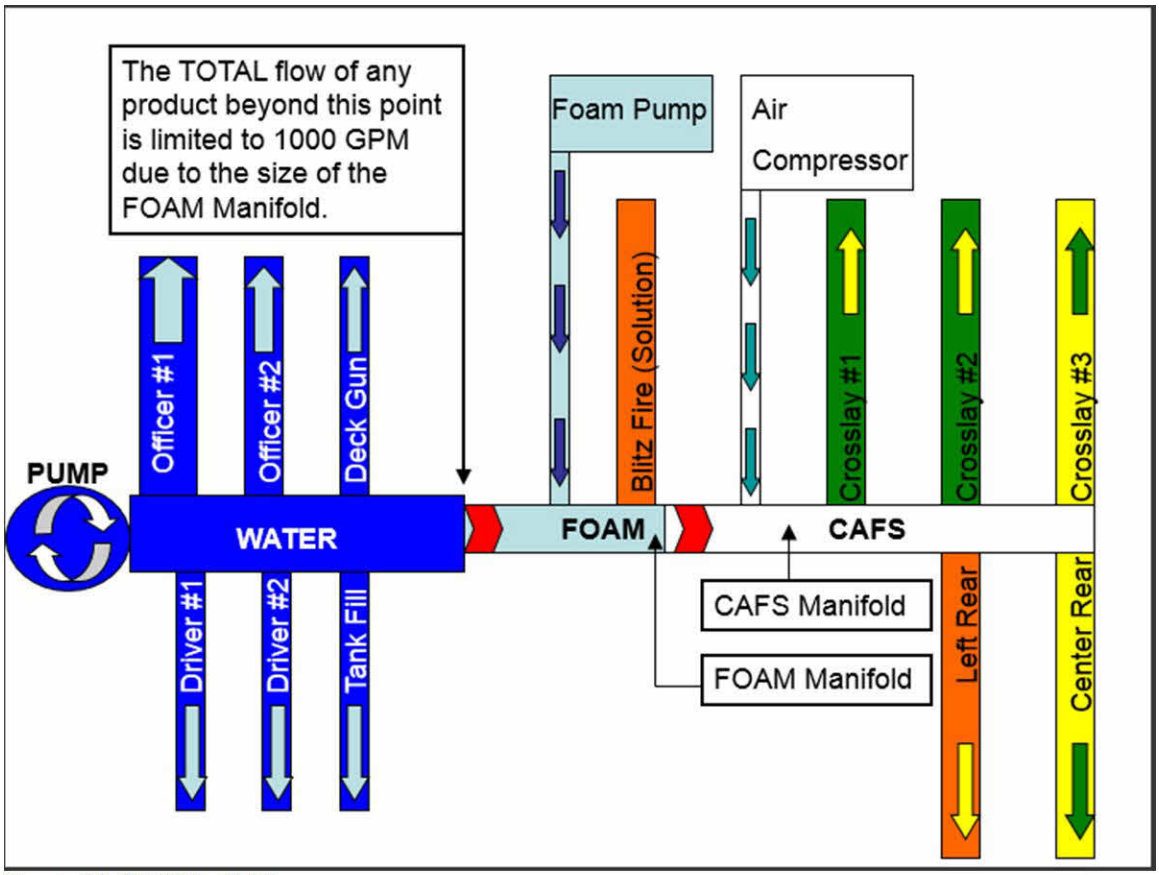


Figure 31 CAFS Manifold

Crimson Lines and Discharges

1 and # 2 Crosslay

-200' of 1 ¾"
-CAFS, solution, or plain water
-Metro 1 nozzle (fog or 7/8" slug)

3 Crosslay

-250' of 2"
-CAFS, solution, or plain water
-Metro 2 nozzle (fog or 1 1/8" slug)

Right Rear Preconnect

-250' of 2.5"
-CAFS, solution, plain water
-1 ¼" or 1 ½" slug

Center Rear Preconnect

-300' of 2"
-CAFS, solution, plain water
-Metro 2 nozzle (fog or 1 1/8" slug)

Left Rear Preconnect

-250' of 2'
-solution, plain water
-Blitzfire

-If flowing the Blitzfire preconnected line you have just used up half the GPM capabilities of your preconnected lines. Since you will be flowing this line at 225 PSI you also have greatly reduced the GPM capabilities of your fire pump (max GPM capability is at 150 PSI.)

-IF flowing the Blitz line at 225 PSI and a 1 ¾ preconect at the same time a surge of at least 80 PSI is possible is possible to the 1 ¾" line before the TPM can reduce the pressure.

-If possible, a better alternative would be to supply the Blitz nozzle with 3" hose to reduce the FL. Furthermore, the pump pressure will be reduced if only a 150' or 200' section of 3" is necessary as apposed to the 250' preconnected line. If it is not necessary to flow foam solution and you have enough time to set up the 3" line hook it up to the Officers #1 or 2 discharge. In this setup you will still have the full 1,000 GPM capability of the preconnected lines and your fire pump will be able to deliver more total GPM.

*** All pre-connected hand lines are plumbed off the foam manifold or downstream from the foam manifold. The foam manifold has a 1,000GPM capacity. Therefore you are limited to a combined total flow of 1,000 GPM at any one time through your pre-connected hand lines. The deck gun, pump panel discharges, and high flow discharges are not plumbed off this manifold.

Discharges

Officers #1 Discharge

-Rated at 1,500 GPM
-Plain water only
-Valve meets NFPA slow close requirements
-Manual hand wheel override
-Discharge pressure is affected by Outboard Relief Valve and TPM

Officers #2 Discharge

-Rated at 2,400 GPM
-Plain water only
-Valve meets NFPA slow close requirements
-Manual hand wheel override
-Discharge pressure is affected by Outboard Relief Valve and TPM

Deck Gun tip sizes and GPM (per Rule of 8's):

-This formula uses the diameter of the tip size in eighths of an inch plus a factor of 2 to roughly calculate the gallons per minute flow from smooth bore nozzle.

- 1 3/8" – 500GPM
- 1 ½" - 600 GPM
- 1 ¾" - 800 GPM
- 2" – 1,000 GPM

-The Deck Gun can flow plain water only.

Friction Loss (there are 3 methods of determining friction loss, know all 3 for testing)

Q Formula:

EP = NP + FL + D + (-) EL

Engine Pressure = Nozzle Pressure + Friction Loss + Device +(-) Elevation

ATTACK HOSE LINES	SUPPLY HOSE LINES
$2Q^2$ = 2 ½" Hose	Q^2 = 3" Hose
$6Q^2$ = 2" Hose	$Q^2 \div 3$ = 3 ½" Hose
$12Q^2$ = 1 ¾" Hose	$Q^2 \div 5$ = 4" Hose
$24Q^2$ = 1 ½" Hose	$Q^2 \div 15$ = 5" Hose

$1100Q^2$ = ¾" Booster Hose
$150Q^2$ = 1" Forestry Hose

MFRI Formula:

MFRI Friction Loss for Attack Lines is 30 psi friction loss per 100 foot Section

FCGO 10-03

Preconnect # & Nozzle	Hose Inches	Length Feet	Nozzle Pressure PSI	Flow Rate GPM	Engine Pressure PSI	Rounded EP PSI by 5's
1 & 2 Fog	1.75"	200	70	175	144	145
1 & 2 7/8" SB	1.75"	200	70	190	137	140
3 Fog	2"	250	50	250	144	145
3 1 1/8" SB	2"	250	50	266	156	155
5 Fog	2"	300	50	250	163	165
5 1 1/8" SB	2"	300	50	266	177	175

Nozzle Pressures

-Blitz = 100 PSI

-Smooth Bore Master Stream Nozzles = 80 PSI

-Smooth Bore Hand Held Nozzles = 50 PSI

-Low Pressure Fog Nozzles 50 PSI

Nozzle Orifice Sizes

- Metro 1 slug tip size = 7/8"

-Metro 2 slug tip size = 1 1/8"

Pump Pressure Calculations for Different Devices and Apparatus:

Standpipe: 150 PSI at Base and 5 PSI per Floor (above the 1st) unless otherwise specified on the connection. 200 PSI max.

Sprinkler: 150 PSI at base regardless of elevation.

Combination (Sprinkler/Standpipe): 150 PSI regardless of elevation.

Master Stream Devices: EP = NP + FL + Device(s) + (-) Elev.

Ladder Company Aerial Apparatus (hose in bed): EP = NP + FL + Device(s) + Elev.

Ladder Pipes: Pump per the specifications of the apparatus (ask the Truck driver).
EP = Base Pressure + FL (to base) + Device(s) + (-) Elev. (elev. to base)

Relay Pressure: 50 PSI for 3" Hose
20 PSI for LDH

Underground Metro Standpipe: Fill at hydrant pressure until your Master Intake and Discharge Gauge read the same pressure. Calculate EP to pump the system at once it is full based on: 150 PSI to connection minus head pressure (HP = 5 PSI per 10' of drop in the Standpipe system). Do not account for the lateral run. Then (if necessary) put in pump gear. You may not need to pump the system with your pump.

Estimating Hydrant Capacity Formula

$$\frac{\text{Static} - \text{Residual}}{\text{Static}}$$

10% drop = 1/3 used thus 2x water flowing is still available
25% drop = 1/2 used thus 1x water flowing is still available

PUMP

-Single-stage Hale QMax pump with double suction impeller
-Rated at 1,500 GPM (from draft using a single intake)
- Single stage pumps use a single impeller to produce water pressure. There are no Volume/Pressure (Series/Parallel) Transfer valves to manipulate. Single stage fire pumps usually take advantage of larger impellers than Two- Stage Pumps. The Hale QMax pumps on MCFRS fire engines use a single double-suction bronze impeller capable of pumping 2250 GPM with the use of multiple intakes.

Tank to Pump Valve

-Air actuated piston opens and closes the tank to pump
-Automatically opens when pump is placed in gear
- NFPA standards require that the pipe from the tank to pump can flow a minimum of 500 GPM.

Tank Fill

-Off the water manifold on the discharge side of the pump
-Will not put foam into the tank
-A great way to circulate water in freezing conditions (as long as no MIVs are open). Also a great way to circulate water in non-freezing conditions regardless of MIVs as long as water is not an issue.

MIV

-Officers, Drivers (preferred for drafting), Rear (preferred for CAFS use)
-6" intake
-Electric override knob

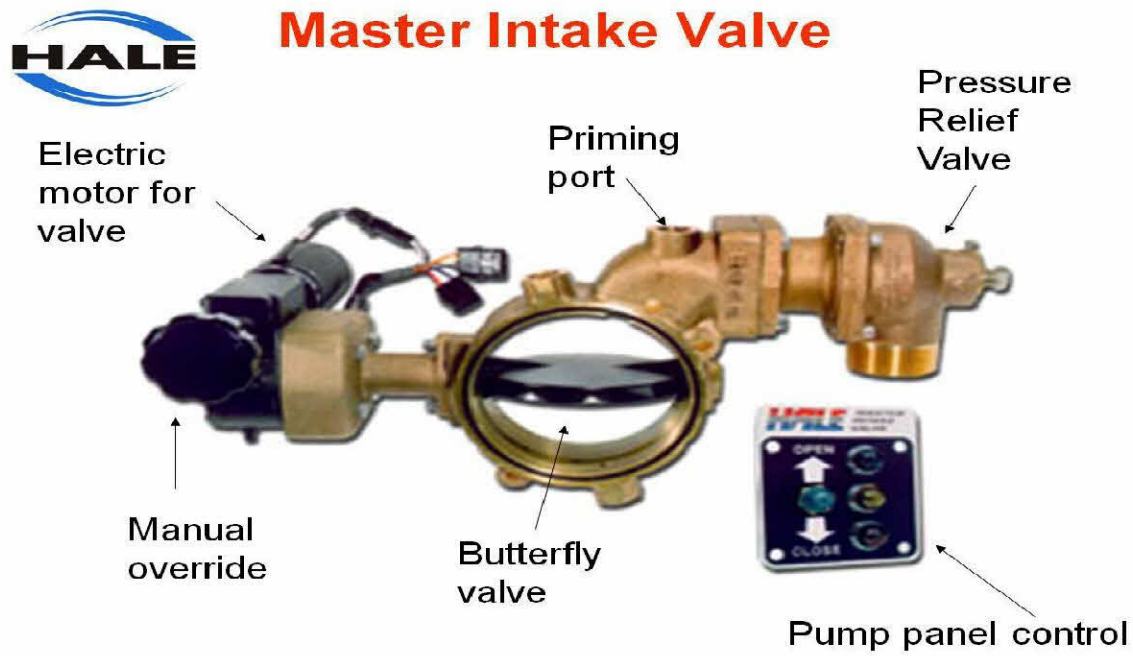


Figure 32 Master Intake Valve

Relief Valves

-There are 4 kinds of Relief Valves on the Crimsons:

Thermal Relief valve
Outboard Relief Valve
TPM
Intake Relief Valve

- Relief valves operate by flowing water to reduce pressure or temperature. This can be internally (back into the tank) or externally (onto the ground.) For the External Relief valve to activate there must be positive intake pressure.

Thermal relief valve

-activates at 120 degrees F

-wax that melts and allows water to flow out of the discharge side of the pump onto the ground for cooling

- when activated other measures need to be taken to cool the pump.

Outboard Relief Valves

-On the Officers #1 and #2 Discharges
-Should be set between 210 and 230 PSI
-If set below 210 PSI notify CMF
-Discharges water on the ground only.
-Exercise these valves when back flushing the pump

Intake Relief Valve

-One on each MIV
-Set at 150 PSI
-Dumps water on the ground only

TPM

-Monitors and responds to pressure variations on both the suction (inlet) and discharge sides of the pump.

-The PAGS will use the terms "open" and "set" the TPM. These terms are defined and in bold below.

-Because it responds to pressure variances on the suction side of the pump it eliminates the need for a dump line in a relay.

- Steps for operation:

- From doing normal daily checkouts the operator should know the accuracy of the white slide indicator.

- Once the pump is confirmed in gear, **open** (clockwise) the TPM to a pressure well above the intended intake or discharge pressure.

- Once line is flowing at the desired discharge pressure, begin slowly closing (counterclockwise) the TPM until the amber light comes on. At this point there will also be a drop in the discharge pressure. There is a delay between when the hand wheel is turned down and the valve activating. When the amber light is solid the Internal Relief Valve has been activated. Flashing amber light indicates the activation of the External Relief Valve. The Internal Relief Valve will activate initially, it will flow water back into the tank to relieve pressure. The Internal Relief Valve can handle up to 400 GPM. If this is not sufficient to reduce the pressure the External Relief Valve will then activate (there must be a positive intake pressure for the External Relief Valve to activate.) The External Relief Valve can flow up to 1,500 GPM to relieve excess pressure.

- Once the amber light comes on slowly open the TPM until the amber light goes off. Then turn the hand wheel ½ turn clockwise. This "**set** pressure" will now be slightly above the operating pressure. The TPM is now **set**.

- If placing another line in service the TPM must be adjusted as appropriate.

-The TPM needs to be **set** per and slightly above the Master Discharge Gauge not the individual discharge gauges.

-The TPM relieves pressure by flowing more water than is currently flowing. This is done through the Internal and External Relief Valves. When the pressure on The Master Discharge Gauge exceeds the "**set** pressure" of the TPM the Internal Relief Valve opens to flow water thus reducing pressure. An open Internal Relief valve is indicated by a solid amber light. The Internal Relief Valve flows water back in the tank and can handle up to 400 GPM. If flowing 400 GPM through the Internal Relief Valve is not sufficient to reduce the Master Discharge Gauge pressure to the "**set** pressure" of the TPM the External relief Valve will then open to flow additional water to relieve pressure. *Note: The External Relief Valve will only activate if there is a positive pressure water source.* An open External Relief Valve is indicated by a flashing amber light and water dumping on the ground. The External Relief Valve can flow up to 1,500 GPM. The External Relief Valve's discharge pipe is on the officer's side, just behind the #2 Officers High Flow Discharge Outboard Relief Valve discharge pipe.

TPM hand wheel

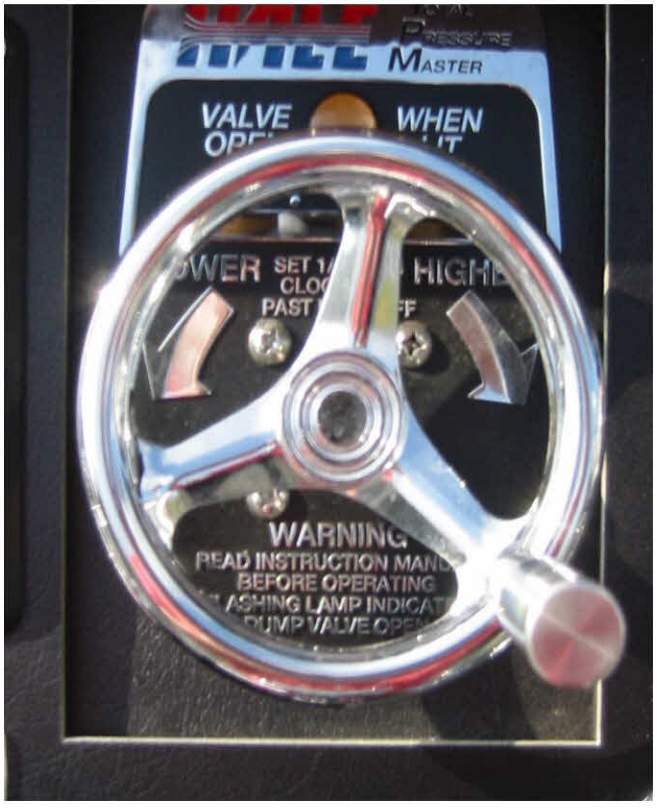


Figure 33 TPM Wheel

Primer pump

-No oil, it is an ESP primer
-12V rotary vein pump
-Don't bump test it like the old ones, run it for about 20 seconds with water discharging on the ground to clean the carbon out of the pump that is created from the veins.
-Don't run for longer than 45 seconds at a time
-Lowers the atmospheric pressure in the pump
-Max theoretical lift is 33.9'
-Max practical lift is 22'
-Up to 6 sections of hard sleeves can be attached with little effect on capabilities (horizontal not vertical.)
-See PAGS for step-by-step procedures for priming

Figure 34 Primer Pump

The primer pump is located on the officers side near the generator exhaust outlet.

4-Way Priming Valve □

-This valve enables you to prime the main pump, or just outboard of the individual MIVs. An operator can be flowing tank water while setting up for drafting, and then achieve□prime in hard sleeves without interrupting operations. The 4-Way□Valve can be used to establish a draft out of one intake, and then prime □another individual MIV if wishing to achieve high flows.

-This valve can prime each of the intakes independently or just the pump.

-The Drivers MIV, Officers MIV, and Rear MIV are plumbed to MIV□priming ports which are outboard of the MIV butterfly valve. --

This valve allows you to achieve a prime all the way to the MIV. Remember to pull the primer as you open the MIV to avoid an air bubble.

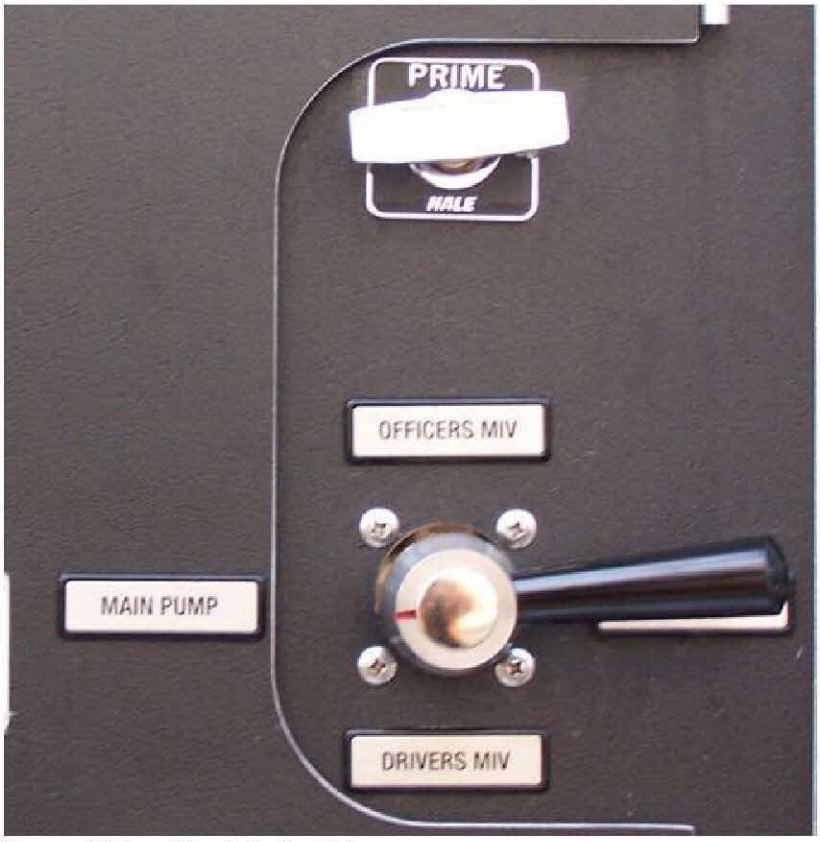


Figure 35 Four Way Priming Valve

CAFS

CAFS is a combination of water, Class A foam concentrate, air and agitation. Montgomery County is not currently using CAFS for offensive interior fire attacks. Below is a picture of the process of making CAFS. See PAGS for proper steps to put CAFS lines in service.

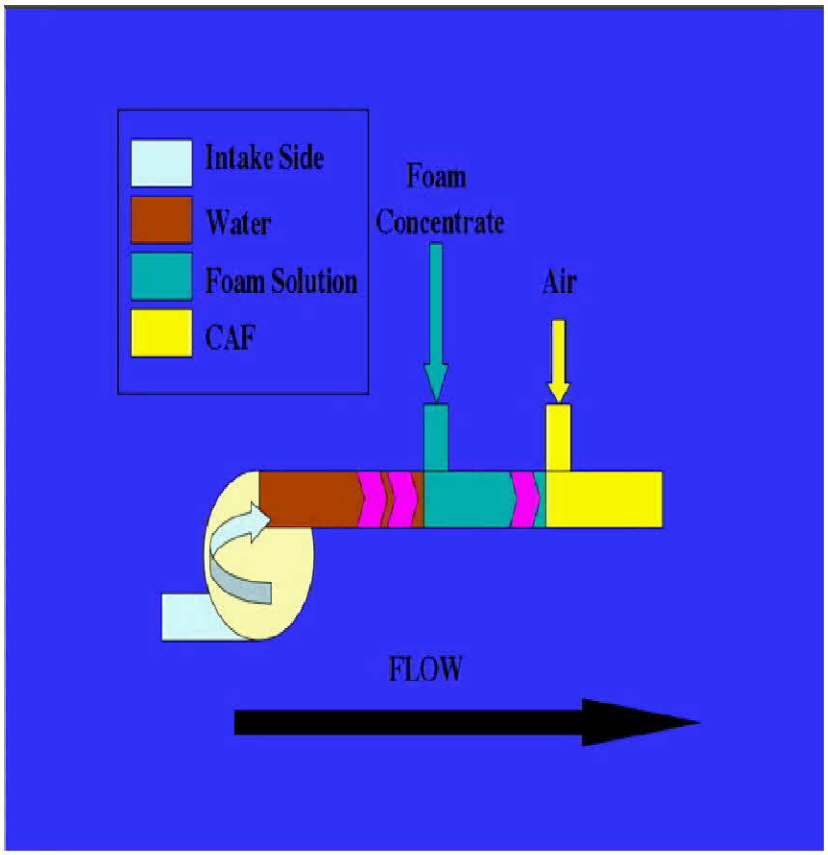


Figure 36 Creating CAFS

Water leaves the discharge side of the pump and enters the water manifold (Officers Side high Flow Discharges, 2.5" pump panel discharges, deck gun, pump cooler are all plumbed off the water manifold.) From there the water enters the Foam Manifold (all preconnected lines are plumbed off this manifold with a 1,000 GPM capacity) where foam concentrate is added to make foam solution. If CAFS is requested, air then agitation is introduced to produce CAFS.

CAFS Manifold is equipped with a gate valve which regulates water flow. If a "Dryer" foam is selected than the valve partially closes. This allows less water into the manifold but allows more air into the stream.

This valve is controlled by the CAFS Controller. When switching from "Wet" to "Fluid" Foam, or "Fluid" to "Dry" Foam, you must hold the up arrow down for three beeps before the controller will allow this action (the CAFS and Foam Logix controllers will be discussed later.) This delay is to make sure that the operator really wishes to perform this action.

For normal operations the .3 default foam setting is appropriate. Remember to change from "Wet" to "Fluid" to "Dry" CAFS adjust the air ratio not the foam ratio.

CAFS Manifold Settings

3 Gated Settings - adjusted by using wet / dry arrows (must hold down for three beeps.)

-Full Flow (Wet) = .5 SCFM / 1 GPM (default)
1.0 SCFM / 1 GPM
1.5 SCFM / 1 GPM

-Medium Flow (Fluid) = 2.0 SCFM / 1 GPM
2.5 SCFM / 1 GPM
3.0 SCFM / 1 GPM

-Reduced Flow (Dry) = 11.0 SCFM / 1 GPM

Max. Water Capacity Per Specific Setting

-1000 GPM (wet)

-400 GPM (fluid)

-40 GPM (dry)

CFMs Per Line

Our CAFS Compressor max is 210 CFM.

1-3/4" Pre–120 GPM – 120 GPM – 60 CFM

2-1/2" Wet – 240 GPM – 120 CFM

3" Portable Master Stream – Wet – 340 GPM – 170 CFM

Maximum Line Combinations

Wet: Combination of up to three 1 3/4" or three 2" hand lines
OR
One 1 3/4" or 2" hand line AND one 2 1/2"

Dry: One 1 3/4" hand line
OR
One 2 1/2" hand line

*You can only have one of these combinations at a time.

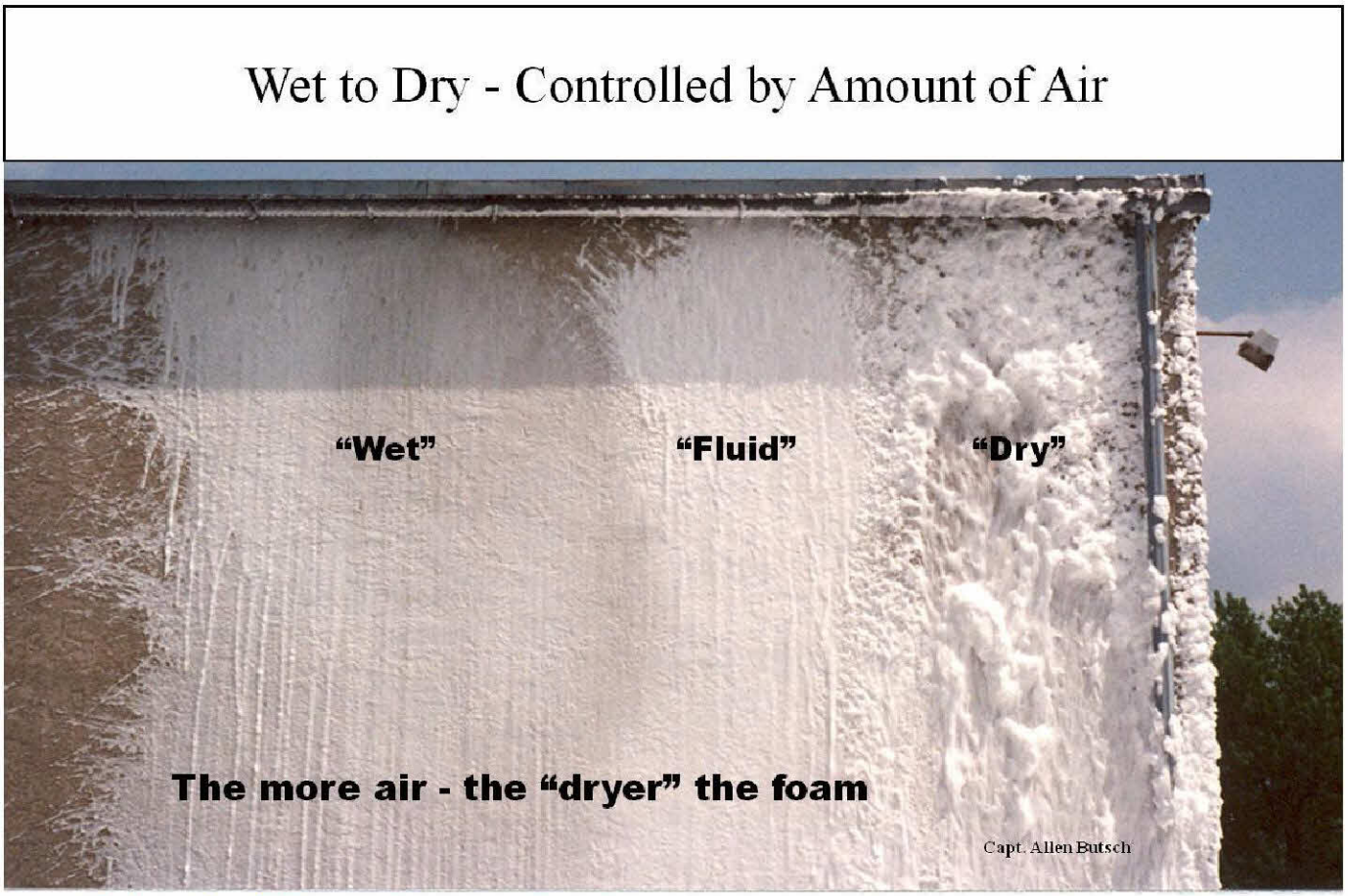


Figure 37 Wet and Dry CAFS

Controllers

In the below picture the FoamLogix is on the left and the CAFSPro controller is on Right. Both are laid out in a similar fashion.

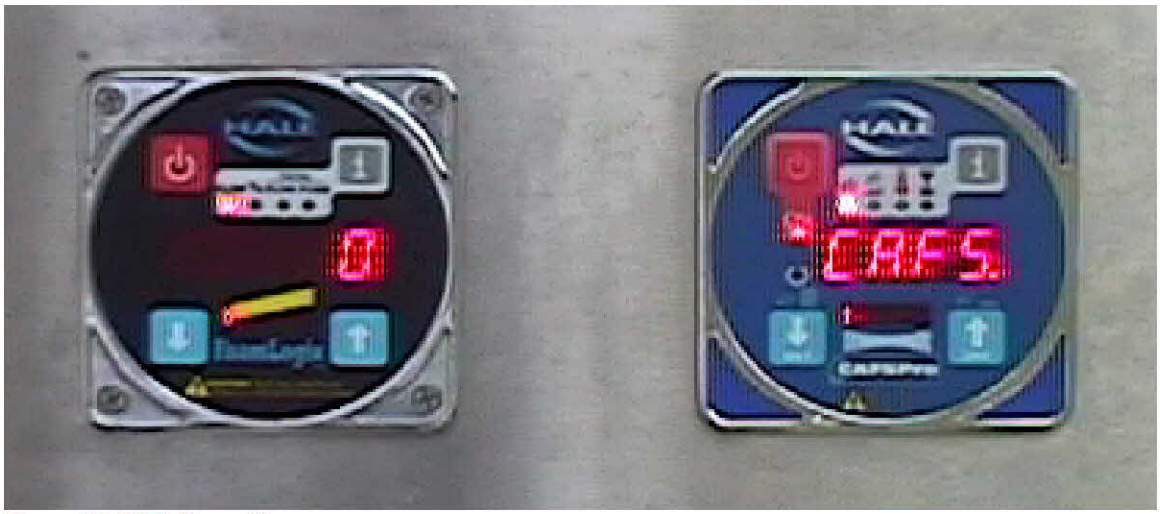


Figure 38 CAFS Controllers

FoamLogix Controller

- On/Off Button = Turns the foam pump on or off.
- "i" Button = Lets you change between the information settings.

  -"Flow" is how much water, foam solution or CAFS that is currently flowing

  -"%" is the current % foam injection rate

  -"Total Flow" is the total water flowed for the current session. The session is reset when the fire pump is taken out of gear or the up and down arrows are held simultaneously.

  -"Total Foam" is the total Class A foam concentrate flowed for the current session. The session is reset when the fire pump is taken out of gear or the up and down arrows are held simultaneously.

- Up and Down Arrows = Allows you to adjust the foam % injection rate.
- LED Bar Graph:

  -No LEDs lit = Foam Pump is off

-One LED lit = Foam Pump is on

-From there the amount of LEDs lit is the capacity of the Foam Pump that is currently being used. All LEDs lid means that the Foam Pump is operating at max capacity.

CAFSPro Controller

- On / Off Button = Places CAFS Air Compressor in On, Off or Stand By mode.

-Standby mode:
Compressor is engaged and running
Then the user taps Power Button once to place in Standby Mode
Air Injection Valve then closes & Controller indicates "*Stby*"
Compressor is still turning
Instant-On if it should be needed

-To turn CAFS Air Compressor completely Off:
Reduce engine speed to idle!
Push on/off button and hold
3 Beeps, & Display shows "*3,2,1, OFF*"
Compressor is now not turning
User Off Mode
After turning air compressor off, pump would need to be throttled back up to move sufficient water
Pump needs to be taken out of gear and re-engaged to bring air back on

-When to turn the CAFS Air Compressor completely Off:
-You need to pump plain water or foam solution above 150 psi
-You run out of foam
-You are going to be only using water and want to avoid adding hours to the CAFS Air Compressor (i.e. Sprinkler, Standpipe, Relay Operation, or "Big Water" situations)
-Failure of foam system and safety interlocks occurs - slug flow or chatter

Slug flow - Air and water do not mix with foam. You get pockets of air and water which causes severe pressure fluctuations.

Chatter - Caused by inadequate foam. Less violent than slug flow. Causes less severe pressure fluctuations.

- "i" Button = Lets you change between the information settings.

    -Current air flow (CFM)

    -Current air / water ratio

    -Current CAFS Air Compressor temperature

- Total CAFS Air Compressor run hours

- Up and Down Arrows = Allows you to adjust the air % injection rate.

CAFS Friction Loss

Many of the same principles for pumping traditional water pumps apply to pumping Compressed Air Foam Systems (CAFS), with a few exceptions. Friction loss still occurs with CAFS, but behaves a little bit differently. Pump operators must still account for appliances and pressure loss/gain for elevation. The primary difference between straight water friction loss and CAFS friction loss is the non-linear relationship between friction loss per length of hose when using CAFS. For example a 200-foot 1 3/4" attack line would develop 60 psi of friction loss, a 300-foot line develops 90 psi, and so on. This describes a predictable and linear relationship between hose deployment and friction loss. A CAFS attack line produces 45 psi for the first 100 feet of attack line, then proportionally less for every additional foot of deployed hose. Basically, CAFS has more "up-front" friction loss, but less overall.

As a general rule: 120 GPM for 1.75" line for 100' to 400' at a pressure range from 120 to 140 psi; 160 GPM for 2" line for the same range.

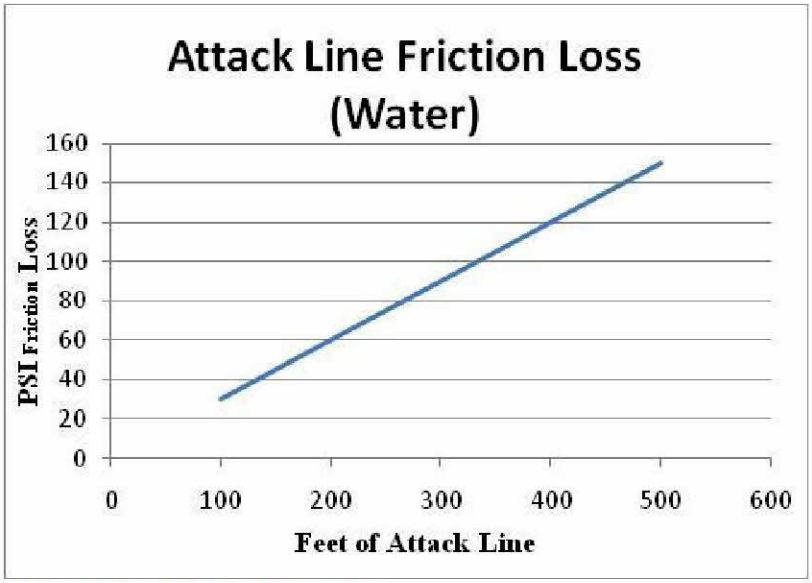


Figure 39 Friction Loss Plain Water

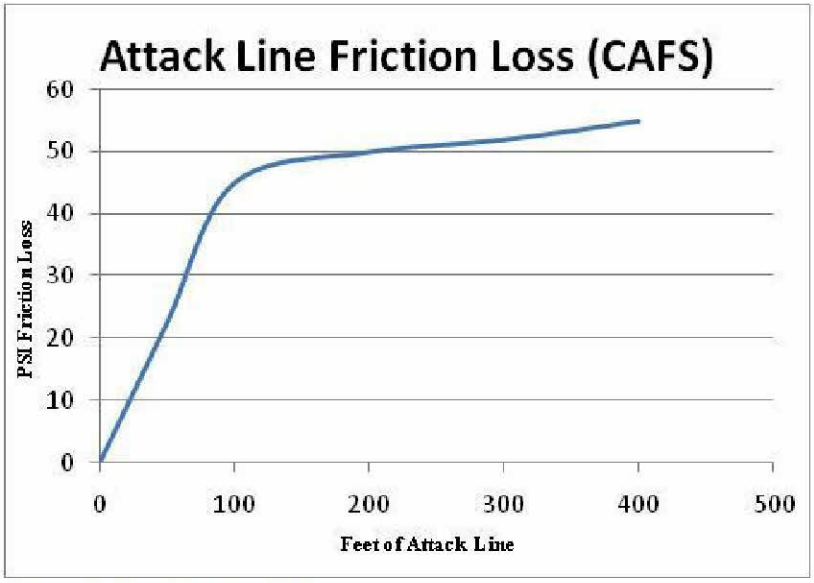


Figure 40 Friction Loss CAFS

Pump Pressure Chart For MCFRS Crimson Engines

	Hose	Hose				
Note	Diameter	Length	EP	Flow	EP	Flow
	1.75	200	120	120	140	140
	1.75	350	120	120	140	140
	1.75	400	120	110	140	130
	2	300	120	160	140	180
1.0 tip	2.5	250	120	170	140	195
1.125 tip	2.5	250	120	205	140	230
1.25 tip	2.5	250	120	245	140	270
Leader	2.5	250				
Line	1.75	200	120	120	140	135

Expected flows for CAFS Handlines, taken using TFT Metro 1 Fog nozzle. (unless otherwise noted.) Flows from 7/8 slug tip can be expected to be slightly higher.

CAFS Hardware

Class A Foam Pump

-Rotary gear
-5 GPM capacity
-There is a paddle wheel sensor that senses the current flow. This lets the foam pump know how much foam concentrate to introduce to produce the requested ratio.
-Can't inject foam at discharge pressures above 250 PSI
-This pump can be found when you tilt the cab and remove the 2 diamond plate panels.

Figure 41 Class A Foam Pump

Class A Foam Filter

-Has a shutoff valve upstream of the filter and a drain downstream
-Keep open for normal operation
-Filters the Class A foam between the tank and pump
-The picture below shows the valve in the open position
-Can be found behind the officers side access panel

Figure 42 Class A Foam Filter

CAFS Air Compressor

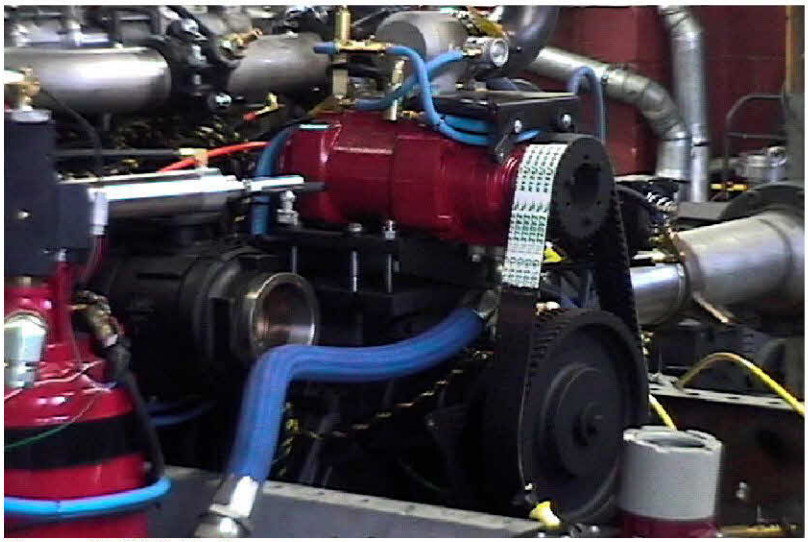


Figure 43 CAFS Air Compressor

-Rotary screw
-Belt driven
-210 CFM max
-Delivers 75 to 150 PSI
-Oil cooled
-The limiting factor for CAFS operations
-For the air compressor to produce adequate CFM and PSI to produce CAFS 1,000 RPM is required. This is why using the Auto Fill is recommended. When the water goes through the AutoFill it is dumped into the tank. Thus loosing the hydrant pressure. Now you must throttle up to create sufficient PSI which in turn creates sufficient RPM.

Cooling the CAFS Air Compressor

We just said that the air compressor is oil cooled. Here is how it works.

The CAFS Air / Oil Separator is in the picture below. This is what you can see looking through the slit on the pump panel. The purpose of the Air / Oil Separator is to reduce the amount of stray CAFS Oil that might be accidentally injected into the compressed air.

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The oil cools the CAFS Air Compressor. In doing so the oil absorbs the heat built up by the CAFS Air Compressor.

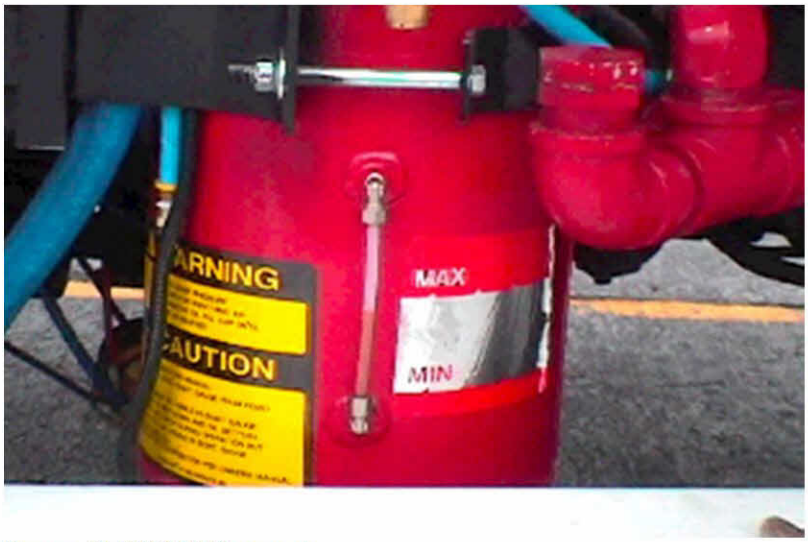

Figure 44 CAFS Oil Reservoir

So now we need to cool the CAFS Oil so it can continue to cool the CAFS Air Compressor.

The heated oil is now sent to the Oil / Water Heat Exchanger (pictured below and located just in front of the priming pump on the officers side) for cooling. The Oil / Water Heat Exchanger uses tank water from the discharge side of the pump for cooling. This is another reason to circulate the water in the pump because if the water in the pump is hot it can't cool the CAFS Oil.

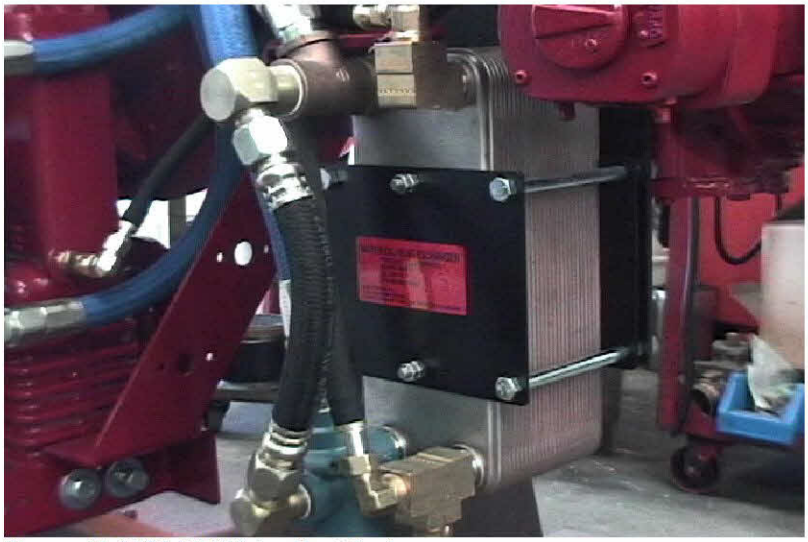

Figure 45 CAFS Oil/Water Heat Exchanger

Pictured below is the cap to the strainer. The strainer strains the tank water before it enters the Oil To Water Heat Exchanger.

Figure 46 Water Strainer

Important considerations for this cooling system:

-Do not open the Strainer cap when it is under pressure.
-Constant heating and cooling of the CAFS Oil creates moisture that settles at the bottom of the CAFS Oil tank. That is why you must periodically drain water from the CAFS Oil tank
-The strainer must be kept free of debris so adequate tank water can pass through
-Keep tank water circulating so the tank water is cool and able to absorb the heat from the CAFS Oil
-When the CAFS Air Compressor can't be cooled an alarm is sounds at 205 F. If actions are not taken to cool the compressor and it continues to build heat it will disengage itself at 220 F.

Figure 47 CAFS Air Compressor Temperature

Auto Fill

Figure 48 AutoFill Valve

- In the "Auto" mode the Auto-fill valve opens when the booster tank level falls below 3/4, and closes when the tank reaches 7/8, if there is at least 10 PSI of positive intake pressure coming in through the rear MIV.
- When a supply line is connected to the rear intake and the Autofill valve is in the "Auto" position the blue light will illuminate meaning there is at least 10 PSI at the intake
- Max capacity is 1,000 GPM
- For CAFS operation use the Auto Fill in the "Auto" position
- After your morning check out it is strongly recommended that that the Auto Fill be placed in the "Auto" position
- When flowing plain water or Foam Solution do not use the Auto Fill. It is ok to use it for initial set up set up however, it is not intended for prolonged water or Foam Solution operations. The preferred method is to open an MIV. This will increase available water and reduce engine RPMs.

Rear Piping of Crimson Engines

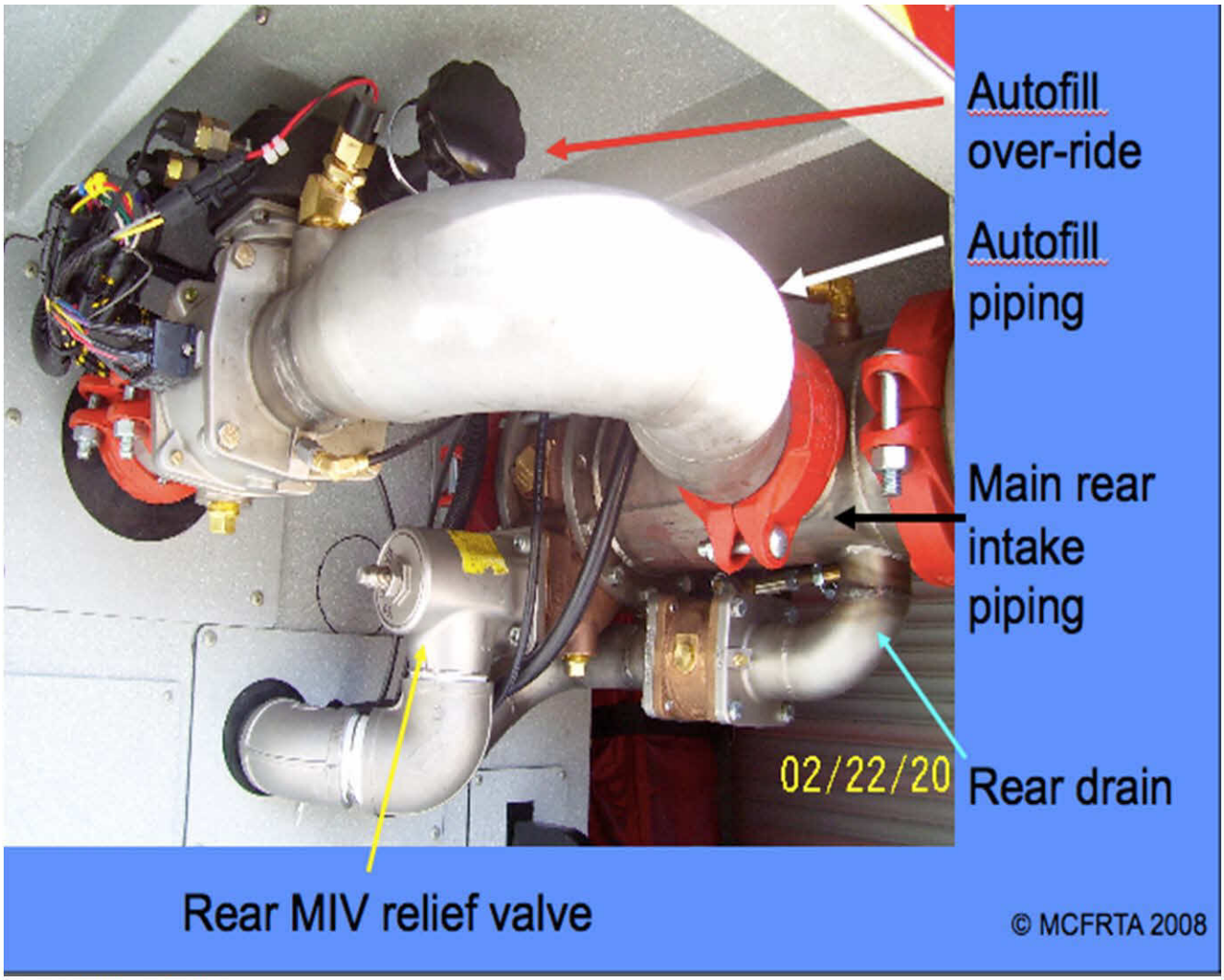

Figure 49 Rear Piping

EZ Fill

- 5 GPM rotary gear pump
- This is used for refilling the Class A foam Concentrate
- Pump will shut off every 60 seconds or when the cell is full.
- Hook fill tube to inlet and place in Foam Concentrate source

Figure 50 Class A Foam Fill

Tank TO Pump

- Air actuated open and close
- Automatically opens when pump is placed in gear
- Keep open when flowing CAFS
-Meets NFPA 500 GPM capacity requirements

Figure 51 Tank To Pump Controller

Foam Definitions

Surfactant –Wetting agents that lower the surface tension of a liquid, allowing

easier spreading and penetration.

Emulsifier – Emulsifiers will surround an oil (or other immiscible molecule) and form a protective layer so that the oil molecules cannot "clump" together. This action helps keeps the dispersed phase in small droplets and preserves the emulsion.

Foam Concentrate – Liquid purchased from the manufacturer with no additional water mixed in. MCFRS is using National Foam's Knockdown for Class A Foam.

Foam Solution – Foam Concentrate and Water.

Class A

-Want to mix with hydrocarbons
-"oleophilic" (oil-loving)
-"hydrophilic (water-loving)
-.3 is the default setting
-FoamLogix pump will allow a range between .1 and 1.0
-25 GPM concentrate tank
-Never mix class A and B foam concentrate
-See PAGS for proper steps to put a Class A foam solution line in service.

Class B

-"oleophobic" (oil-hating) this is why it forms a layer on top of the fuel
-We use AFFF-ATC (Aqueous Film Forming Foam- Alcohol Type Concentrate)
-1% Hydrocarbons (Oil)
3% Polar Solvents (Gasoline, Ethanol, Alcohol)
-The class B eductor is a 95 GPM eductor.
- To flow a class B foam line you must have 200 PSI at the eductor and the hand line can not exceed 200' in length.
-3 methods of application:
    Roll on
    Bank down
    Rain down
-25 GPM concentrate tank
-See PAGS for proper steps to put a Class B foam solution line in service.

Maintenance

Lubricate Hale Valves (monthly)

The following valves must be greased on a weekly basis: CAFS Air Valve, LDH # #1 and 2, Rear AutoFill and Tank to Pump Valves. When we first got the Crimsons we were told to open the valves and give 5 pumps of green grease. Green grease is still what we use however, we found that there is an issue with the number of pumps of grease that we put in. The lines that run from the Zerk fittings to the valves are thin plastic and we have found that forcing grease into the fittings can cause the plastic lines to rupture. It is now recommended that the valves are completely opened and grease is pumped in until resistance is felt or the grease starts ooze out around the Zirc fitting and the end of the gun.

Here is how to open, grease and exercise each valve.

CAFS Air Valve- With engine running place in Pump Gear. This will turn on the CAFS Air Compressor and partially open the CAFS Air Valve. To fully open the valve you must open the valve to 11 (.5 is the default) at this point grease is to be put in the Zirc fitting. To exercise the valve you need to cycle down to the .5 setting then to Standby. Repeat the opening and closing of the valve a few times to Exercise.

LDH #1 and 2- With the discharges capped open the 2 valves at the pump panel. Insert grease into the appropriate Zirc fittings . Then open and close each valve a few times to exercise.

AutoFill Valve- Place the AutoFill valve in the "Manuel" position. Manually Open the AutoFill and grease. Then manually open and close the valve. Return the AutoFill to the "Auto" position.

Tank to Pump- Open the air actuated valve, grease then open and close a Few times to exercise.

Figure 52 Zerk Grease Fill

Back flush (monthly or when necessary)

-See PAGS for proper back flushing procedures.

Exercise External Relief Valve (monthly)

-Place pump in gear
-Open TPM to approximately 150 PSI
-Obtain a positive external water supply through an open MIV
-Throttle up to 150 PSI
-Slowly back the TPM down until the amber light is flashing and water is discharging on the ground.
-Open the TPM until the valve closes
-Repeat several times

Exercise Outboard Relief Valves (monthly)

-Place pump in gear
-Open TPM to approximately 250 PSI
-Obtain a positive water supply through an open MIV
-Ensure the Officers #1 and#2 discharges are capped
-Open the Officers #1 discharge and slowly throttle up until water discharges on the ground.
-Note at what PSI water begins to discharge onto the ground.
-Continue to slowly throttle up. Note at what PSI the relief valve fully opens. You will see a difference in GPM discharged onto the ground with the Valve partially open and fully open. Throttle down until the valve fully Closes. Repeat several times to exercise. Close Officers #1 discharge Open Officers #1 Bleeder. Repeat this process with the Officers #2 Discharge. Note: There is a separate outboard relief valve for the Officers #1 and Officers #2 Discharges.

Exercise AutoFill Valve (monthly)

-Place pump in gear
-Open TPM to appropriate pressure
-Ensure Autofill is in the "Auto" position
-Obtain a positive water supply through rear intake
-Ensure blue light is on
-Ensure Tank to Pump is open
-Flow water through a discharge
-Ensure Auto fill valve opens and closes as appropriate
-Continue this process until Autofill valve has cycled several times
-Shutdown and ensure Engine is ready for service

Drain water from the CAFS Oil Tank (Air / Oil Separator) (monthly)

-Ensure CAFS Oil has a chance to sit and is not frothy
-Remove drain plug at bottom of tank
-Place a collection container under drain
-Open ¼ turn valve
-Once water is drained (if any) and only pure oil is coming out close the ¼ turn valve and replace plug.
-Note the new CAFS Oil level

Flush Class B foam system (monthly)

-Place collection container under Class B concentrate discharge
-Remove Class B discharge cap
-Quickly open and close class B discharge valve to exercise and ensure it is not frozen in place.
-Once Class B concentrate has stopped coming out remove collection container.
-Hook a garden hose up to 5/8" female Class B flush connection and turn water on. Note: this system is designed for low pressure, high pressure will cause the system to fail.
-Allow water to flow until it has no Class B in it.
-Turn water off, remove garden hose, replace Class B cap.

Driving Principles

- **True Emergency** – is defined as a situation in which there is a high probability of death or serious injury to an individual or significant property loss.
- **Due Regard** – for the safety of others means that a reasonably careful person performing similar duties under similar circumstances would act in the same manner.
- **Negligence** – A legal deficiency or wrong that results whenever a person fails to exercise that degree of care that a prudent person would exercise under similar circumstances.
- **Gross Negligence** – Is the reckless disregard of the consequences of an act to another person. It occurs when a person's actions (or lack of) result in the failure to exercise even a slight degree of care.
- **Willful and Wanton** – Intentional or with careless indifference (considered the most serious for of negligence).
- **Vicarious Liability** – The legal liability placed on one person for the acts committed by another person.

- Maintain hands in the "3 and 9" position on the steering wheel.

-When driving in urban areas in an emergency mode, your speeds in excess of a posted limit are rarely justified

-Backing off the siren and giving the other driver a chance to think and react is the best way to handle confused motorist

-Intersections are the most accident likely areas.

U*ncontrolled intersection* = Intersection that does not offer a control device (stop sign, yield sign, or traffic signal) in the direction of travel of the emergency vehicle; or when a traffic signal is in the green mode for the emergency vehicle. Scan the intersection for possible hazards (right turn on red, pedestrians, vehicles traveling very fast, etc.). Observe traffic in all four directions. Slow down and cover the brake pedal with your foot.

controlled intersection is defined as any intersection that the vehicle must stop at, including stop signs and traffic signals. Come to a complete stop before entering. Establish eye contact with other vehicle drivers; have partner communicate all is clear; reconfirm all other vehicles are stopped. Proceed one lane of traffic at a time. Treat each lane of traffic as a separate intersection.

-Change the siren cadence not less than 200 feet from the intersection.

-Emergency vehicles are considerably larger in size, mass, and weight than smaller passenger cars, and require longer stopping distances when traveling at high speeds.

-A safe way to determine following distance for an emergency vehicle is the four second rule. The four second rule keeps a separation of at least four seconds between the emergency vehicle and the vehicle being at 40mph. For each additional 10mph another 1 second is added to the time. In adverse weather conditions, add another 1 second per 10 MPH to the time.

-Common sense must prevail in determining when to increase following distances

-Contingency situations can arise at any time. A contingency situation is described as a possible future event, condition, or an unforeseen occurrence that may necessitate special measures.

-TO help regain control no matter what type of skid is occurring, *STAY OFF THE BRAKE; STAY OFF THE ACCELERATOR; AND COUNTERSTEER!*

4 Gas Meter

-Monitors: CO, O2, H2S and LEL

CO:

- Product of incomplete combustion
- Lighter than air
-Measured in PPM
- >35 PPM utilize SCBA
- > 12,800 PPM atmosphere is combustible. This is 10% of the LEL. The LEL of CO is 128,000 PPM or 12.8 % (12.8 X 10,000 = 128,000 thus 128,000/10 = 12,800)

LEL (lower explosive level):

-Measured in %
-4 Gas Meter will alarm at 10% of the LEL
-Below 19.5% O2 concentration will cause the LEL reading to be scud
- < 10% LEL continue to work with caution
- 10 to 25% LEL continue to work with extreme caution
- > 25% LEL withdraw immediately

H2S:

- Measured in %
- > 5% utilize SCBA and consider withdrawing due to inadequate protection

O2:

- Measured in %
- 20.9 to 21% is normal
- < 19.5 utilize SCBA
- > 23.57 explosion hazard withdrawal immediately
- 19.5 to 23.57 continue to work and monitor atmosphere

Considerations when using the 4Gas:

-There are substances that will poison or inhibit the sensors in the 4Gas Meter. Remember to keep the meter away from Armor-All and gasoline (when possible.) There are also others but these are the most likely for us to encounter that will accidentally damage the meter.

-Any sensor is susceptible to adverse conditions. Humidity, extreme high or low temperatures and corrosive atmospheres can have an adverse effect on a sensor. These effects can be seen by a “stray” in a sensors reading. You may see a 1 or a 2 reading when first turning on a meter or you may see a -1 or -2 reading. This does not mean that your meter is not working properly. To acclimate your meter to its surroundings, do a “Zeroing” function to the meter. If the problem persists, have the meter calibrated.

- Turn the meter on in a clean atmosphere.

-Calibration is accomplished by exposing the sensors to a known concentration of gas. These known concentrations are set so when the sensor is exposed to that gas in the future, it can determine how much of the gas is present. Calibration should be performed on a MONTHLY basis.

Apparatus Positioning

Auto Fires: Montgomery County PSTA Practical Skills Manual

Ideally position Engine uphill and upwind. Park Engine blocking necessary lanes of traffic in roadway or parking lot to protect crews and pump operator. Park Engine at least 100ft from any Auto fire.

Personal Injury Collisions: FRC Policy 24-04 Vehicle Accident Response

Position Engine behind the collision scene blocking necessary lanes of traffic in roadway or parking lot to protect crews and pump operator if the vehicle should catch fire. EMS transport units and Rescue Squad should be in front of the Engine. Do not count on police to block the collision scene. Many may block the scene and later move their cars for other reasons. They may not understand what safety needs the fire department has on the scene of collisions. If you require assistance, be specific and communicate with the police.

Trench Collapse: FRC Policy 65-89 First Responder for Trench Collapse Incidents

Park the Engine 250 feet from the scene. Turn off apparatus if possible. Establish an off-site staging area for other apparatus arriving at the scene. Eliminate all sources of vibration up to 500 feet.

Policy 24-07 AMII

Safe Structural Firefighting Policy

NOTE at the time this guide was developed, Policy 24-07 AM II was under review. Please see the current policy for changes.

Definitions:

RIC- Rapid Intervention Company
- Relieves the Standby Team
-3rd due

RID-Rapid Intervention Dispatch
- Aerial, Squad, EMS other than the first, Command Officer

RIG- Rapid Intervention Group
- RIC + RID

Structure Fire:

E1- Lay line, hit connections (if equipped), position side A if possible, don't imped incoming units, advance line to fire floor

E2- Ensure and expand upon 1st E water, advance hose line to back up E1

E3- Don't imped incoming units, secure hose line, relieve Standby Team, RIC

E4- Lay line from unused hydrant, position on Side C if possible

E5- Ensure and expand on 4th E water, report to IC for instructions

T1- Position Side A, horizontal vent as necessary, ladders, report to fire floor for search and open up, lights, fans

T2- Position side C if possible, horizontal vent as necessary, forcible entry for E4, ladders, vertical vent as directed by IC, search, open up, lights, fans

RS1- Searches, utilities, ventilation

A1- Position so unit can leave the fire ground if necessary.

Rural Water:

E1- Drop clappered Siamese at end of driveway or dumpsite, If water source is located within 3,000' of E1 clappered Siamese a relay is preferred. Advance line to fire floor

E2- Position as close to E1 as possible and give them your tank water, Don't block tanker or T1, advance line to backup E1

E3- Uncommitted location, may: draft, lay lines in relay, pump. Siamese, assist E4 with dumpsite
Relieve Stand By Team, RIC

E4- Shuttle: draft at dump site and pump Siamese
Relay: Lay lines

E5- Shuttle: Fill site, set up 2 LDH lines capable of filling tankers at a rate of 500 GPM each, with a ¼ turn ball valves. The desired tanker fill rate is 1,000 GPM.

Tanker1- Nurse tanker, drop off folding tank near clappered Siamese, position near E1 and give E1 your tank water, connect the line from clappered Siamese to tanker, maintain a full tank if possible

Tanker2- Pump the Siamese, drop folding tank and necessary appliances

Tanker3- If dump site is set up drop enough water for E4 to get a draft, once draft is achieved drop remaining water

Water Supply Task Force- One Engine + three Tankers, second fill site, set up 2 LDH lines capable of filling tankers at a rate of 500 GPM each, with a ¼ turn ball valves. Desired tanker fill rate is 1,000 GPM.

High Rise:

E1- Lay line, hit connections and charge (if equipped), position side A if possible, don't imped incoming units, advance line to fire floor

E2- Ensure and expand upon 1st E water, advance hose line to back up E1

E3- Don't imped incoming units, secure hose line, relieve Standby Team, RIC (usually 1 floor below)

E4- Lay line from unused hydrant, position on Side C if possible, hit the connections, advance a line to the floor above or most threatened exposure

E5- Ensure and expand on 4th E water, Lobby Control

FCGO 14-10

Station, Apparatus and Equipment Security

- While on emergency incidents a reasonable effort must be made to leave a crew member with the apparatus and equipment
- While conducting routine business (inspections, shopping, etc.) the apparatus must NEVER be left unattended

Policy 25-07

Natural Gas Incident Response

-Major gas leak= A natural gas leak with an imminent threat of life safety.
-Minor gas leak= A natural gas leak not believed to pose an imminent threat of life safety.

Minor gas leak outside (no fire):
First unit position upwind
Establish a Hot Zone
Eliminate sources of ignition
Check exposures

Major gas leak (no fire):
First unit position a safe distance away
Establish a Hot Zone
Level I stage remaining units 500 yards away from first due
Check exposures

Outside gas leak with fire:
Don't put the fire out

Gas leak Inside (no fire)
Position a safe distance away
Level I stage remaining units 500 yards away from first due
Do not ring doorbell

Policy 24-02

Vehicle Collision and Reporting

-Report collision and incidents to ECC and immediate supervisor
-Request assistance and police as appropriate
-Ensure proper medical attention is given
-Make no statements to individuals at the scene except to the collision investigator as to fault, liability or preventability

Policy 24-06 AMII

Metro SOP

Metro Box:

E1- Report to dispatched location or entry point, initiate water supply and charge standpipes
E2- Report to dispatched location or entry point, ensure and expand upon E1s water
E3- RIC
E4- Report to dispatched location or entry point, initiate water supply and charge second standpipe
E5- Report to dispatched location or entry point, ensure and expand upon E4s water

Metro Yard Incident:

E1- Initiate water supply and charge standpipes
E2- Report to Yard Tower and function as the YCU
E3- Ensure and expand upon E1s water, RIC
E4- Establish secondary water and charge standpipes
E5- Ensure and expand upon E4s water

Policy 808

Safe Emergency Vehicle Operation

- Drivers must reduce the speed of the vehicle at all intersections to negotiate a full stop when the intersection cannot be safely entered. The driver must slow down to a safe speed that it can be stopped to avoid an accident should another vehicle enter the intersection.
- The minimum following distance is 3 seconds.
- Don't overdrive your headlights.
- Pedestrians must always be given the right of way.
- Don't drive into an overhead door opening when the door is not fully up
- Never stop or park in an overhead door opening
- Don't park in Fire Lanes while conducting routine business.
- If no backup person is present and the driver must back up he/she must perform a circle check first.
- No emergency vehicle shall pass another emergency vehicle while responding unless advised to do so by the lead vehicle.
- Emergency vehicle drivers must not pass a school bus with its lights on unless cleared to do so via eye contact and/or other visual signals.
- While driving emergency or non-emergency all emergency vehicles must come to a complete stop at all guarded and unguarded intersections
- Headlights must be on while responding and when the windshield wipers are on
- Max speed with chains is 35 MPH per policy 808 (25 MPH per FCGO 08-17)
- When driving with chains the window must be down at least 3"
- For Engine Companies wheel chocks must be used while parked any where other than inside the station

FCGO 12-01

Winter Driving and the Use of Snow Chains

-Allow several times your stopping distance

Automatic Chains
- Engage between 3 and 25 MPH
- Do not work well in accumulations over 6" of snow
- Raise when not absolutely necessary
- Can be used in conjunction with Removable Crosslink Chains
- Do not use unless you are stuck and have a wheel spinning

Removable Crosslink Chains
- Applied manually to outside duals
- Use bungee style tensioners to ensure they are snug
- Recommends with 6" of snow on the ground and more predicted
- Listen for a broken chain, if this happens stop in a safe location and fix
- Carry 16 gauge mechanics wire to temporally fix broken chains
- Never drive on interstates with Crosslink Chains due to the reduction of speed

FCGO 08-17

Winter Driving and the Use of Snow Chains

-All Crimson Engines are equipped with ATC. ATC operates automatically by reducing drive wheel over-spin and by reducing motor power if the drive wheels do spin. If manually activated it is a momentary switch
- Do not exceed 30 MPH using ANY type of snow chain.

FCGO 10-03

CAFS

- CAFS shall not be used during offensive interior attacks
- CAFS is only authorized during overhaul, exterior fire fighting and exposure protection. Provided that the CAFS line does not come off the same Engine that is flowing interior hose lines for an interior attack.
- This FCGO states that the CAFS Air Compressor shall be placed in the "Stand BY" mode, the manufacture states to turn "OFF" the CAFS Air Compressor when flowing over 150 PSI (i.e. The 300' rear 2" line)
- Crimson Engine Plain Water Flows:

Preconnect # & Nozzle	Hose Inches	Length Feet	Nozzle Pressure PSI	Flow Rate GPM	Engine Pressure PSI	Rounded EP PSI by 5's
1 & 2 Fog	1.75"	200	70	175	144	145
1 & 2 7/8" SB	1.75"	200	70	190	137	140
3 Fog	2"	250	50	250	144	145
3 1 1/8" SB	2"	250	50	266	156	155
5 Fog	2"	300	50	250	163	165
5 1 1/8" SB	2"	300	50	266	177	175

PAGS

The following section contains the Practical Application Guide Sheets (PAGS). These serve as a template for best practices to complete an evolution in a controlled environment. In the field they may not always serve as the best practices. The PAGS are to be used as a learning aid and a testing template. These are the exact papers that test evaluators use at the PSTA. No secrets, no surprises.

Anyone can memorize these sheets step by step. A good wagon driver will fully understand the concepts and know how and why the operations are completed. These are a plan "A" make sure you have a plan "B," "C," "D," and etc.