BLASTMAX 300 PUMP

ADVANCED PRESSURE SYSTEMS

OPERATION AND MAINTENANCE MANUAL

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APS
SHAPE TECHNOLOGIES GROUP®

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ADVANCED PRESSURE SYSTEMS 2022

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About This Content

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Overview

The APS Series 300 is a powerful positive displacement, triplex plunger pump system. These pumps are designed and manufactured to operate in continuous service at a designed flow and pressure. With pressures ranging from 5,000 psi to 40,000 psi (345 bar to 2,758 bar), the Series 300 is an extremely versatile pump. The Series 300 is designed for full-scale industrial use including but not limited to industrial cleaning, surface preparation and hydrostatic testing applications.

Features include:

- *A triplex, belt-drive, high-pressure pump with easy access to seals and check valves.*
- *Multiple diesel engine options:*
  - *302 hp Caterpillar Model C-7.1 Tier 4 diesel engine.*
  - *275 hp Caterpillar Model C-7.1 Tier 3 diesel engine. (export only)*
  - *335 hp Caterpillar Model C-9.3 Tier 3 diesel engine. (export only)*
- *Multiple electric options ranging from 150 hp to 300 hp.*
- *A closed-loop oil lubrication system*
- *An inlet water booster pump with water filtration to 10 microns absolute.*
- *Over-pressure protection discs, as equipped.*

Adhering to the recommended procedures for operation and maintenance outlined in this manual will ensure optimum benefit is obtained from the high-quality components used in the design and construction of the Series 300 pump system.

Safety

Advanced Pressure Systems designed your high-pressure waterjet cutting system and related equipment with safety in mind. Although the waterjet can appear harmless, it is a high-energy cutting tool capable of cutting many materials such as composites, metals, plastics, and wood products. Misuse of this equipment or carelessness in its application is extremely hazardous to personnel. Always treat the waterjet system with respect.

READ CAREFULLY BEFORE USE. KEEP FOR FUTURE REFERENCE!

Safety Precautions

Follow all safety precautions to ensure safe operation of the equipment.

- *Only trained, qualified personnel shall service and maintain the equipment.*
- *Safety glasses and ear protection shall be worn when operating or working near the pump.*
- *Do not allow the waterjet stream to touch any part of your body—it will cause serious injury.*
- *Never point a waterjet cutting or cleaning tool at yourself or any person. Do not aim any waterjet tool at anything you do not want to cut.*
- *During equipment maintenance, take the system out of service. Lock and mark the controls with a warning sign. See Lockout/Tagout for details.*
- *All personnel required to do any system operation or service function must pay particular attention to all warning signs and notices posted in the plant and on the equipment.*
- *All protective guards, shields, and covers must be in place on the equipment at all times.*
- *First aid facilities shall be provided in convenient locations throughout the plant. All personnel must know the locations of the first aid facilities.*
- *Always keep the work area around the equipment clean and free of debris. Fluid spillage results in slippery floors. Clean up spills immediately.*
- *Any unfavorable conditions that can result in injuries must be reported to the plant supervisor immediately.*
- *Do not wear loose clothing or jewelry while working around equipment with moving parts.*
- *Pressurized air can drive particles into the eyes and skin if handled incorrectly. Use appropriate personal protective equipment and exercise caution.*
- *Only use water-based solvents for cleaning parts.*

Diesel engines

- *Do not allow the engine to exhaust into a closed work area. Provide either adequate ventilation or vent the exhaust outdoors.*
- *Do not overfill the fuel tank.*
- *Do not operate the engine in an explosive or flammable environment.*
- *Do not allow flammable liquids to touch the engine while it is hot.*
- *Do not operate the engine without its protective covers in place.*
- *Do not attempt to service the engine while it is in operation.*
- *Do not allow moving parts to contact either your clothing or body.*
- *Do not allow fuel to contact exposed portions of your body.*

Electrical

- *Only a certified electrician shall do electrical and/or electronic troubleshooting and servicing of electrical devices.*
- *Always assume that power is ON in all electrical systems. Always examine and lockout the main power switches before servicing the equipment. Post a sign, "Maintenance in Progress—Do Not Energize."*
- *Be aware that live electrical circuits are present in the control console whenever the master disconnect switch is in the ON position, regardless of whether the E-Stop is engaged.*
- *Turn off the circuit breakers located inside the electrical enclosure before servicing the electrical system. If this is not possible, have someone stand by to prevent someone from powering up the system.*
- *Take extra precautions when servicing the power system in a damp environment.*
- *Never alter or bypass protective interlocks or devices.*
- *Never use jumper wires across fuses, fuse holders, or breakers.*
- *Never use metal rulers, flashlights, pencils, or tools that have exposed conductive material when working near electrical/electronic components.*
- *Ensure all tools are correctly insulated for the job. Use only correct test apparatus; regularly examine to ensure they are working correctly. Use caution when connecting a test probe to test points.*
- *When connecting a voltmeter to terminals for measurement, use a range higher than the expected voltage.*
- *All replacement wires shall conform to the manufacturer's specifications, including color-coding, wire numbers, and size.*
- *Close and latch the control panel doors or junction box covers after servicing.*
- *Maintain all electrical components, protective guards, and shutdown devices according to approved practices.*

High-Pressure Cleaning Tools

- *Turn off equipment and relieve water pressure before replacing nozzles, tips, or bits.*
- *Hang a warning sign on the control panel that states that the equipment is being serviced and is not available for use until servicing is complete.*
- *Install all protective covers and shielding on equipment before starting the pump.*
- *Examine for leakage after nozzle or tip replacement and correct the leak immediately.*
- *Use only Flow manufactured or approved waterjet nozzles, cleaning tips, and drilling or cutting bits.*

Mechanical

- *Do not start the system unless you know how to stop it.*
- *Never maintain, service, or clean around the equipment while it is operating.*
- *Do not use incorrect tools—they can cause injury or costly damage to equipment.*
- *Use only approved test equipment. Examine the equipment regularly for correct operation and calibration.*
- *Never climb on or around the equipment on makeshift devices. Use only approved catwalks, ladders, or platforms.*
- *Do not exceed specified pressure setting limits for pneumatic or hydraulic components. Exceeding these limits may result in serious injury to personnel or damage to the equipment.*
- *Shield and bundle equipment hoses and cables so they do not obstruct the operator's freedom of movement.*
- *Always be alert when working around the equipment.*
- *Remove all tools, parts, and rags from moving parts after servicing the equipment.*

Safety Messages

Safety messages are highlighted with the safety alert symbol and a signal word or a signal word panel. Pay particular attention to these safety messages and all safety precautions posted on the equipment.

Safety Alert Symbol

This is the safety alert symbol. The safety alert symbol informs you of potential physical injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

Signal Words

WARNING! *WARNING indicates a hazardous situation, which if not avoided, can result in death or serious injury.*

CAUTION! *CAUTION indicates a hazardous situation, which if not avoided, can result in minor or moderate injury.*

Signal Panel Words

DANGER indicates a hazardous situation, which if not avoided, will result in death or serious injury.

CAUTION emphasize operating or service procedures, or conditions that can result in equipment damage or impairment of system operation.

NOTICE indicates a non-hazardous situation, which if not avoided, can result in property damage.

Personal Protective Equipment (PPE)

Personal protective equipment (PPE) is equipment worn to minimize exposure to serious workplace injuries and illnesses.

Helmets must be worn at all times by all personnel within the work area. Helmet material must withstand a mechanical shock to 10 G in 8 ms without fracturing.

Operators must wear safety glasses with side shields and a visor, or goggles and a visor, to guard against spray and flying debris.

Operators and other personnel must wear safety footwear with steel toecaps a minimum of 5 mm (0.02-in.) thick. The toecap must cover at least 30% of the footwear length. Footwear must have metatarsal guards to provide instep protection.

The operators and other personnel exposed to noise levels of more than 90 dBa for more than 1 hour must wear suitable ear protection. Earplugs and muffs are usually adequate.

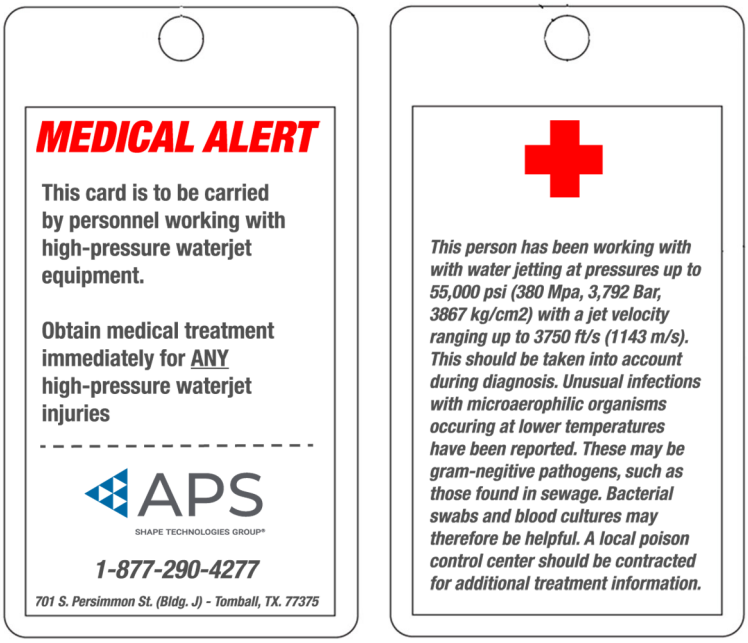
The operators must wear gloves at all times; leather gloves are preferred.

Waterproof garments only protect the operator from spray and flying debris. They do NOT deflect direct jet impact.

Emergency Medical Information

WARNING! *Obtain medical treatment immediately for ANY high-pressure waterjet injuries.*

It is vital that medical personnel have information about this type of injury. We recommend that all personnel working with waterjet equipment carry a medical alert card or tag that describes their work and the nature of injuries inherent in using waterjets.



Lockout/Tagout

You can lock out the water supply and electrical systems separately. Under most circumstances, you should lock out both systems.
This lockout/tagout procedure is designed to protect all employees from injuries caused by the unexpected energizing or startup of the machine, or the release of stored energy during service and maintenance.
This is accomplished with energy isolating devices that prevent the transmission or release of energy. An energy source is any source of electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other energy source that could cause injury to personnel.
A lockout device utilizes a lock and key to hold an energy isolating device in the safe position and prevents the machine from being energized. A tagout device is a prominent warning device that can be securely attached to the machine warning personnel not to operate the energy isolating device. This procedure requires the combination of a lockout device and a tagout device.

Water Supply

1. *Shut down the pump.*
2. *Look at the gauges on the display to ensure that the UHP pressure is bled down.*
3. *Turn off the water supply to the boost pump.*
4. *Close the inlet water valve, and then install a lockout/tagout device.*
5. *Open the top and bottom petcocks on the water filter canister to drain the filter canister. If the draining water appears to be under pressure, ensure that the inlet water valve is closed.*
6. *If equipped, ensure isolation of the inlet water by looking at the Pre-Filter and After-Filter pressure on the Pump Data screen. Both readings should be at zero.*

Electrical

1. *Shut down the system.*
2. *Remove the battery box cover.*
3. *Use a 9/16-in. wrench to remove the negative (black) lead from the battery. This cable connects from the battery to the battery disconnect.*
4. *Install a lockout/tagout device over the negative battery cable.*
5. *Use a 9/16-in. wrench to remove the positive (red) lead from the positive battery post. This wire connects from the battery to the engine starter motor.*
6. *Install a lockout/tagout device over the positive battery cable.*

Operation

Overview

Commissioning requirements and procedures are detailed in this section. These procedures require a thorough understanding of the individual components, safety issues, and the overall operation of the system.

All personnel involved in the operation and/or service of the system must carefully review this manual prior to commissioning and operating the machine.

The Technical Service Department at Advanced Pressure Systems is available to assist in the commissioning and operation process. Service and repair training for maintenance personnel is also available.

Transporting

The weight of the machine is not evenly distributed from one end to the other, particularly on the larger horsepower models. Do not attempt to lift the machine from either end. Note the warnings stamped on the unit. The center of gravity is located at approximately the location of the lifting eye if so equipped. The forklift should be positioned accordingly.

When the machine has been removed from the crate, note the position of the fork pockets on the bottom of the machine if so equipped. The pockets are positioned in relationship to the center of gravity to balance the weight on the forklift.

Trailer units should be transported based on the type of hitch provided and the weight rating of the unit. The unit should only be transported with the water and fuel tanks empty.

Before Starting the System

Prior to starting the system review the manufacturer's manuals included in the appendix covering the operation of the engine and drive train.

1. *Set unit on a level surface to ensure that oil in the power end reaches the crankshaft main bearings.*
2. *Check oil and coolant levels in the pump and engine. Refer to Section 8, Specifications for information regarding power end lubrication. Refer to the engine manual in the appendix for system component lubrication.*
3. *If the pump has an oil level shutdown switch, set the shutdown trips 1/2 inch above and 1 inch below the dipstick Hi-Lo level marks.*

4. *Inspect battery cables and hoses to ensure they are tight and secure.*
5. *Check fuel tank levels on engine powered units.*
6. *Check engine power take off and drive train for tension and lubrication, see the manufacturer's manual in the appendix.*
7. *Check charge pump drives, if applicable.*
8. *Ensure the plunger and intermediate rod connections are tight.*
9. *Verify all bolts are torqued to the specified level.*
10. *Verify connections on the suction and discharge manifolds are tight and do not leak.*

    ⚠ CAUTION *Do not tighten high pressure connections when the system is pressurized. Remove all pressure from the system before tightening connections.*

11. *Ensure the supply water and the filters and strainers are clean.*
12. *Verify the pressure rating stamped on the application tag for the pump matches the pump speed, plunger size, engine horsepower and the accessories to be used with the unit.*
13. *If supplied, verify the pressure relief valve is set 10 to 15 percent above the specified maximum working pressure.*
14. *Ensure the supply water line to the pump is airtight. Air entering the suction side, supply line will cause severe knocking and cavitation of the pump.*
15. *Attach a pressurized supply water line to the pump system inlet connector, 30 psi (1.4 bar) minimum or 80 psi (5.5 bar) minimum for 40,000 psi (2,758 bar) applications. The inlet supply line must be sized to flow at least double the GPM to be pumped from the system.*

    NOTICE *DO NOT gravity feed the pump. Fluid supplied to the suction side must be pressurized to help protect against cavitation damage.*

16. *Check to ensure supply water is flowing to the system.*

Startup

1. *Disengage the clutch on diesel or gasoline engine units or open the bypass flow regulating valve on electric powered units. Open the regulator valve for the charge pump, if applicable.*
2. *Remove the nozzles or disconnect the pump for the work to allow maximum flow to be pumped without pressure for one minute.*
3. *Turn on the pressurized supply line water.*
4. *Start the engine or the electric motor.*
5. *Engage the engine clutch and/or close the bypass flow regulating valve.*

    ⚠ CAUTION *Ensure that you have charge pump water pressure and oil pressure if power end is forced lubricated before engaging the PTO.*

6. *With the nozzles removed, pump fluid through the system for at least one minute.*

7. *Stop the engine or motor and replace the nozzles.*
8. *Start the engine or motor and gradually increase flow through the system to the maximum allowable pressure. Observe the pump pressure gauge to ensure the reading does not rise above the specified allowable working pressure. If applicable, verify the charge pump pressure is at least 30 psi (1.4 bar), or 80 psi (5.5 bar) for 40,000 psi (2,758 bar) applications.*
9. *Set the manual and automatic throttle speed controls on the engine or adjust the by-pass flow regulating valve on electric motor driven systems to obtain the specified allowable working pressure.*
10. *With the pump operating at its rated full speed the maximum working pressure should be reached easily. If the maximum working pressure cannot be reached at full speed, check the nozzle size or the system plumbing for leakage. Refer to Section 7, Troubleshooting, if the issue is not resolved.*
11. *Ensure the suction and discharge valves remain fully open during operation.*

    ⚠ CAUTION *Never close the suction or discharge valves while the pump is running.*
12. *Check the plunger packing for leakage.*

Proper Operation

In most jetting operations is it common practice to employ a minimum of two persons as a team. The nozzle operator holds a gun, lance or delivery hose and controls the motion and direction of the jet(s). The pump operator monitors and controls the pressurizing pump during jetting operation

1. *The nozzle and pump operators should be aware of the working pressure for the job and pump and nozzle orifice sizes should be selected to match these conditions.*
2. *The pump operator should not start the unit until told to do so by the nozzle operator. Before the bringing the system up to pressure, the pump operator should ensure the jetting nozzle is either directed at the work piece; that the nozzle operator has a secure stance and control of the nozzle; and each team member is in the proper position to perform their task.*
3. *The pump operator should slowly raise the pressure of the system to allow the nozzle operator to adjust to the changing reaction force from the nozzle. Once the operating pressure has been reached, the pressure should not be further adjusted without the operator's awareness. When the pressure is reduced at shutdown, the pressure should also be lowered slowly to prevent the sudden lack of force from causing the operator to lose their balance.*

    ⚠ CAUTION *The reaction force experienced by the nozzle operator can suddenly change when the trigger on a gun activates a dry shutoff or dump valve.*

    ⚠ CAUTION *The operator should be familiar with the change in thrust at various pressures, including the working pressure for the job. The operator's stance should allow them to withstand these changes.*
4. *Both before and after bringing the system up to pressure the pump operator should visually examine the hose and connections to the jetting gun or nozzle for leaks.*

Decommissioning

All local regulations must be adhered to for recycling and decontamination before the pump is decommissioned and taken out of service for any reason.

System Storage

If the system will be idled for an extended period, it must be prepared for storage as detailed below.

1. *Drain and clean the power end. Leave the drain open to permit air circulation and prevent condensation buildup.*

   NOTICE *Fluids can be evacuated from the pump by blowing compressed air through the suction manifold.*

2. *Coat all bearings and machined surfaces inside the crankshaft with a rust inhibiting oil.*
3. *Rotate the crankshaft each month.*
4. *If T4 Engine start and run for 15 minutes once every other week.*
5. *Read the engine maintenance manual for instructions regarding storage.*

Cold Weather Storage

The following additional steps should be taken when the system is taken out of service in temperatures below freezing.

1. *If compressed air is available, connect an appropriately secured compressed air line to the inlet connection on the suction manifold and evacuate fluids from the pump and associated plumbing.*
2. *If compressed air is not available, introduce anti-freeze into the suction line and rotate the pump to mix any fluid remaining in the system with anti-freeze.*
3. *Read the engine maintenance manual for instructions regarding cold weather storage.*

Startup After Storage

A system that is removed from storage must be thoroughly inspected for damage before it is returned to service. Verify that all component parts are in working order.

⚠ CAUTION *Failure to observe the following instructions can result in equipment damage.*

1. *Open the covers on the power end, engine, and drive train.*
2. *Verify the bearings are clean and in good condition.*
3. *Verify the plungers, valves and packing are properly installed and in good condition.*
4. *Verify proper tightness of bolts, nuts, studs, and fluid connections.*
5. *Fill the power end to the proper level with clean oil of the proper viscosity.*
6. *Pour oil into the crosshead reservoir and work into all the bearings.*

7. *If applicable, fill the engine with oil as recommended in the engine manual shipped with the pump.*
8. *Grease the power take off or u-joints.*
9. *Follow the startup and operations instructions in this section.*

Operation Safety Guidelines

Overview

Advanced Pressure Systems products are sold with the understanding that the purchaser agrees to thoroughly train all operating and maintenance personnel in the correct and safe installation, operation and maintenance of waterblast equipment and to provide adequate supervision of personnel at all times.

Waterblast operators must be made aware that the cleaning nozzle's discharge jet can inflict serious bodily injury.

Additional safety information and updates may be obtained from the Waterjet Technology Association website at www.wjta.org.

General Safety Guidelines

Advanced Pressure Systems high pressure pump systems are designed to produce specifically related flows and pressures. Use caution when selecting nozzles and adjusting pressures to match the flow and working pressure of the specific pump model.

⚠ CAUTION *Never over-pressurize the system.*

1. *Use only products intended for high pressure water blasting. No product should be altered without the written consent of the manufacturer.*
2. *Read and follow all manufacturers' instructions prior to using any waterblast product. Contact the manufacturer should questions remain.*
3. *Inspect the condition of all components prior to use. Do not use an item in questionable condition.*
4. *Place barricades with warning signs or barricade tape around the work area.*

Operational Safety

⚠ DANGER *Never direct high-pressure fluid jets toward anyone or to any part of your body. High pressure water will penetrate all parts of the human body. The liquid stream and the material ejected by the extreme pressure can result in severe injury.*

1. *The operator handling the cleaning device and nozzle* ***must always*** *have control of the water pressure.*

   A surface cleaner operator should operate a trigger style, control gun capable of instantaneously stopping pressure to the nozzle.

A tube cleaning lance operator should operate a foot gun capable of instantaneously stopping pressure to the lance.

2. *Before attaching a nozzle to the control gun or tube cleaning lance operate the pump at low speed to purge dirt and debris from the system.*

   ⚠ CAUTION *Dirt and debris can clog the nozzle orifice(s) and cause excessive system pressures that could lead to a lance failure.*

3. *With the nozzle installed, operate the pump at a low pressure to test the system. If system repairs or adjustments are necessary, stop the pump and relieve all pressure before making required repairs or adjustments.*
4. *With the system operating properly, increase pump pressure slowly until the operating pressure is reached and adjusted. Pressure adjustments should always be made slowly.*
5. *Use the minimum pressure required for cleaning. Do not exceed the operating pressure of the system's lowest pressure rated component. All equipment pressure rating markers and warning tags should be left intact.*
6. *If equipment or system malfunction is suspected, immediately stop cleaning activities and relieve the pressure in the system before attempting any repairs. Always follow the manufacturer's repair instructions.*
7. *Following any repairs, operate the pump at a low pressure to test the system. Bring the system up to the operating pressure slowly.*
8. *If the system is shutdown, even for brief periods, in freezing conditions, drain the water from all components. Prior to startup in freezing conditions, the operation of all components must be carefully checked to ensure they are not frozen and will operate properly.*

Pressure Relief Devices

A waterblast system should include both primary and secondary pressure relief protection.

⚠ DANGER *Properly adjusted and maintained pressure relief devices are imperative for the protection of both the operator and the equipment against dangerous over pressurization.*

- *For primary protection a spring load relief valve is set at 1.25 times the maximum operation pressure. A relief valve is set at 12,500 psi (862 bar) if the maximum operating pressure is 10,000 psi (689 bar).*
- *For secondary protection a rupture disc assembly containing a manufacturer's approved disc with a burst rating of 1.5 times the maximum operating pressure is recommended.*

  If a rupture disc assembly is used for primary pressure relief protection, it should contain a manufacturer's approved disc with a burst rating of 1.25 times the maximum operating pressure.

DANGER *Only use a rupture disc holder that will not permit the use of coins or other objects in place of discs.*

CAUTION *Never adjust relief valves to open at more than 15 percent above the maximum working pressure of the pump.*

CAUTION *Never adjust relief valves while the pump is operating under pressure.*

1. *Relief devices should **never** be mounted so the discharge could strike personnel.*
2. ***Never** install a shut-off valve between the pump and the relief device.*
3. ***Set pressure must be prominently displayed on all relief devices.** Never install a relief device unless its set pressure is known.*
4. *The operation of relief valves and the accuracy of the set pressure should be field checked in accordance with manufacturer's instructions at regular intervals, **at least every 40 operating hours.***
5. *Do not attempt to correct a leaking relief valve by increasing spring tension. This will increase the set pressure.*
6. *Do not use a pressure relief valve as a combination relief and throttling device.*
7. *Keep relief valves dry during freezing conditions.*

High Pressure Hose and Lance Assemblies

*The minimum burst rating for high pressure hoses must be a minimum of 2.5 times the operating pressure. For example, when operating at 10,000 psi (689 bar), the hose must have a minimum burst rating of 25,000 psi (1,724 bar). **Do not** use a high-pressure hose with an unknown burst rating or manufacturer's operating pressure rating.*

- *Use of a safety shroud where the hose connects to the control gun is strongly recommended.*
- *Position the wrench on the wrench flats when making threaded connections. **Do not** position wrench on the fitting ferrule (collar).*
- *Protect the hose from contact with sharp objects, abrasive surfaces and foot or wheel traffic.*
- *Support hoses, pipes and fittings to prevent excessive sway and/or wear created by vibration or stress on the end connections.*
- *Inspect hoses for damage, wear or imperfections prior to and periodically during operation.*
- *Disconnect, drain, coil and store hoses properly after use.*

DANGER *Never attempt to repair or re-couple hoses in the field. High pressure hose fittings are permanently crimped and can only be properly installed with hydraulic crimping equipment.*

Hoses must be removed from service if the:

- *cover is damaged and reinforcing wires are exposed to rust and corrosion.*

- *cover is loose, has blisters or bulges.*
- *hose has been crushed or kinked.*
- *end fittings show evidence of damage, slippage, or leakage.*
- *hose has been exposed to pressures greater than 50% of burst rating.*
- *hose is three or more years old, regardless of condition.*

Control Gun and Control Device Safety

1. *Prior to use, thoroughly inspect the control gun or device for smooth and proper operation. Control guns and devices should also be inspected for proper operation before each operating shift.* **Do not** *use any device that has not been inspected before your operating shift.*
2. *A control gun operator using a hand-held gun should position and brace their body for the gun's rearward reaction force before depressing the gun trigger. The rearward reaction force is high and is usually 40 to 50 pounds of force. The operator should maintain firm, solid footing to counter the rearward reaction.*

   DANGER

   Do not use a hand-held control gun if the nozzle discharge can accidently strike the operator's body. *A 48-inch long discharge barrel* ***must*** *be used on hand-held control guns to prevent nozzle discharge from accidently striking the operator's feet, legs or body.*
3. *The use of a safety shroud and a safety whip hose is strongly recommended for operator protection against a possible burst in the high-pressure hose connected to the gun. Use of a hand grip and a shoulder stock with hand-held guns will provide greater comfort and thus increase cleaning production.*
4. *Fall protection should be provided when blasting on scaffolding or sloping surfaces. Do not operate a hand-held control gun while standing on slippery surfaces.*
5. *The control gun operator should always start blasting with a* ***low system pressure*** *and* ***slowly increase*** *blasting pressure. When operating pressure is reached* ***depress and release the control gun trigger/pedal several times to check the gun's operation before starting cleaning operation.***
6. *A dump-type control gun should* ***always*** *open fully and reduce the system pressure to near zero* ***immediately*** *when the trigger/pedal is released. If the gun does relieve system pressure immediately or pressure does not fall below to 200 psi (14 bar) when the trigger/pedal is released, do not use the control gun.*
7. *The operator should* ***never*** *pass a control gun to another operator without first stopping the pump and water flow to the gun. Failure to do so is dangerous because of possible accidental trigger actuation.*
8. ***Do not*** *use a control gun or control device that has malfunctioned, or you suspect malfunctioned without having it repaired and/or thoroughly checked for proper operation by a qualified high-pressure maintenance mechanic or your supervisor.*
9. ***Do not*** *use a control gun that does not have a trigger guard.*

10. *Never tie, wedge, or clamp a control gun's trigger in the blast position.*
11. *Hand-operated control guns should never be used as foot-operated devices.*
12. *Any hose used for transporting dump water back to the pump should have a large enough diameter and short enough length to keep potentially dangerous back pressure low. Protect the hose from traffic.*
13. *All electric throttle control cords should be rated for wet conditions. All cord connectors and switches should be kept out of water.*

Rigid Tube Cleaning Lance Safety

Do not use a rigid lance with a burst rating less than 3.0 times the operating pressure. A rigid lance operating at 10,000 psi (689 bar) must have a minimum burst rating of 30,000 psi (2,068 bar). Do not use a rigid lance with an unknown burst or manufacturers' operating pressure rating.

1. *Clearance between the lance and tube must be enough to permit the unrestricted backflow of water and debris. With tubes containing hard deposits, this clearance should be a minimum of 1/8 inch on the diameter, or 1/16 inch per side, of the lance. With tubes containing soft, pliable deposits, this clearance should be greater. Insufficient side clearance may cause lance to blow back toward the operator.*
2. *Where practicable, a safety shield should be installed around the lance to prevent a lance nozzle from inadvertently being withdrawn and possibly causing injury.*
3. *Ensure the nozzle, lance and adapter thread sizes are compatible before installing the nozzle and adapter on the lance. Do not use a rigid lance that has damaged or missing threads.*
4. *When a pipe wrench is used to connect the lance, avoid deep wrench marks that may weaken the lance or lance connectors.*
5. *A rigid lance over 4 feet long requires two operators for support and safe operation. The operator at the tube entrance should use a foot control gun so they can instantly relieve system pressure in case of emergency.*
6. *When using and moving the lance support it in a manner to avoid stress and possible breakage at the inlet end connection.*
7. *Never 'ramrod' the lance into tube blockage.*
8. *Transport and store lances in tubes or racks to avoid bending, corrosion or other damage. Damaged lances (bends, marks, etc.) should be removed from service.*

Flexible Tube Cleaning Lance Safety

The following lance accessories are strongly recommended for safer lance operation:

- *A lance flex guard helps prevent fitting failure on the inlet end of the lance.*

- *A lance stinger provides greater control of the nozzle, establishes a safety zone so the operator knows when the nozzle is about to exit the tube and eliminates the possibility of nozzle and lance 'double back' toward the operator in large diameter pipe.*
- *A safety grip prevents the lance from exiting the tube unexpectedly.*

DANGER *Serious injury may occur if a lance with a live nozzle exits the tube.*

***Do not** use a flex lance with a burst rating less than 2.5 times the operating pressure. A rigid lance operating at 10,000 psi (689 bar) must have a minimum burst rating of 25,000 psi (1,724 bar). **Do not** use a flex lance with an unknown burst or manufacturers' operating pressure rating.*

1. ***Do not use a flex lance that is kinked, worn, frayed** or when its ability to hold pressure is questionable.*
2. ***Do not** use a flex lance with damaged or missing threads.*
3. ***Clearance** between the lance and tube **must be enough** to permit the unrestricted backflow of water and debris. With tubes containing hard deposits this clearance should be a **minimum** of 1/8 inch on the diameter, or 1/16 inch per side, of the lance. With tubes containing soft, pliable deposits this clearance should be greater. **Insufficient side clearance may cause lance to blow back toward the operator**.*
4. *Use only nozzles designed for use with flex lances. For example, a nozzle drilled with enough rearward orifices, so nozzle pulls the lance through the tube.*
5. *Where the length of the nozzle and rigid coupling is less than the inside diameter of the pipe, a length of rigid pipe, not less than the diameter of the pipe being cleaned, should be fitted directly behind the nozzle, or a suitable safety shield should be provided to protect the operator.*
6. *If end fittings do not have wrench flats, use properly adjusted pipe wrenches to connect the nozzle onto the lance and to connect the lance to a pressure source. When installing the nozzle on the lance apply the wrench on the end fitting directly behind the end fitting thread, **not on the fitting ferrule or collar.** Do not clamp the lance hose in a vice when installing the nozzle.*
7. *Avoid rough handling, stretching or straining of the lance.*
8. ***Never attempt to 'ramrod' the lance** into tube blockage or to repair or re-couple lances.*
9. *After use, drain, coil and restore the lance properly. Ensure safety tags remain intact.*

Nozzles

***Do not** use a nozzle with a burst rating of less than 3.0 times, or a manufacturers' pressure rating of a least, the nozzle's operating pressure.*

1. *Prior to installation make sure the nozzle has no clogged orifices. Blocked orifices can cause excessive system pressure and failure. If an orifice appears clogged or partially blocked with dirt or debris, immediately remove the nozzle from the control gun or lance and clean.*

2. *Use Teflon tape when connecting nozzles with male pipe (NPT) threads. Do not let the tape overlap the thread end, tape fragments may enter the water stream and clog the orifices in the nozzle.*

   Pipe thread connections should be hand-tight plus two (2) full wrench turns. Do not tighten past two (2) turns. All pipe thread connections must have a minimum engagement of four (4) threads.

   ⚠ CAUTION *Use wrench flats when available or a properly adjusted pipe wrench for tightening nozzle. Avoid deep wrench marks that may weaken the nozzle.*

3. *Special nozzles requiring a thread locking pin* ***must*** *have the pin installed prior to use or the nozzle may unscrew from the lance while in service, causing the lance to blow back toward the operator.*
4. *With nozzles requiring adjustment, always read applicable instructions.*

Personal Protective Equipment

Proper safety apparel should be provided to all operators. It is strongly recommended that instructions be given regarding when and how specific clothing and other types of protective devices shall be worn.

⚠ DANGER *Protective equipment may not prevent injuries to operators and other workers caused by the direct impact of high-pressure waterjets or from debris that may be thrown out by the impact of the jet.*

- *Head Protection*
  All operators shall be issued suitable head protection which shall be worn at all times while at the worksite. Where possible, head protection should include a full-face shield.

- *Eye Protection*
  Eye protection shall be provided to, and worn by, all high-pressure waterjet equipment operators and all visitors to waterjet operations while they are in the working area. Eye protection must provide the protection needed and must fit properly. Eye protection shall meet appropriate ANSI requirements for that type of eye protection. Side shields to glasses and goggles should prevent liquids from getting through.

  ⚠ DANGER *In some cases, liquids may be in use that can cause eye damage. In those cases, a combination visor and goggles or a full hood with shield should be used.*

- *Hearing Protection*
  Waterjets generate considerable noise; both in the air and under water. All operators and all visitors shall be issued and shall wear hearing protection while in the working area. Hearing protectors should be regularly inspected and properly maintained and should comply with federal and/or state OSHA standards.

All personnel, operators and others in the vicinity of waterjet equipment should be taught how to fit and properly use ear protection so that their exposure to noise does not exceed OSHA or other regulatory limits.

- *Body Protection*
  Protective clothing should be waterproof and have an outer layer that repels casual rebounding water. Protective clothing should also provide some protection from the impact of rebounding debris from the jet impact point where this may be a hazard to the operator.

  Waterjets can penetrate clothing, most protective suits, skin, and cause serious injury.

- *Everyone working around a waterjet operation should be provided with, and should wear, sufficient waterproof clothing to provide protection from the type of exposure to water and debris that the work might create. Garments should completely cover the operator, including their arms.*

  Liquid or chemical resistant suits shall be worn when there is a reasonable chance such equipment can prevent an injury.

- *Hand Protection*
  All operators should be provided with adequate means to protect their arms and hands. This protective equipment shall be worn when there is a reasonable chance it can prevent an injury.

- *Foot Protection*
  All operators and workers in the vicinity of a jetting operation should be supplied with, and shall wear, waterproof boots that have been fitted with steel toe caps. A metatarsal guard should also be worn by jetting gun operators.

- *Respiratory Protection*
  A respiratory program shall be implemented where there is a reasonable chance it can prevent an injury.

Maintenance

Overview

In order to keep the equipment in optimum operating condition, routine and preventive maintenance is essential.

Only trained personnel should be authorized to perform maintenance or repairs to the equipment. All manufacturers' repair instructions, including tool, torque, clearance and lubrication recommendations should be followed. ***Do not attempt to install or use a part whose dimensions, clearances, function or use are suspect.***

Repaired equipment must be thoroughly and carefully tested before it is returned to service. Do not put any piece of repaired equipment in service if its performance is questionable.

Maintenance procedures and intervals for the diesel engine are found in the Caterpillar manual.

Maintenance Precautions

Observe these precautions whenever you maintain the equipment.

- *Protect all machined and lapped mating surfaces against nicks, scratches, and burrs.*
- *Carefully clean and blow out all parts to be reassembled. Do not use paper towels. Do not create airborne dust.*
- *Do not use any substitutes for the fluids, sealants, and lubricants recommended by Advanced Pressure Systems.*
- *Lubricate threads for all high-pressure connections with blue lubricant before assembly.*
- *Lubricate new bearings before installation.*

General Precautions

Observe the following general precautions at all times.

Mechanical

- *Do not make any unauthorized alterations to the equipment or components.*
- *Use only high-pressure fittings, hoses, valves, and tubing with a minimum burst rating of 2.5 times the system operating pressure when making alterations or additions to the high-pressure water system.*
- *Repair any leaks in fittings or connections immediately. Do not over-torque fittings to stop leakage. Refer to the Torque specifications table below.*
- *Torque all fittings to the manufacturer's specifications.*

- *Follow the tubing manufacturer's recommendations for high-pressure tubing bending radii.*
- *When pressurizing any new, rebuilt, or serviced high pressure components, remove all personnel from the immediate area until the system pressure has been applied for three minutes and has been cycled on and off at least three times. Gradually increase pressure [maximum of 1380 bar (20,000 psi) per minute].*
- *High-pressure water may remain in the system for a prolonged period after closing the high-pressure water source. Bleed the system pressure off before servicing any part of the pump.*
- *Follow the manufacturer's recommendations for servicing the pump and use only original manufacturer replacement parts.*
- *Visually examine the entire system before placing it in operation. If you detect any fault or malfunction, correct it.*

Tools

- *Use only approved test equipment. Examine the equipment regularly for correct operation and calibration.*
- *Use the correct tools for the job. Use of incorrect tools can result in injury to personnel or costly damage to the equipment.*
- *Remove all tools and rags from around the machine after you service and before you start the pump.*
- *Use only approved work platforms. Never climb on or around the equipment on makeshift devices.*

Protective Clothing

- *See Personal Protective Equipment (PPE) for more information.*

Torque Specification

If a torque value for a gland nut is not specified, reference this table to determine torque value. Always leave 3–4 threads showing between the end of the high-pressure tubing and gland nut collar.

TUBING O.D.	*TORQUE [FT. LB. (Nm)]*
1/4"	*15 – 25 (20 – 34)*
3/8"	*47 – 60 (35 – 45)*
9/16"	*60 – 70 (80 – 100)*

Daily Inspection

The following inspection procedures should be performed each day. If problems are detected, they should be remedied before placing the equipment in service.

- *Prior to startup, check power end and engine oil levels and inspect oils for dirt or contamination.*

DANGER *Do not check the oil while the pump is running.*

- *Check all system connections to ensure they are tight and leak proof.*
- *Check suction and discharge supply line valves to ensure they are fully open.*
- *Review relevant sections of engine and drive train manuals.*
- *As the machine is started and water pressure increases, listen for unusual sounds.*
- *Check for plunger packing leakage.*
- *Check for leakage between the barrels and suction manifold.*
- *Check the intermediate rod and main bearing oil seals for leakage.*
- *Review relevant sections of engine and drive train manuals.*

Monthly Maintenance

A number of factors can contribute to component failure: poor water quality, operating conditions, or improper maintenance procedures. Maintaining a service log can be a useful method of tracking component life and maintenance trends. Analyzing service intervals will assist in preparing a preventive maintenance schedule tailored to your specific requirements. Periodic maintenance, at regularly scheduled intervals, will minimize unscheduled downtime and premature component failure.

Improper assembly can lead to the premature failure of components. Maintenance procedures must be followed carefully; components must be properly cleaned prior to assembly and tightened to the correct torque specifications.

- *Degrease, wash, and clean the system monthly.*
- *Drain and refill the power end every 500 hours or as often as required to maintain clean, sludge free oil of the proper viscosity.*
- *Clean the pump and engine air breathers with a non-explosive solvent.*
- *Check studs, nuts and bolts for tightness and tighten as required.*
- *Check gaskets for leaks and replace as required.*

To avoid unsafe conditions and the risk of equipment damage, operating personnel and service technicians must carefully read and follow the procedures in this manual.

High Pressure Fittings and Connections

The minimum burst rating for high pressure fittings must be a minimum of 2.5 times the system operating pressure.

- *All fittings shall be cleaned before installing in the system.*
- ***Never** use a damaged or corroded fitting, or one with damaged or missing threads.*

- *Check the condition of thread connections prior to the makeup of any high-pressure connection. **Do not** use a component with missing or damaged threads on high pressure connections.*
- *Use Teflon tape on male pipe threads (NPT) for sealing purposes. Do not let the tape overlap the pipe thread end. Tape fragments may enter the system water stream and clog nozzle orifices.*
- *Properly tighten all high-pressure connections. All pipe connections **must have a minimum engagement of four (4) threads**. Pipe connections should be hand-tight plus two (2) full wrenched turns. **Do not** tighten pipe threads past two wrenched turns.*
- *Position the wrench on the wrench flat when making threaded connections. Do not position the wrench on the fitting ferrule. If wrench flats are not available, use a properly adjusted pipe wrench to tighten fittings. Deep wrench flats weaken fittings.*

Filters and Strainers

Regular checks should be made of all fluid filters to ensure they are not blocked or damaged. Care should be taken when examining, changing, or cleaning filters to ensure that no solid particles escape into the supply lines to the pump and nozzle. Solid particles can damage valves and nozzles and make the pump run poorly.

All fluid filters should be checked at regular intervals, especially when the supply water is of a poor quality.

Nozzles, Holders and Lance Connections

The system should be flushed with water before installing the nozzle. Nozzles should be checked to ensure they are not blocked or damaged and that they seat properly in the holder or manifold. The condition of the threads holding the nozzle in place should be checked to ensure they are in good condition and not worn. All damage shall be repaired, or the parts replaced, before jetting begins.

Trigger and Valve Controls

Each hand-operated and foot-operated valve shall be manually checked before a unit is placed in operation to ensure it is clean and properly functioning. Valves should be periodically disassembled to examine the condition of the internal components and to replace worn parts. Valve guards should also be inspected and any defects that might interfere with the proper operation of the unit shall be corrected.

High Pressure Hoses

Hose assemblies must be visually inspected prior to each use and thoroughly tested every six (6) months or sooner, regardless of whether they were in use or not.

A visual inspection should be made at periodic intervals to determine if a hose assembly is suitable for continued service.

The visual inspection must include checking for loose covers, kinks, bulges or soft spots that might indicate broken or displaced reinforcement. Couplings or fittings must be closely examined and, if there is an indication of displacement of the hose from the couplings, the hose must be removed from service.

Hydrostatic Testing

A hydrostatic test should be performed at periodic intervals to determine if a hose assembly is suitable for continued service. Hose assemblies must be hydrostatically tested for one minute for 1.5 times of the recommended working pressure every six (6) months.

Water is the usual test medium. During the hydrostatic test, the hose should be straight, not coiled or in a kinked position. A regular schedule for testing hose assemblies must be established and verified with formal Inspection Records maintained in a permanent and accessible file.

Prior to hydrostatic testing the hose assembly must be depressurized and laid out straight for visual inspection.

1. *Look for cuts, gouges or worn spots in the hose cover that expose the wire reinforcement. Remove hose with exposed reinforcement from service.*
2. *Look for bulges in the hose cover, or for sections with mashed flats or kinks. Remove hose showing any of these faults from service.*
3. *Inspect for hose cover blisters or loose outer cover. Remove hose showing either of these faults from service.*
4. *Examine the 18-inch length of hose adjacent to the coupling carefully for damage, such as kinks, soft spots, cover cracks or permanent deformation. Remove hose showing any of these faults from service.*
5. *If possible, inspect the inside of the hose assembly for blisters and soft or gummy spots. Remove hose showing any of these internal faults from service.*
6. *Check couplings for damage. Replace all damaged couplings and hydrostatically test the hose assembly before returning it to service.*
7. *Check couplings for worn threads. Replace all damaged couplings and hydrostatically test the hose assembly before returning it to service.*
8. *Inspect couplings for excessive corrosion or rust. Replace all rusted couplings and hydrostatically test the hose assembly before returning it to service.*

Only trained personnel, using proper tools and procedures, should conduct the hose assembly pressure tests.

DANGER *Before conducting pressure tests on hose assemblies, provisions must be made to ensure the safety of personnel performing the tests and to prevent possible damage to property.*

9. *Use only clean water with a maximum temperature of 80º F (27 º C). Air or other compressible gas must not be used as the test medium.*
10. *Prior to building up water pressure entrapped air should be bled through an outlet valve while the hose is being filled.*
11. *The hose being pressure tested must be restrained by placing it in a series of anchored steel straps close to each end and at approximately 10-foot (3 m) intervals along the length. If failure occurs during the test the anchored straps should not destroy the hose but can prevent a whipping action from causing other damage or injury.*
12. *The outlet end of the hose should be bulwarked so that a blown-out fitting cannot escape.*
13. *Sheet metal or a heavy matting shroud must be placed over the hose end to protect testing personnel from flying objects should a hose and bulwark failure occur during testing.*
14. *Test personnel must never stand in front of or to the rear of the hose ends during testing.*

Proper Hose Storage

Hose assemblies in storage can be affected adversely by temperature, humidity, ozone, sunlight, oils, solvents, corrosive liquids and fumes, insects, rodents and radioactive materials.

The appropriate method for storing hose depends largely on the diameter and length, the quantity to be stored and the way it is packaged. Hose should not be piled or stacked to the extent that the weight of the stack creates distortions on the lengths at the bottom. Hoses with a very thin wall will not support as much load as hoses with a heavier wall or wire reinforcement. Hose shipped in coils or bales should be stored so the coils lie flat on a horizontal plane.

Hose assemblies should be stored in a container. Containers can provide protection against the deteriorating effects of oils, solvents, and corrosive liquids. Containers also give some protection against ozone and sunlight.

Rodents and insects can damage rubber hose products. Protection from them must be considered.

The ideal temperature for storing hose assemblies ranges from 35º to 80º F (2º to 27º C) with a maximum limit of 100º F (38º C). If stored below 32º F (0º C) some hose will become stiff and will required warming before being placed in service. Hose assemblies should not be stored near sources of heat, such as radiators or space heaters.

Replacing Maintenance Items

Replace the Inlet Water Filters

Dirty or incorrect filters can shorten pump life.

TASK

1. *Do the Lockout/Tagout procedure.*

   ***WARNING!** Failure to do the lockout/tagout procedure can result in equipment damage or injury to personnel.*

2. *Remove the inlet line to the high-pressure manifold and then drain the filter canister.*
3. *Open the air bleed valve located on the filter canister lid.*
4. *Open the drain valve located at the bottom of the filter body to drain the filter canister.*
5. *To remove the filter canister lid, unscrew the canister lid clamp T-bolt.*
6. *If the clamp does not disengage from the filter assembly, gently strike the clamp with a mallet to disengage it.*
7. *Remove the filter lid.*
8. *Remove the filters from the canister. Examine them for unusual contamination and then discard them.*
9. *Examine the contents of the canister.*

   These inspections can provide early warning of a change in inlet water quality. The quality of the inlet water directly affects the life of the filter.

10. *Flush the canister with fresh water or use a wet-dry vacuum to clean debris from the bottom of the canister.*
11. *Install new filter cartridges.*
12. *Align the filter canister lid to the filter body.*
13. *Apply a thin layer of blue lubricant to the threads and face of the clamp T-bolt, and then tighten the clamp.*

    You may need to strike the clamp gently with a mallet to seat correctly on the flanges.

14. *Flush the inlet line to the high-pressure manifold with fresh water to remove any contaminants that may have bypassed the filter housing.*
15. *Connect the inlet line to the high-pressure manifold.*
16. *Gradually open the inlet water valve and carefully examine the manifold and filters for leaks.*
17. *Use the bleeder valve on top of the filter housing to remove air from the system.*
18. *Do a final inspection to remove tools, parts, and rags from the equipment before startup.*

Replace the Hydraulic Oil Filters

TOOLS

- *36-mm socket and appropriate ratchet or equivalent wrench*

PARTS

- *Particulate filter*
- *Shell Morlina S3 BA 100 oil, adequate amount to fill the pump hydraulic oil reservoir*

SUPPLIES

- *Silver anti-seize*

TASK

1. *Do the Lockout/Tagout procedure.*

***WARNING!** Failure to do the lockout/tagout procedure can result in equipment damage or injury to personnel.*

2. *Remove the filter housing by turning the 36 mm nut located at the bottom of the housing.*
3. *Remove the filter.*
4. *Clean the housing.*
5. *Install a new filter.*
6. *Apply silver anti-seize to the housing threads.*
7. *Reinstall the filter housing.*
8. *Run the pump. While the pump is running, monitor the level of oil in the pump hydraulic oil reservoir. Add oil to the reservoir until the oil level is between the low and high marks of the site gauge.*

Power End Assembly

Overview

This section describes the instructions for repairing the Series 300 power frame. It must be read carefully and understood before performing any repair operations on the power frame. Proper use and adequate maintenance are fundamental for the power frame's functionality and longevity. Advanced Pressure Systems declines any responsibility for damage caused by the misuse, or the disregard of the instructions described in this section.

Improper assembly can lead to the premature failure of components. Maintenance procedures must be followed carefully; components must be properly cleaned prior to assembly and tightened to the correct torque specifications.

Power End Disassembly

DANGER *Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance.*

DANGER *Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.*

Intermediate Rod and Oil Wiper Seal Removal

1. *Use the packing nut wrench to loosen the plunger collet nut from the intermediate rod. Use a punch or screwdriver to remove the plunger collet. Insert the punch or screwdriver through the access hole in the rod and pry against the collet. If necessary, turn the pump crankshaft by hand to retract the rod and remove the collet and the collet nut.*

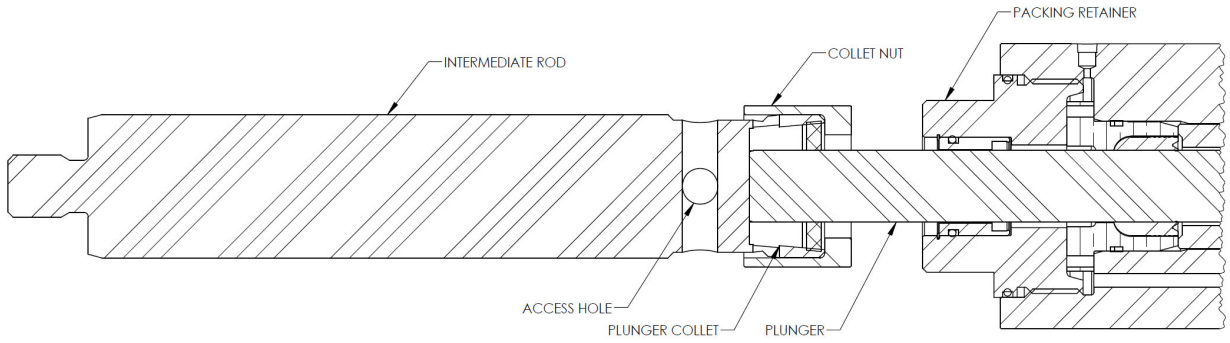


Figure 1: Intermediate Rod Removal

2. *Remove the cap screws attaching the wiper seal holder to the power frame. Leave the holder, gasket, and seals as an assembly with the intermediate rod.*

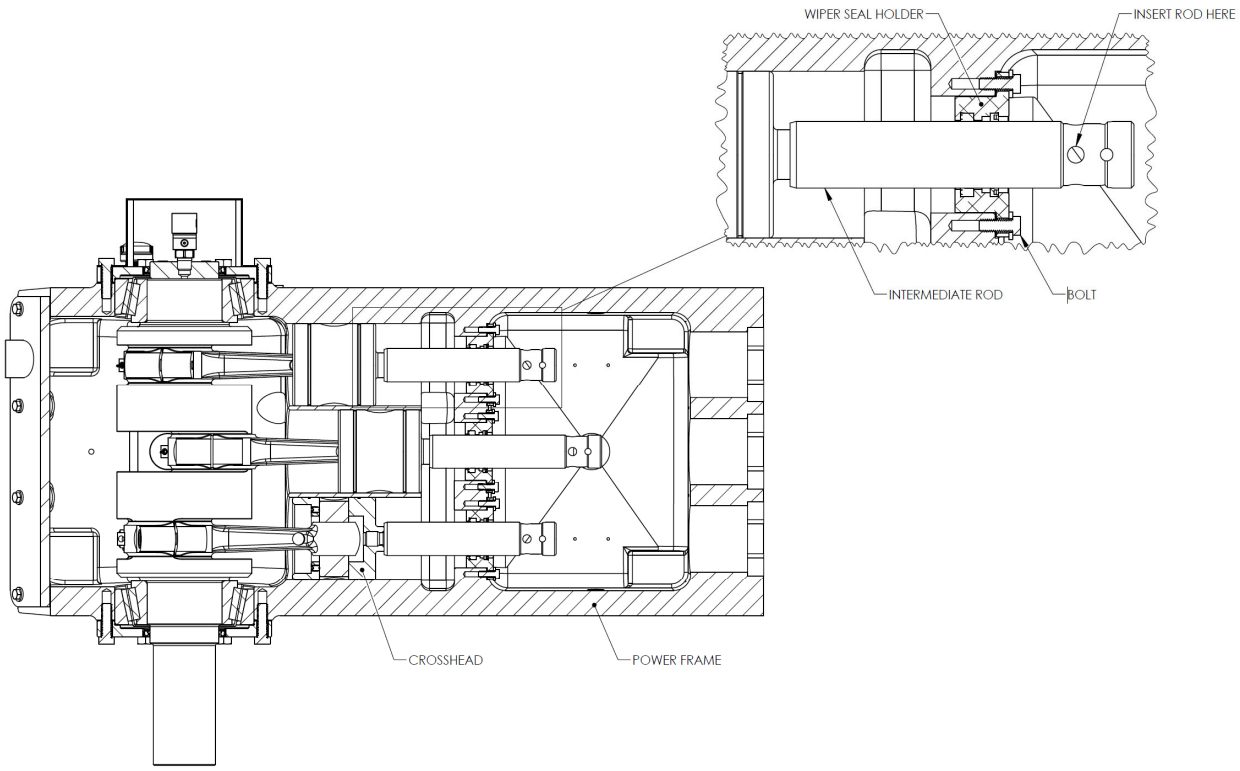


Figure 2: Wiper Seal Removal

3. *Push the plunger forward into the packing retainer.*
4. *Insert a rod into one of the holes in the end of the intermediate rod and strike with a hammer to loosen. Unscrew the rod from the crosshead and remove the wiper seal holder and the rod as an assembly.*
5. *Repeat this procedure for the remaining two intermediate rods.*

⚠ CAUTION *Take care not to score the area where the oil wiper seal rides.*

Crankshaft Removal

1. *Drain the oil following the procedure, Power End Lubrication, and remove the rear inspection cover.*
2. *Cut the safety wires on the connecting rod bolts.*
3. *Guide tubes are used around the connecting rod bolts to align the connecting rod caps with the connecting rods. To remove the rod caps, loosen the rod bolts approximately 3/4-inch from the caps. Alternately, tap the upper and lower bolts until the guide tubes break free from the rods. Note the position of each of the metal stamped rod caps and remove the caps.*
4. *Push the three connecting rod assemblies fully forward, away from the crankshaft.*

⚠ CAUTION *Ensure the oil seal is protected during removal.*

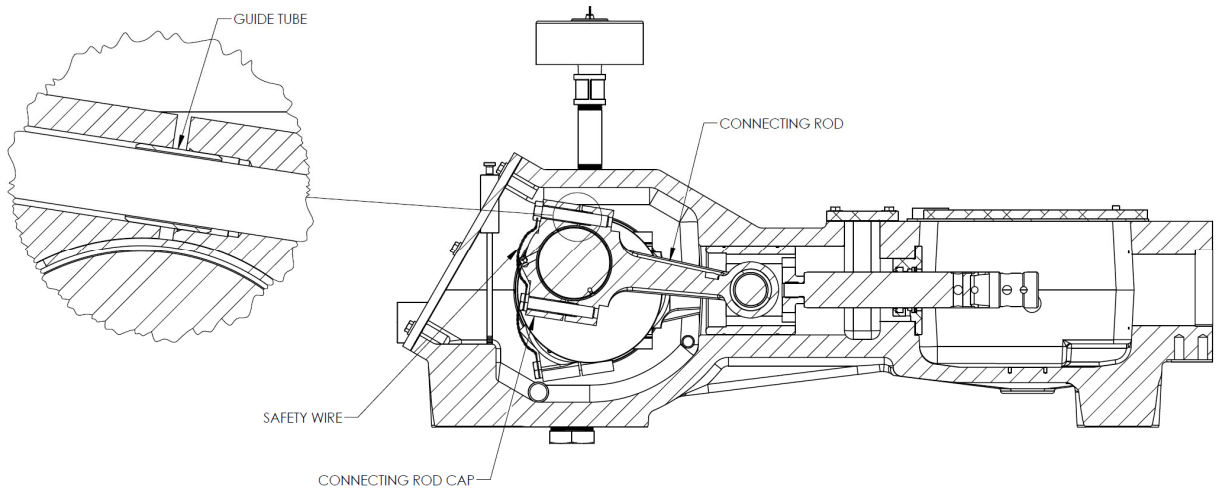


Figure 3: Connecting Rod Cap Removal

5. *Remove the cap screws from the bearing retainers on both ends of the crankshaft. Pry the retainers loose with the o-ring, oil seal and shims intact. Do not remove the main roller bearings from the crankshaft. Tie the shims to their respective retainers and mark for reassembly in the original location.*
6. *Support the crankshaft during removal by placing a piece of wood inside the power frame under the crankshaft. Pull the crankshaft out of the power frame while supporting the outer race on the bearings as they are removed with the crankshaft.*

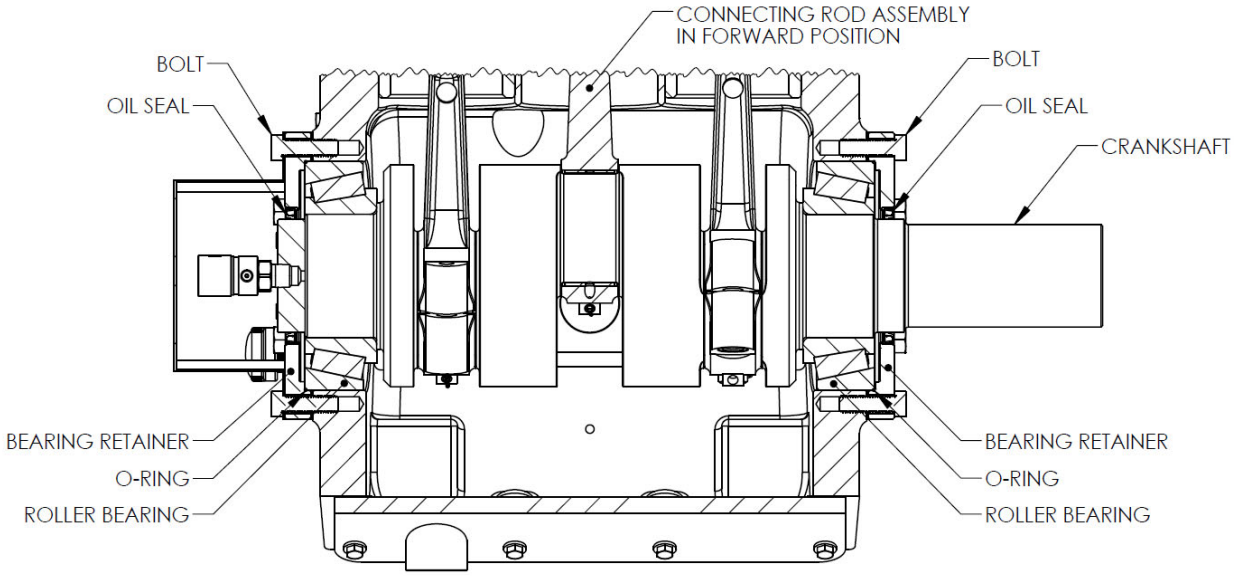


Figure 4: Crankshaft Removal

7. *Inspect the tapered roller bearings while on the crankshaft. The bearings should not be removed unless worn or damaged.*

Connecting Rod Removal

1. *Remove the connecting rod/crosshead assembly from the power end.*
2. *Lightly heat the setscrews in the wrist pins to soften the Loctite and remove the screws.*
3. *Use a hydraulic press or a brass rod and hammer to press the wrist pins out of the crossheads.*
4. *Slide the connecting rod assemblies out of the crossheads.*

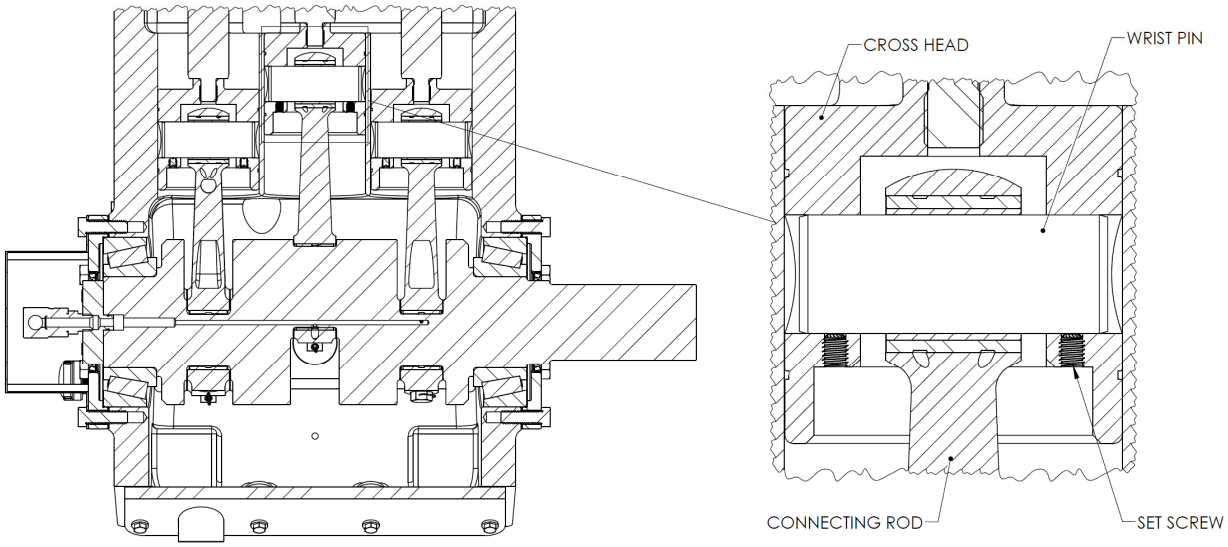


Figure 4: Crankshaft Removal

Power End Installation

In addition to component installation, the following procedures include instructions for replacing wear components.

Main Roller Bearing Replacement

If replacement is required, remove the main roller bearings from the crankshaft and proceed with Step 1 below.

1. *Thoroughly clean and remove all burrs from the ID of the new roller bearing assemblies and from the bearing surfaces on the crankshaft.*
2. *Heat the new bearing assemblies in a controlled temperature oil bath to 280º F (138 ºC)*

   ⚠ CAUTION *Avoid overheating the bearing assemblies. Do not use a torch to heat the bearings.*

3. *When the bearings have reached the specified temperature, firmly support the crankshaft and install the bearing assemblies on the crankshaft. Press fit the bearing assemblies firmly against the shoulders on the crankshaft with the high side of the tapered roller toward the crankshaft journal.*

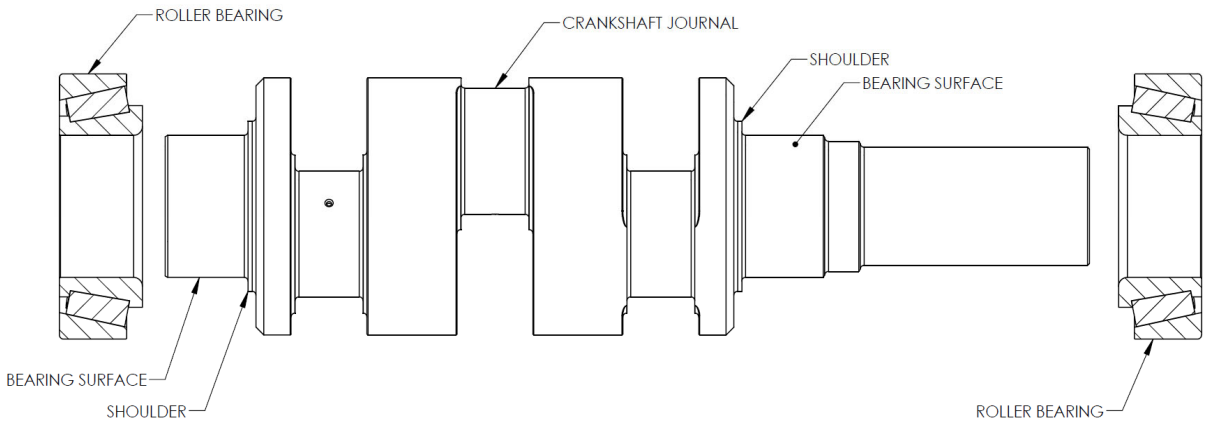


Figure 5: Main Roller Bearing Replacement

Connecting Rod & Crosshead Assembly Installation

1. *Remove all burrs and nicks from the connecting rod, crosshead and wrist pin bearing assembly.*
2. *Remove all burrs and nicks from the connecting rod, crosshead and wrist pin bearing assembly. After installation, test the fit with a wrist pin. There should be no binding. Allowable clearance between the pin and the bearing is 0.001-0.007" (0.025-0.178 mm).*

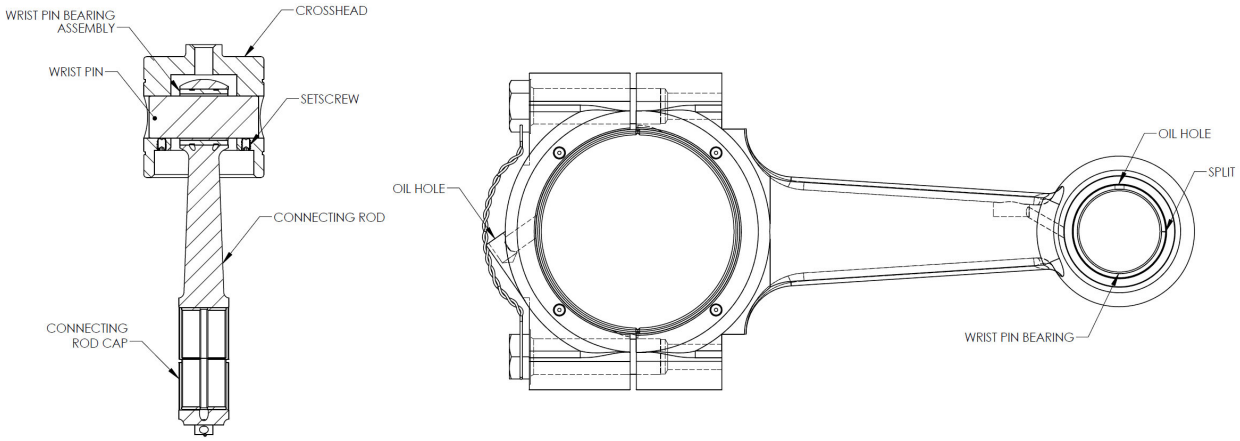


Figure 6: Connecting Rod and Crosshead Assembly

3. *Chill the wrist pin. Insert the connecting rod into the crosshead. Press the wrist pin into the crosshead bore, through the wrist pin bearing. Interference between the pin and the crosshead is 0.0015-0.0030" (0.038- 0.073 mm).*

   NOTICE *To ease assembly, the crosshead may be preheated in an oil bath to no more than 280º F (138 ºC).*

4. *Apply a light coat of Loctite 262 to the setscrew and firmly tighten against the wrist pin.*
5. *Remove the match marked rod cap from the connecting rod and set aside.*
6. *Slide the connecting rod/crosshead assembly into the crosshead bore of the power frame.* ***Be sure to install the connecting rod with the oil holes facing up.*** *Note the position of each*

connecting rod as indicated by the two-digit number stamped on the end of the rod. The crosshead is a sliding fit in the bore with an allowable clearance of 0.010-0.015" (0.254-0.384 mm).

7. *Repeat this procedure for the remaining two assemblies.*

NOTICE *The connecting rod and crosshead assemblies must be installed and pushed forward into the crosshead bores in the power frame prior to installing the crankshaft.*

Crankshaft Installation

1. *Verify the main roller bearing bores in the pump frame are clean and free from burrs.*
2. *Place a piece of wood, approximately 2 inches thick, in the bottom of the power frame to support the crankshaft during installation.*

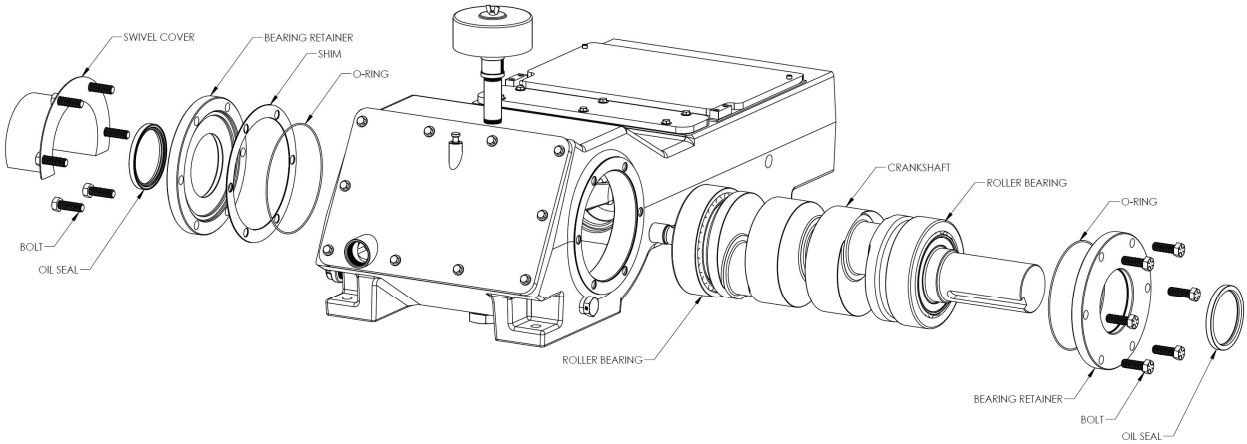


Figure 6: Crankshaft Installation

3. *With the roller bearing assemblies in position on the crankshaft, slide the crankshaft through either of the power end bearing bores.*
4. *The bearing outer races are a slip fit in the power frame with an allowable clearance of 0.001-0.003" (0.025-0.076 mm). Use a brass hammer to tap the races into the power frame until the bearing retainer cap screws will draw them in the rest of the way.*
5. *Install the shims, o-rings and bearing retainers in their original locations.*
6. *Rotate the crankshaft occasionally to be sure it is not binding. If the crankshaft begins to lock up, add shims under one of the bearing retainers as needed.*
7. *Adjust the roller bearings by removing shims until there is a slight drag when the crankshaft is rotated manually. Then add shims to remove the drag or preload, approximately 0.001-0.003" (0.025-0.076 mm).*

NOTICE *Divide the total thickness of shims as equally as possible between the two bearing retainers to center the crankshaft in the power frame.*

8. *Torque the cap screws in the bearing retainer to 120 ft-lbs. (163 Nm) and perform the final test of the crankshaft. The bearings are correctly adjusted when there is no noticeable play on the end of the crankshaft and the crankshaft rotates freely.*

   ⚠ CAUTION *Do not preload the main roller bearings.*

9. *Replace the oil seal on the drive side, bearing retainer. Cover sharp edges on the keyway in the crankshaft extension to protect the seal from damage during installation. Press the new seal into the retainer so the lip faces the bearing. The outer lip excludes dirt and moisture.*

Crankshaft Journal Bearing Replacement

The two-piece journal bearings on the crankshaft are tri-metal steel shells, non-adjustable and easily replaced when worn. The bearings must be inspected periodically and replaced as required.

1. *Thoroughly clean the crankshaft journals and the bearing surface on the connecting rod and its mating cap. Lightly oil the crankshaft journal.*
2. *Snap the half of a bearing set into the connecting rod, ensuring the tang on the end of the bearing fits into the small groove in the rod. Snap the other half of the bearing into the rod cap.*

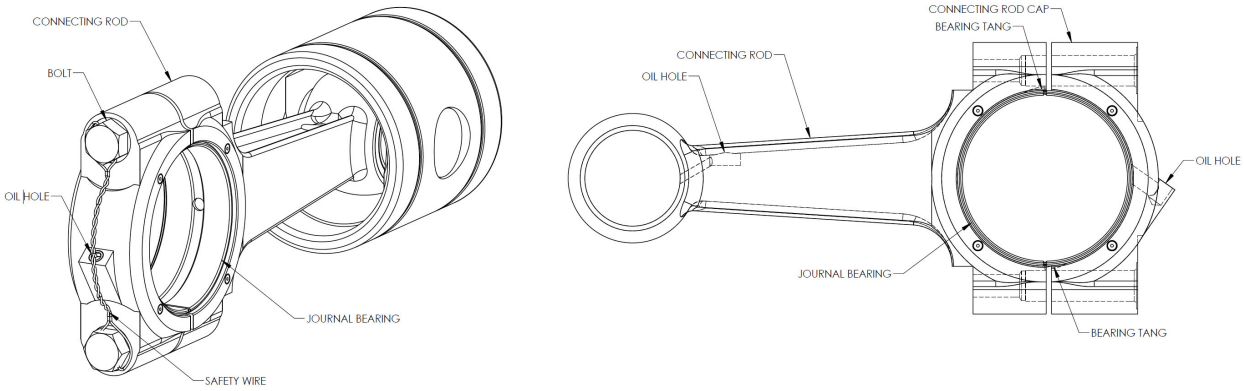


Figure 7: Crankshaft Journal Bearing Installation

3. *Verify the oil hole in the connecting rod is facing up. Pull the connecting rod up to the crankshaft and place the rod cap in position on the crankshaft journal.*
4. *Thread the connecting rod bolts into the connecting rod and evenly torque the bolts to 120 ft-lbs. (163 Nm). Do not lubricate the rod bolt threads.*
5. *Manually rotate the crankshaft once to check for binding.*
6. *Using the drilled holes in the head of the rod bolts, crosswire the two bolts to each other to prevent the bolts from loosening.*
7. *Repeat this procedure for the remaining two connecting rods.*
8. *Replace the oil in the power end following the procedure, Power End Lubrication.*

Crankshaft Wiper Seal Replacement

1. *Clean the groove ID in the wiper seal holder. Install the oil wiper seals in the holder with 2 of the seal lips of the seal facing the inside and 2 facing the outside.*

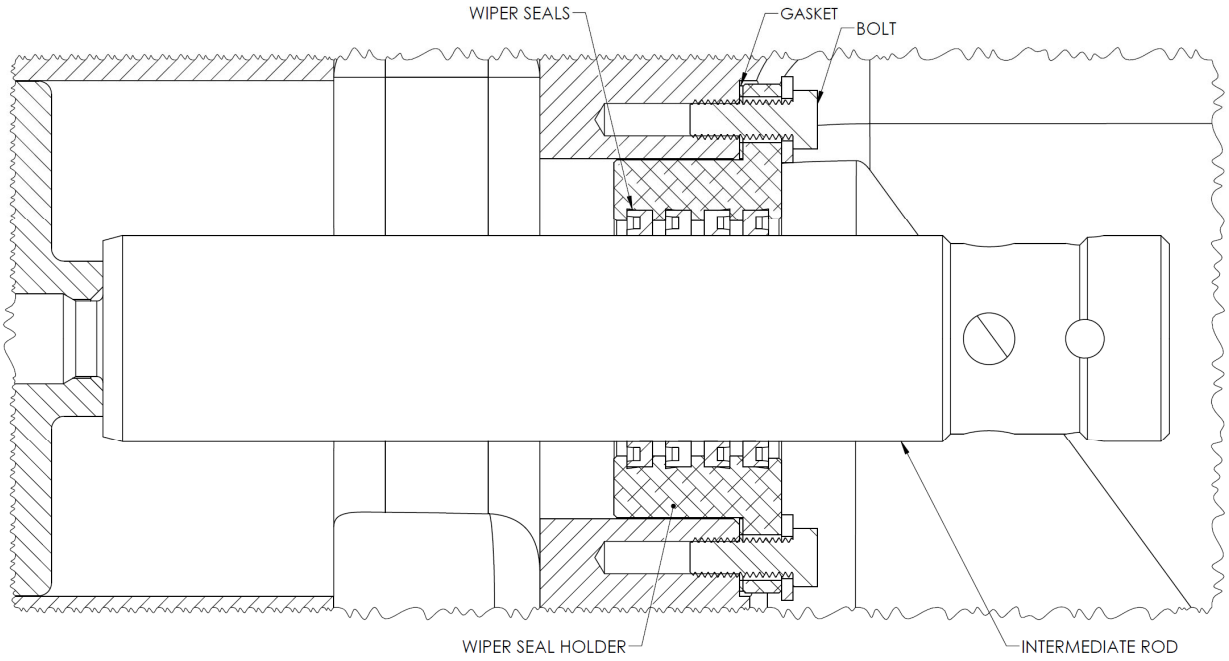


Figure 8: Intermediate Rod Installation

2. *Apply an oil resistant sealant to one side of the gasket to hold it in position and install the gasket onto the power frame.*
3. *With the stamped TOP marking on the holder facing up, push the seal holder onto the intermediate rod and hand-tighten the rod into the crosshead.*
4. *Tighten the rod and wiper seal assembly into the crosshead by inserting a steel bar into the access holes in the rod and striking the bar with a hammer.*
5. *Push the seal holder into the power frame and tighten the cap screws to secure it to the frame.*
6. *Repeat this procedure for the remaining two intermediate rods.*

Power End Lubrication

The use of quality lubricating oils, combined with appropriate condensed water drain and oil filter change intervals, are critical factors in maintaining performance and durability. Change the power end oil every 500 hours or six (6) months, or as frequently as operating conditions require to maintain clean, sludge and moisture free oil or proper viscosity.

See section 'Specifications', for recommended types of power end lubricating oils.

Types of Lubrication

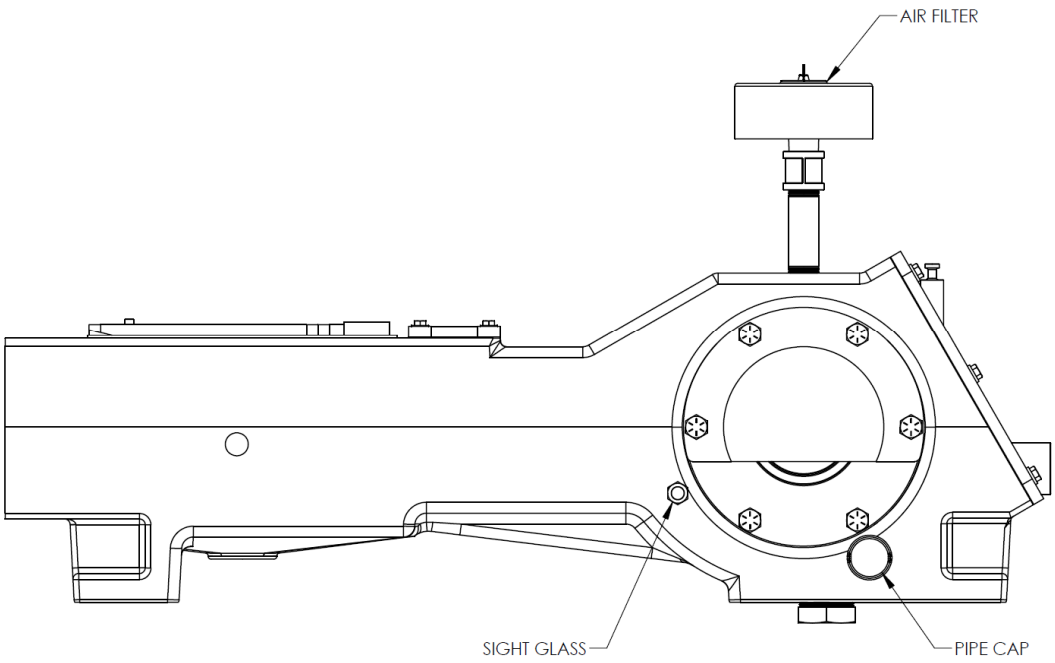
The power frame of the S300 utilizes two methods for lubricating the journal bearings. These include splash lubrication and force lubrication. The utilization of the force lubrication method allows for a higher load on the connecting rods, thus a higher horsepower rating.

When utilizing the splash lubrication method, the oil hole in the connecting rod cap is left open. The rotation of the crankshaft allows oil to 'splash' into this orifice and is drawn to the journal bearing via capillary action.

When utilizing the force lubrication method, the oil hole in the connecting rod cap is plugged. Oil is forced through the drilled crankshaft to lubricate the journal bearings.

Oil Replacement

1. *Drain the oil from the power end by removing the pipe cap shown below.*
2. *Replace the oil by removing the air filter and filling the power end from this location.*
3. *Fill oil until the level reaches the center of the sight gauge.*



LP Fluid End Assembly

Maintenance Overview

The following table provides a listing of low-pressure fluid end assemblies included in this portion of the manual.

LOW PRESSURE FLUID END ASSEMBLIES		
PART NO.	PLUNGER SIZE	DESIGN PRESSURE*
25-510-024	1-1/2" (1.50)	10,000 PSI (689 BAR)
25-510-026	1-5/8" (1.63)	10,000 PSI (689 BAR)
25-510-028	1-3/4" (1.75)	10,000 PSI (689 BAR)
25-510-030	1-7/8" (1.88)	10,000 PSI (689 BAR)

**Fluid end designed for stated pressure, rod load not to exceed 15,700 lbs for splash lubricated, 17,500 lbs for forced systems.*

Never perform any type of maintenance on the fluid end assembly while it is pressurized. Always turn the power off and bleed the high-pressure water before servicing.

Improper assembly can lead to the premature failure of components. Maintenance procedures must be followed carefully; components must be properly cleaned prior to assembly and tightened to the correct torque specifications.

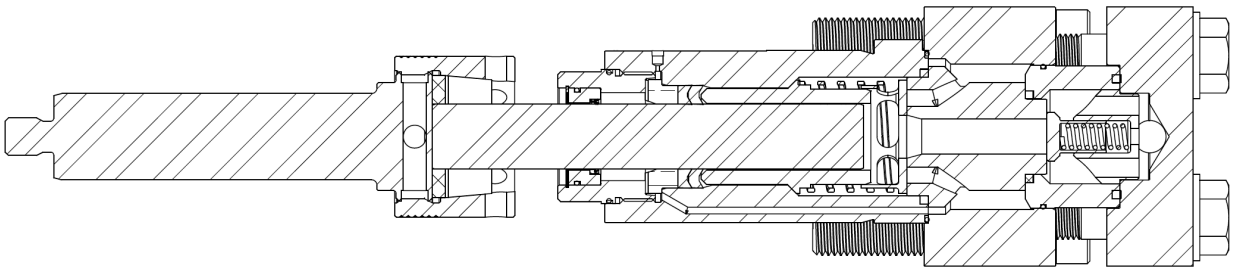


Figure 1: Fluid End Assembly

NOTICE *Refer to fluid end drawing for a complete listing of replacement parts and part numbers.*

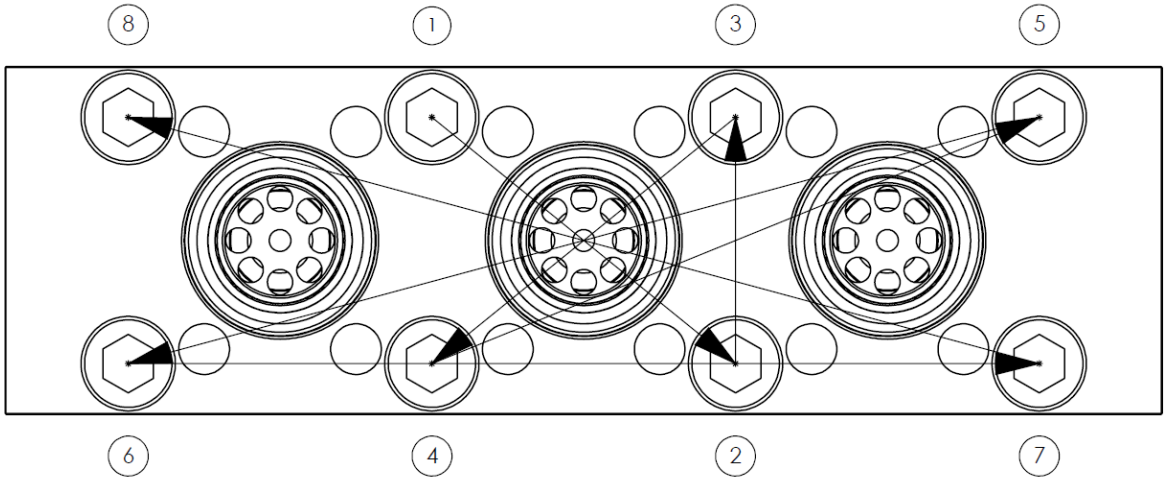
Specialized Maintenance Tools

Most of the tools required to maintain and adjust the Series 300 pump can be found in an ordinary set of mechanics hand tools.
APS has designed specialized tool kits to facilitate the removal and installation of some system components. These tool kits are supplied with each pump and are in the table below.

TOOL KIT	25-500-021
PACKING NUT WRENCH	25-500-022
VALVE SEAT PULLER	61115311
PACKING CARTRIDGE REMOVAL TOOL	61121208

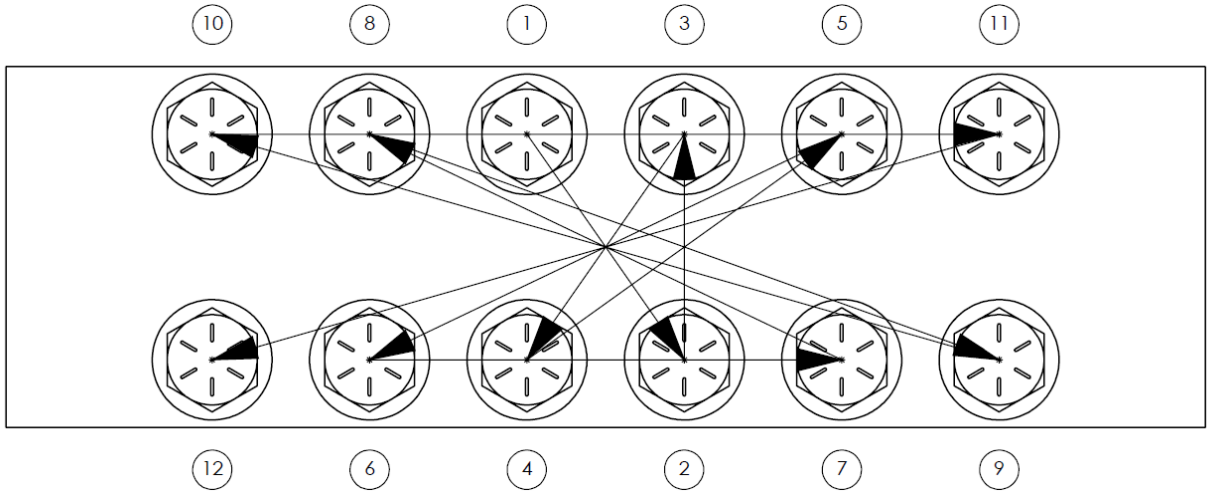
Torque Specification

- *Suction Manifold:*



1. *Apply silver grade anti-seize to threads and torque to 500 ft. lbs. in increments of 100 ft. lbs.*
2. *Tighten bolts in order indicated by numbers.*

- *Discharge Manifold:*



1. *Apply silver grade anti-seize to threads and torque to 350 ft. lbs. in increments of 100 ft. lbs.*
2. *Tighten bolts in order indicated by numbers.*

- *Plunger Collet Nut*

1. *Apply silver grade anti-seize to threads and torque to 60 ft. lbs.*

Valve Assemblies

The fluid end valves are spring loaded, flat disc and seat type. Both the discharge and suction valves and seat can be removed from the front of the fluid end.

Valves and seating surfaces encounter high wear during operation. Frequent inspection, maintenance and/or replacement are required to ensure proper operation. Poor suction and water quality can reduce valve life and result in rapid mechanical wear of the power end components.

- *Valve springs should be replaced after 2,000 hours of operation to reduce the possibility of a fatigue break; or when the coils have flat wear spots due to rubbing during normal operation.*
- *The valve seat provides a seating surface for both the discharge and suction valve. Valve seat surfaces are flat and can be restored by surface grinding to a 4 to 16 RMS surface finish.*
- *Mating surfaces of the valve seat and the valves must be smooth and free from nicks and scratches.*

DANGER *Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance.*

DANGER *Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.*

1. *Disconnect all piping to the discharge manifold.*
2. *Remove the cap screws and washers attaching the discharge manifold to the suction manifold. Lift and remove the discharge manifold, separating it from the discharge spacers.*

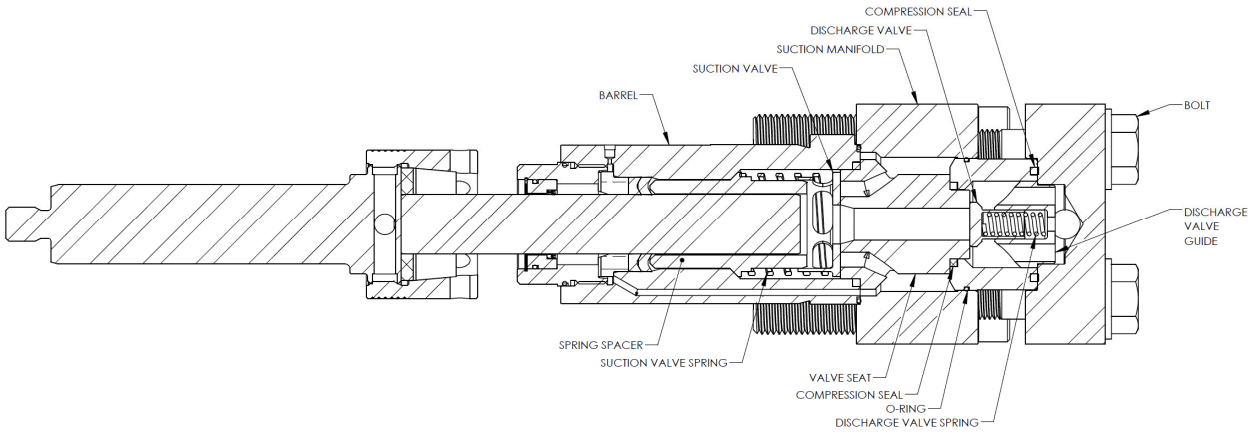


Figure 2: Valve Removal

3. *Remove the discharge valve guide, discharge valve and valve spring from the spacer.*
4. *Use the valve seat puller to remove the discharge spacer and valve seat as one piece. Inspect the o-ring and two compression seals installed on the spacer. Do not remove the components unless they are damaged and require replacement.*

5. *Remove the suction valve, valve spring and spring spacer from the barrel by pulling the components out through the bore in the suction manifold.*
6. *Assemble a new suction valve, suction valve spring and spring spacer as one assembly and install in the barrel, spacer first.*
7. *Inspect the valve seat for damage and replace or rework if necessary. Install the valve seat in the barrel ensuring the suction side is installed first. The suction side includes a center hole with several smaller holes around the flat surface of the seat.*
8. *Apply a light coat of Loctite 76764 anti-seize or equivalent to the suction manifold bore and press the discharge spacer into the manifold until it contacts the valve seat. Tap into position with a rubber mallet.*
9. *Assembly a new discharge valve guide, discharge valve spring and discharge valve as one assembly and insert in the discharge spacer, valve first.*
10. *Lift the discharge manifold into position, ensuring the shoulders on the discharge spacers slip into the counter-bores in the manifold.*
11. *Apply Loctite 76764 anti-seize or equivalent to the threads on the cap screws and install the washers and screws. Torque the screws to the specifications above, Torque Specifications.*

Packing Assemblies

Depending on plunger size, high pressure units utilize either a packing cartridge or a chevron style packing. Replacement procedures differ for each style and are detailed below.

Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance on the system components.

Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.

Chevron Packing

1. *Use the packing nut wrench to loosen the plunger collet nut from the intermediate rod. Insert the collet removal tool through the access hole in the collet nut and pry against the collet to loosen. If necessary, turn the pump crankshaft by hand to retract the rod and remove the collet and the collet nut.*
2. *Break loose but do not unscrew the intermediate rod.*
3. *Push the plunger forward through the packing retainer.*
4. *Remove the cap screws attaching the oil wiper seal holder to the power frame. Slide the holder forward, leaving it on the intermediate rod.*
5. *Use the access holes in the intermediate rod to unscrew the rod from the crosshead and remove the rod and wiper seal holder as an assembly.*

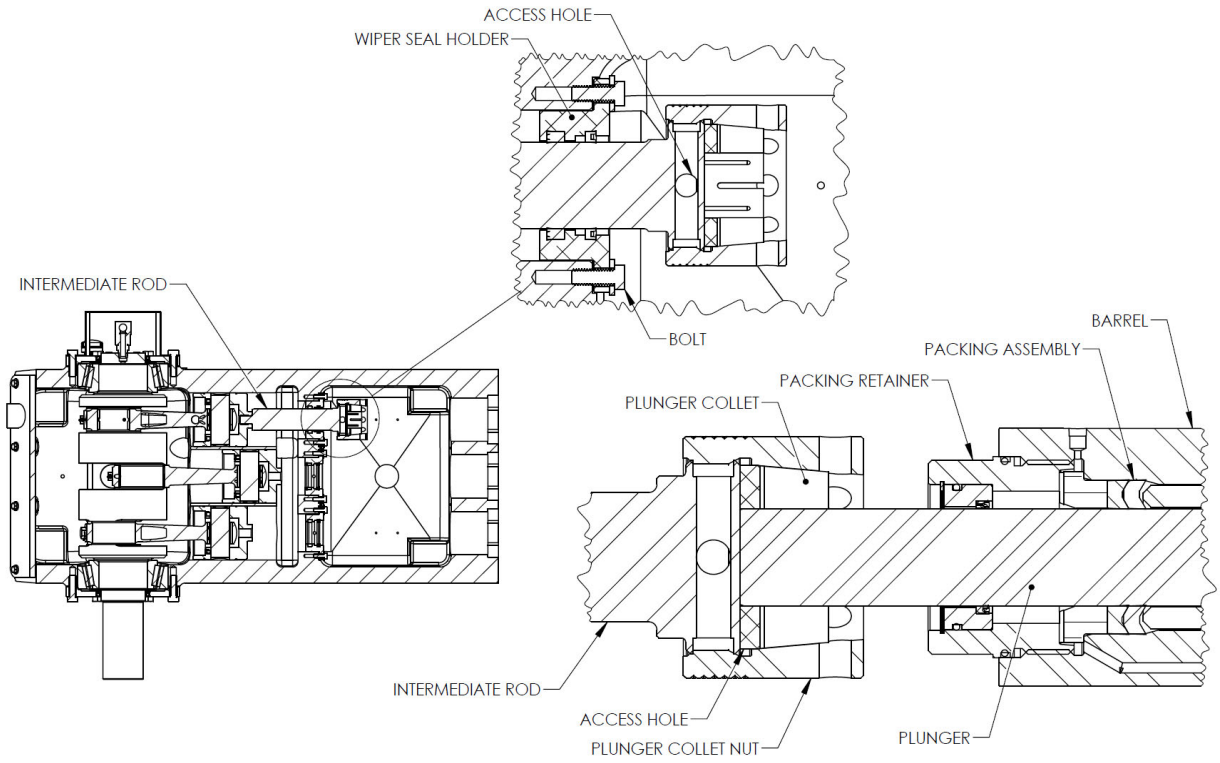
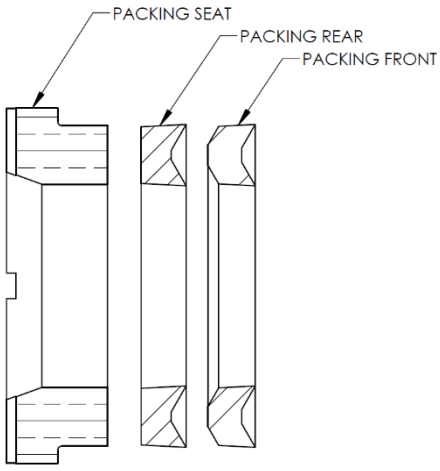


Figure 3: Packing Removal

⚠ CAUTION *Take care not to score the area where the oil wiper seal rides.*

6. *Remove the plunger from the packing retainer by pulling it straight back, into the opening in the power frame.*
7. *Use the packing nut wrench or a large pipe wrench to unscrew the packing retainer from the barrel.*
8. *Remove the packing seat and packing from the barrel.*
9. *With the plunger removed from the barrel, slide the new front and rear packing onto the plunger. Position the packing in the middle of the plunger and slide the packing seat onto the plunger behind the rear packing.*
10. *Position the plunger in the barrel and center the packing in the beveled guide at the barrel entrance.*
11. *Rotate the crankshaft until the crosshead is moved to the rear of the power frame. Screw the intermediate rod with the oil wiper seal holder into the crosshead and hand-tighten. Insert a lever into the access holes in the rod and strike the rod with a hammer to tighten. Push the oil wiper seal holder into the power frame and tighten the screws to secure it to the power frame.*



12. *Inspect the o-ring on the packing retainer and replace if necessary. Thoroughly coat the threads on the packing retainer and on the barrel with Loctite 76764 anti-seize or equivalent and position the retainer on the plunger. Use the packing nut wrench to screw the packing retainer into the barrel. Continue turning until the retainer and packing seat make metal-to-metal contact against the barrel. Maintain pressure on the packing nut wrench and strike the wrench once with a hammer to complete.*
13. *Place the collet nut and collet on the plunger. Rotate the crankshaft by hand until the intermediate rod contacts the plunger. Slide the collet and collet nut up to the rod. Tighten and torque to the specifications in the section above, Torque Specifications. If the plunger is too far forward to contact the intermediate rod, tighten the collet nut and rotate the pump by hand to withdraw the plunger. Then loosen the collet nut and advance the rod one more time before final tightening.*

⚠ CAUTION *The intermediate rod must contact the plunger before tightening. Failure to do so can result in damage to the plunger as the pump reaches full operating pressure.*

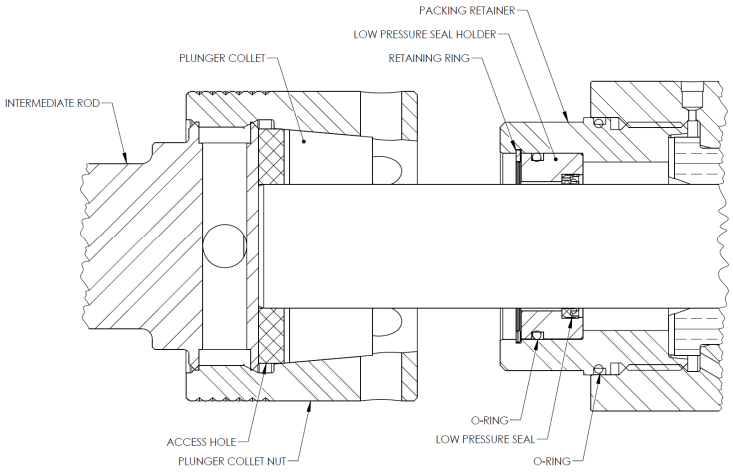
14. *When all three plungers are installed, turn the crankshaft one complete revolution by hand to ensure nothing interferes with the plunger's movement.*

Low Pressure Seal Assemblies

⚠ DANGER *Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance on the system components.*

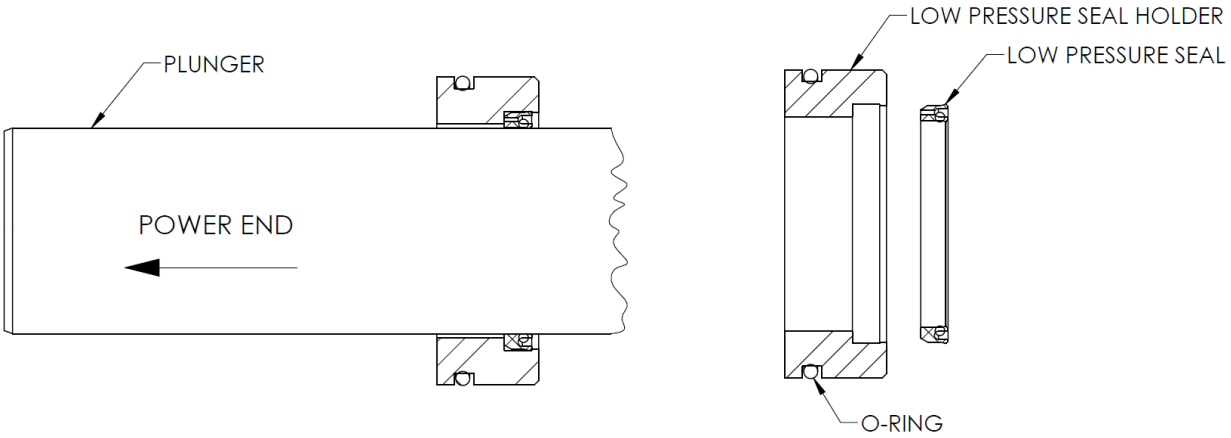
⚠ DANGER *Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.*

1. *Use the packing nut wrench to loosen the plunger collet nut from the intermediate rod. Use a punch or screwdriver to remove the plunger collet. Insert the punch or screwdriver through the access hole in the rod and pry against the collet to loosen. If necessary, turn the pump crankshaft by hand to retract the rod and remove the collet and the collet nut.*



2. *Rotate the crankshaft to fully retract the intermediate rod.*
3. *Use the packing nut wrench to unscrew the packing retainer.*
4. *Remove the retaining ring and then remove the low-pressure seal holder from the packing retainer.*
5. *Remove the low-pressure seal and the o-ring from the holder.*

   NOTICE *Some plunger sizes do not utilize an o-ring on the low-pressure seal holder.*
6. *Install a new low-pressure seal in the seal holder and install a new o-ring on the holder, if applicable. Ensure the correct orientation of the seal as illustrated below.*



7. *Apply a small amount of FML-2 grease to the o-ring and insert the seal holder into the packing retainer. Secure the holder in position with the retaining ring.*
8. *Apply Loctite 76764 anti-seize or equivalent to the threads on the packing retainer and install the retainer on the plunger. Use the packing nut wrench to tighten the retainer into the barrel.*
9. *Place the collet nut and collet on the plunger. Rotate the crankshaft by hand until the intermediate rod contacts the plunger. Slide the collet and collet nut up to the rod. Tighten and torque to the specifications in the above section, Torque Specifications. If the plunger is too far forward to contact the intermediate rod, tighten the collet nut, and rotate the pump by hand to withdraw the plunger. Then loosen the collet nut and advance the rod one more time before final tightening.*

   ⚠ CAUTION *The intermediate rod must contact the plunger before tightening. Failure to do so can result in damage to the plunger as the pump reaches full operating pressure.*
10. *When all three plungers are installed, turn the crankshaft one complete revolution by hand to ensure nothing interferes with the plunger's movement.*

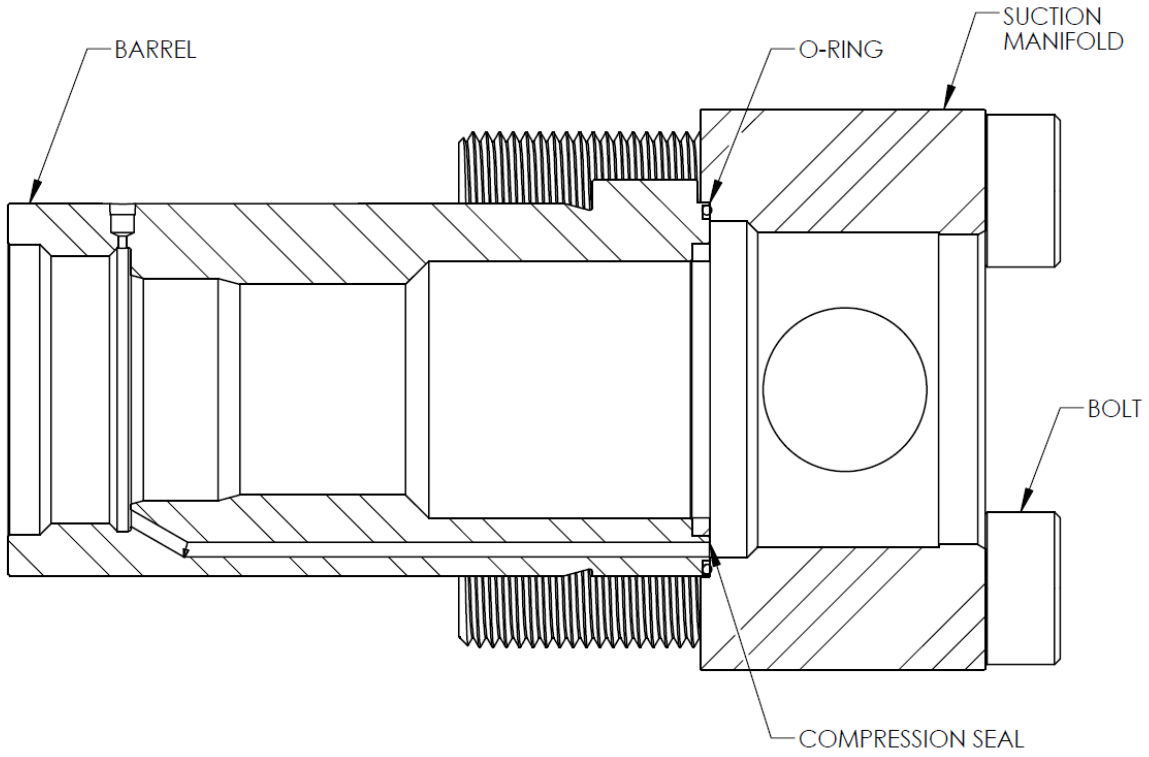
Barrel Assemblies

Before the barrels can be removed for service, the valve and packing assemblies must be removed. Follow the procedures detailed above for removing these assemblies and then proceed with Step 1 below.

DANGER *Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance on the system components.*

DANGER *Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.*

1. *Remove the cap screws attaching the suction manifold to the power frame. Remove the suction manifold to expose the o-rings and compression seals in the barrels. Remove the o-rings and the seals.*



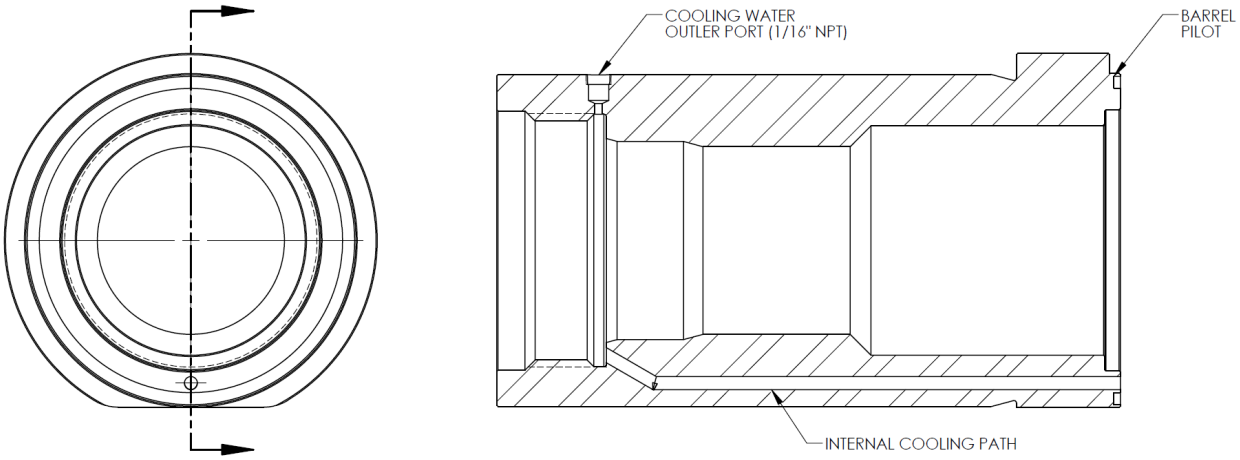
2. *Use a brass hammer to tap out the barrels. If removal by tapping is not possible, a hand operated hydraulic jack is recommended.*

NOTICE *If using a hydraulic jack, reinforce the face of the power frame with a 6" x 14" x 1/2" steel plate.*

3. *Remove any nicks or burrs from all mating surfaces on the power frame and the barrels.*

4. *Insert the barrels into the power frame, aligning the cooling water ports as shown below. The barrel should be positioned in the power frame with the cooling water port aligned with the relief in the power frame to permit the attachment of the cooling lines.*

⚠ CAUTION *Place a block of wood over the end of the barrel to prevent damage while tapping it into position.*



5. *Insert the o-ring and the compression seal into the appropriate grooves on the face of the barrel. Apply a light coat of FML-2 grease to the o-ring to hold it in position.*
6. *Install the suction manifold by carefully positioning the counter-bores on the manifold over each of the barrel pilots.*
7. *Apply Loctite 76764 anti-seize or equivalent to the threads on the cap screws and install the screws to secure the manifold to the power frame. Verify that none of the o-rings have shifted during the installation of the manifold. Cross torque the screws to the specifications in the above section, Torque Specifications.*

HP Fluid End Assembly

Maintenance Overview

The following table provides a listing of low-pressure fluid end assemblies included in this portion of the manual.

HIGH PRESSURE FLUID END ASSEMBLIES		
PART NO.	PLUNGER SIZE	DESIGN PRESSURE*
25-520-012	3/4" (0.75)	20,000 PSI (1,379 BAR)
25-520-014	7/8" (0.88)	20,000 PSI (1,379 BAR)
25-520-016	1" (1.00)	20,000 PSI (1,379 BAR)
25-520-018	1-1/8" (1.13)	20,000 PSI (1,379 BAR)
25-520-020	1-1/4" (1.25)	20,000 PSI (1,379 BAR)
25-520-022	1-3/8" (1.38)	20,000 PSI (1,379 BAR)

**Fluid end designed for stated pressure, rod load not to exceed 15,700 lbs for splash lubricated, 17,500 lbs for forced systems.*

Never perform any type of maintenance on the fluid end assembly while it is pressurized. Always turn the power off and bleed the high-pressure water before servicing.

Improper assembly can lead to the premature failure of components. Maintenance procedures must be followed carefully; components must be properly cleaned prior to assembly and tightened to the correct torque specifications.

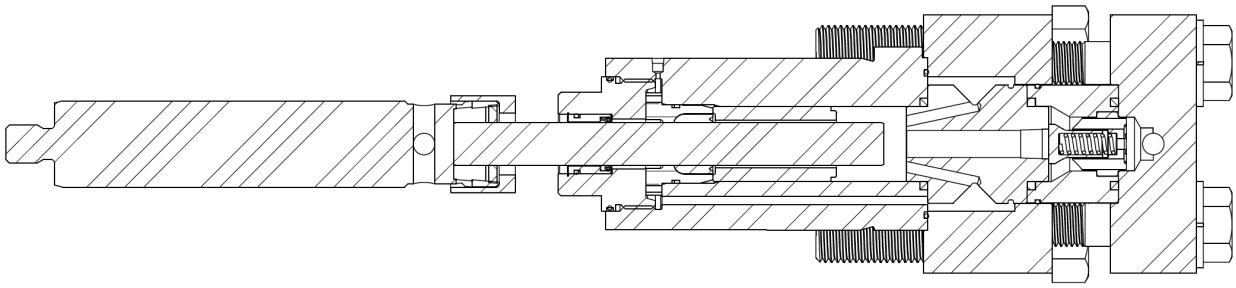


Figure 1: Fluid End Assembly

NOTICE *Refer to fluid end drawing for a complete listing of replacement parts and part numbers.*

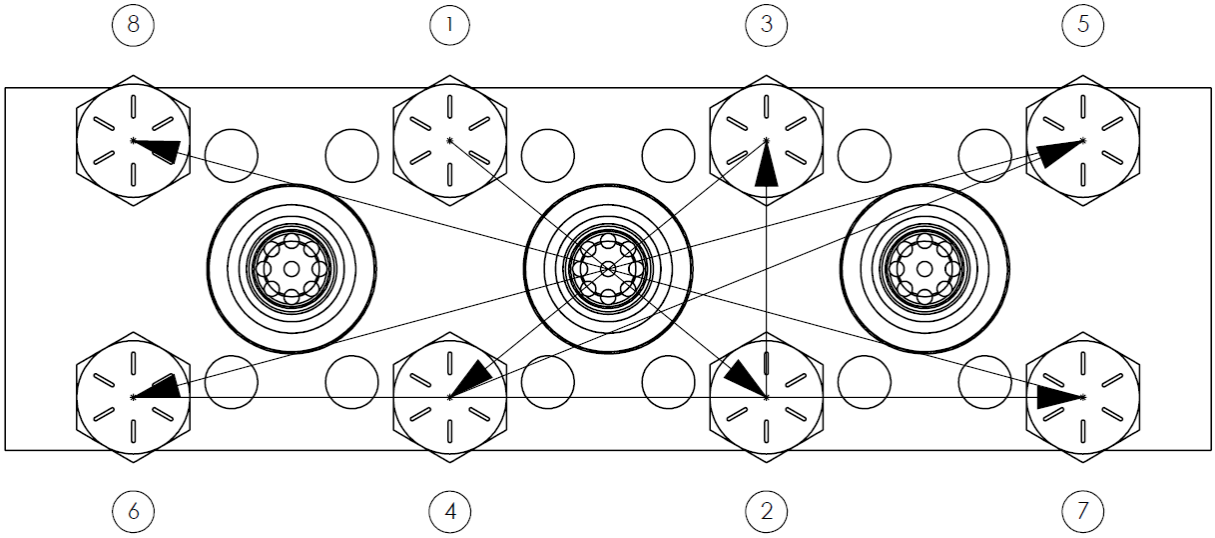
Specialized Maintenance Tools

Most of the tools required to maintain and adjust the Series 300 pump can be found in an ordinary set of mechanics hand tools.
APS has designed specialized tool kits to facilitate the removal and installation of some system components. These tool kits are supplied with each pump and are in the table below.

TOOL KIT	61109016
PACKING NUT WRENCH	61122702
VALVE SEAT PULLER	61115311
PACKING CARTRIDGE REMOVAL TOOL	61121208

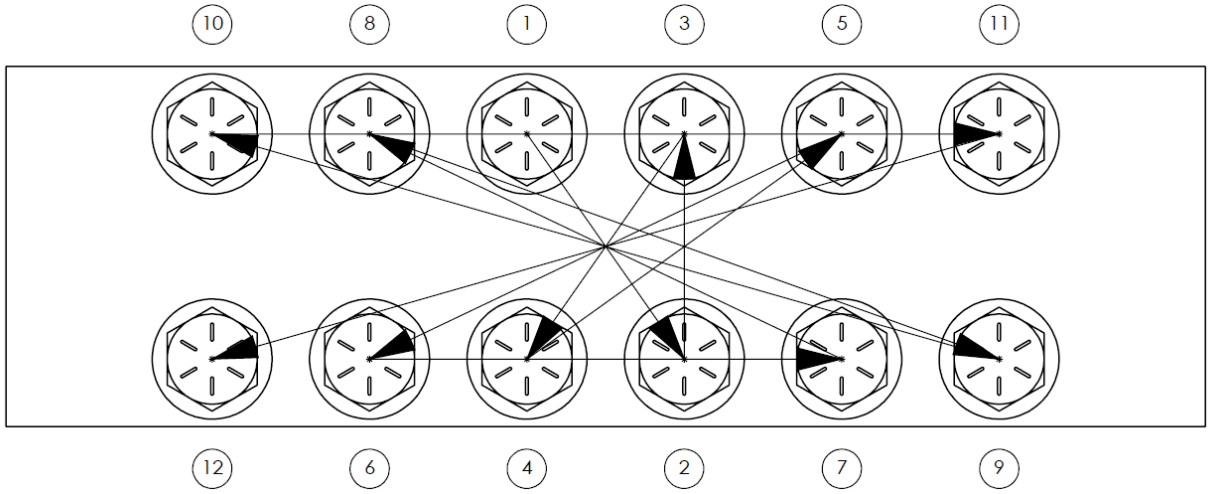
Torque Specification

- *Suction Manifold:*



3. *Apply silver grade anti-seize to threads and torque to 500 ft. lbs. in increments of 100 ft. lbs.*
4. *Tighten bolts in order indicated by numbers.*

- *Discharge Manifold:*



3. *Apply silver grade anti-seize to threads and torque to 300 ft. lbs. in increments of 100 ft. lbs.*
4. *Tighten bolts in order indicated by numbers.*

- *Plunger Collet Nut*

2. *Apply silver grade anti-seize to threads and torque to 60 ft. lbs.*

Valve Assemblies

The fluid end valves are spring loaded, flat disc and seat type. Both the discharge and suction valves and seat can be removed from the front of the fluid end.

Valves and seating surfaces encounter high wear during operation. Frequent inspection, maintenance and/or replacement are required to ensure proper operation. Poor suction and water quality can reduce valve life and result in rapid mechanical wear of the power end components.

- *Valve springs should be replaced after 2,000 hours of operation to reduce the possibility of a fatigue break; or when the coils have flat wear spots due to rubbing during normal operation.*
- *The valve seat provides a seating surface for both the discharge and suction valve. Valve seat surfaces are flat and can be restored by surface grinding to a 4 to 16 RMS surface finish.*
- *Mating surfaces of the valve seat and the valves must be smooth and free from nicks and scratches.*

DANGER *Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance.*

DANGER *Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.*

1. *Disconnect all piping to the discharge manifold.*
2. *Remove the cap screws and washers attaching the discharge manifold to the suction manifold. Lift and remove the discharge manifold, separating it from the discharge spacers.*

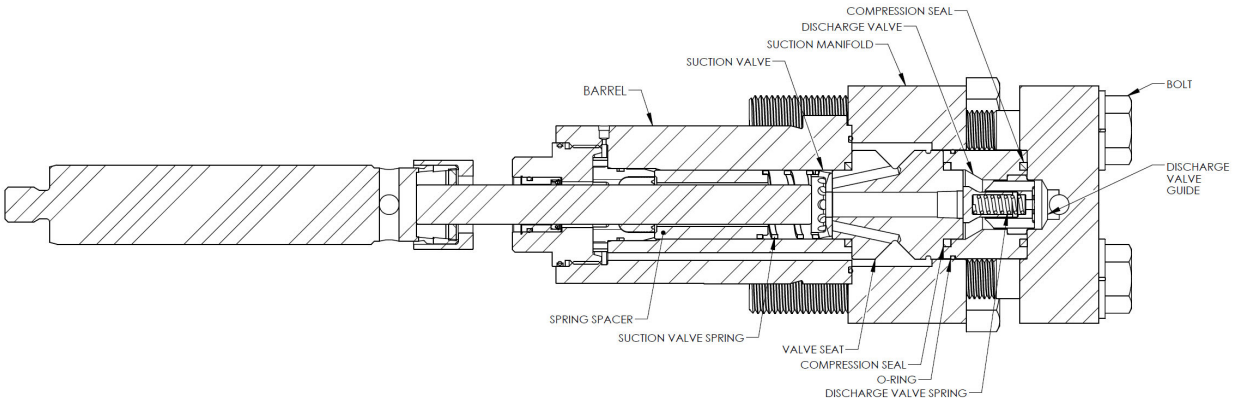


Figure 2: Valve Removal

3. *Remove the discharge valve guide, discharge valve and valve spring from the spacer.*
4. *Use the valve seat puller to remove the discharge spacer and valve seat as one piece. Inspect the o-ring and two compression seals installed on the spacer. Do not remove the components unless they are damaged and require replacement.*

5. *Remove the suction valve, valve spring and spring spacer from the barrel by pulling the components out through the bore in the suction manifold.*
6. *Assemble a new suction valve, suction valve spring and spring spacer as one assembly and install in the barrel, spacer first.*
7. *Inspect the valve seat for damage and replace or rework if necessary. Install the valve seat in the barrel ensuring the suction side is installed first. The suction side includes a center hole with several smaller holes around the flat surface of the seat.*
8. *Apply a light coat of Loctite 76764 anti-seize or equivalent to the suction manifold bore and press the discharge spacer into the manifold until it contacts the valve seat. Tap into position with a rubber mallet.*
9. *Assembly a new discharge valve guide, discharge valve spring and discharge valve as one assembly and insert in the discharge spacer, valve first.*
10. *Lift the discharge manifold into position, ensuring the shoulders on the discharge spacers slip into the counter-bores in the manifold.*
11. *Apply Loctite 76764 anti-seize or equivalent to the threads on the cap screws and install the washers and screws. Torque the screws to the specifications above, Torque Specifications.*

Packing Assemblies

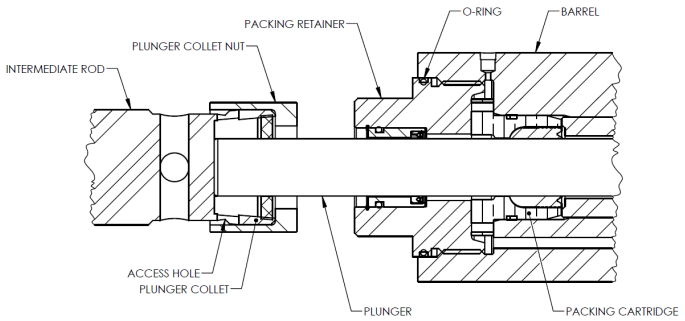
Depending on plunger size, high pressure units utilize either a packing cartridge or a chevron style packing. Replacement procedures differ for each style and are detailed below.

DANGER *Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance on the system components.*

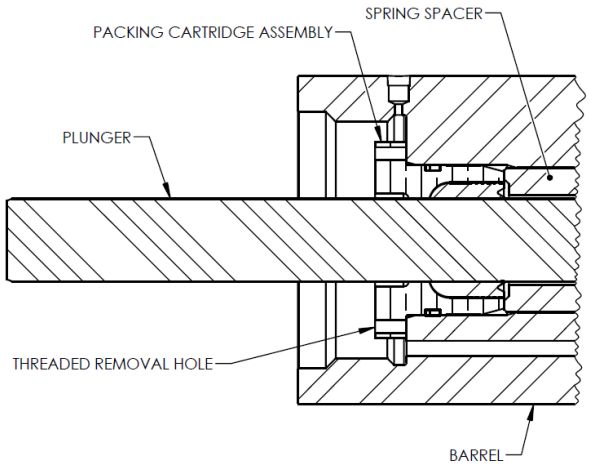
DANGER *Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.*

Packing Cartridge

1. *Use the packing nut wrench to loosen the plunger collet nut from the intermediate rod. Use a punch or screwdriver to remove the plunger collet. Insert the collet removal tool through the access hole in the rod and pry against the collet to loosen. If necessary, turn the pump crankshaft by hand to retract the rod and remove the collet and the collet nut.*



2. *Rotate the crankshaft to fully retract the intermediate rod. Use the packing nut wrench or large pipe wrench to unscrew the packing retainer from the barrel.*
3. *Thread the packing cartridge removal tool into the packing assembly cartridge until the tool bottoms out against the barrel. Continue turning the tool until the outer seals on the cartridge break free from the barrel, and the cartridge is loose.*



4. *Remove the packing removal tool and use the plunger to work the spring spacer out of the barrel. Remove the plunger, packing assembly and spacer as an assembly.*
5. *Insert the plunger through the new packing assembly from the small end of the packing cartridge. Position the packing in the middle of the plunger and install the spring spacer in front of the plunger.*
6. *Apply a light coat of Loctite 76764 anti-seize or equivalent to the outer seals on the packing cartridge*
7. *Install the plunger with the packing assembly and spring spacer into the barrel. Push the packing assembly forward until the outer seals contact the barrel.*
8. *Inspect the o-ring on the packing retainer and replace if necessary. Thoroughly coat the threads on the packing retainer and on the barrel with Loctite 76764 anti-seize or equivalent and position the retainer on the plunger. Use the packing nut wrench to screw the packing retainer into the barrel. Continue turning until the retainer and packing cartridge make metal-to-metal contact against the barrel. Maintain pressure on the packing nut wrench and strike the wrench once with a hammer to complete.*
9. *Place the collet nut and collet on the plunger. Rotate the crankshaft by hand until the intermediate rod contacts the plunger. Slide the collet and collet nut up to the rod. Tighten and torque to the specifications in the above section, Torque Specifications. If the plunger is too far forward to contact the intermediate rod, tighten the collet nut, and rotate the pump by hand to withdraw the plunger. Then loosen the collet nut and advance the rod one more time before final tightening.*
10. *When all three plungers are installed, turn the crankshaft one complete revolution by hand to ensure nothing interferes with the plunger's movement.*

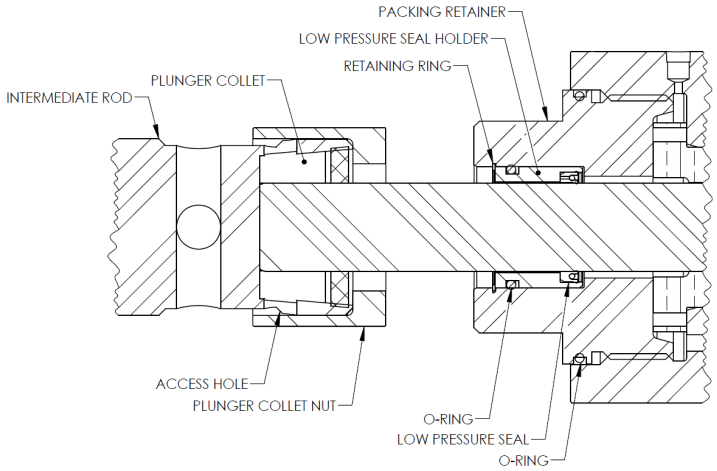
⚠ CAUTION *The intermediate rod must contact the plunger before tightening. Failure to do so can result in damage to the plunger as the pump reaches full operating pressure.*

Low Pressure Seal Assemblies

⚠ DANGER *Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance on the system components.*

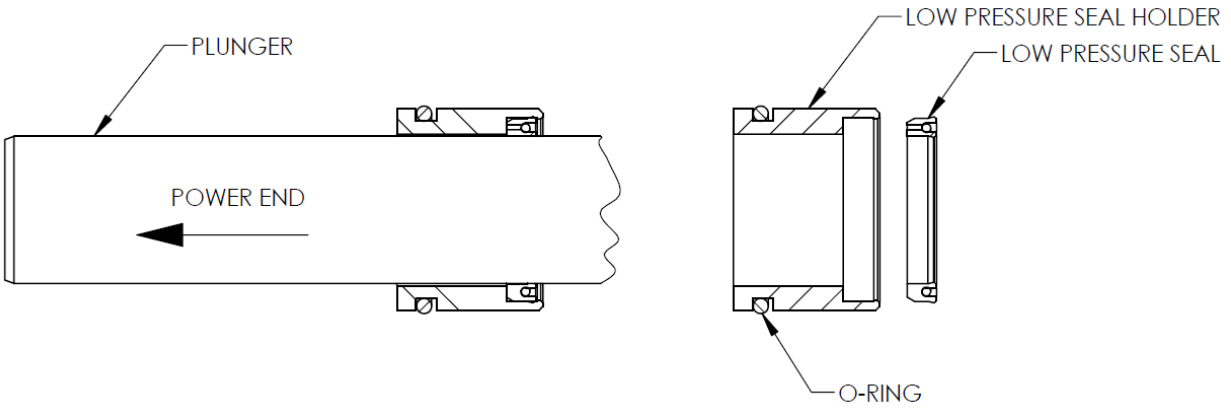
⚠ DANGER *Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.*

1. *Use the packing nut wrench to loosen the plunger collet nut from the intermediate rod. Use a punch or screwdriver to remove the plunger collet. Insert the punch or screwdriver through the access hole in the rod and pry against the collet to loosen. If necessary, turn the pump crankshaft by hand to retract the rod and remove the collet and the collet nut.*



2. *Rotate the crankshaft to fully retract the intermediate rod.*
3. *Use the packing nut wrench to unscrew the packing retainer.*
4. *Remove the retaining ring and then remove the low-pressure seal holder from the packing retainer.*
5. *Remove the low-pressure seal and the o-ring from the holder.*

   NOTICE *Some plunger sizes do not utilize an o-ring on the low-pressure seal holder.*
6. *Install a new low-pressure seal in the seal holder and install a new o-ring on the holder, if applicable. Ensure the correct orientation of the seal as illustrated below.*



7. *Apply a small amount of FML-2 grease to the o-ring and insert the seal holder into the packing retainer. Secure the holder in position with the retaining ring.*
8. *Apply Loctite 76764 anti-seize or equivalent to the threads on the packing retainer and install the retainer on the plunger. Use the packing nut wrench to tighten the retainer into the barrel.*
9. *Place the collet nut and collet on the plunger. Rotate the crankshaft by hand until the intermediate rod contacts the plunger. Slide the collet and collet nut up to the rod. Tighten and torque to the specifications in the above section, Torque Specifications. If the plunger is too far forward to contact the intermediate rod, tighten the collet nut, and rotate the pump by hand to withdraw the plunger. Then loosen the collet nut and advance the rod one more time before final tightening.*

⚠ CAUTION *The intermediate rod must contact the plunger before tightening. Failure to do so can result in damage to the plunger as the pump reaches full operating pressure.*

10. *When all three plungers are installed, turn the crankshaft one complete revolution by hand to ensure nothing interferes with the plunger's movement.*

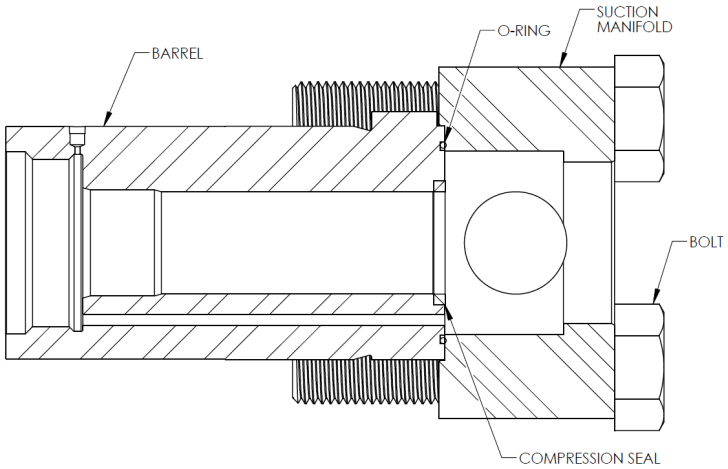
Barrel Assemblies

Before the barrels can be removed for service, the valve and packing assemblies must be removed. Follow the procedures detailed above for removing these assemblies and then proceed with Step 1 below.

⚠ DANGER *Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance on the system components.*

⚠ DANGER *Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.*

1. *Remove the cap screws attaching the suction manifold to the power frame. Remove the suction manifold to expose the o-rings and compression seals in the barrels. Remove the o-rings and the seals.*

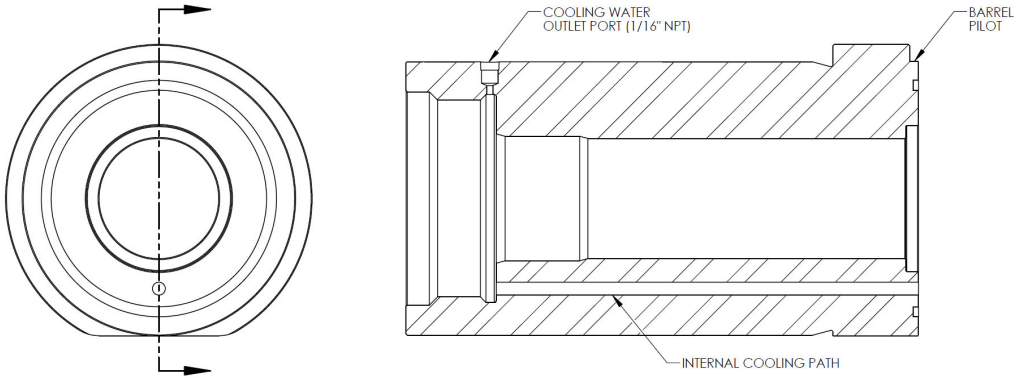


2. *Use a brass hammer to tap out the barrels. If removal by tapping is not possible, a hand operated hydraulic jack is recommended.*

   NOTICE *If using a hydraulic jack, reinforce the face of the power frame with a 6" x 14" x 1/2" steel plate.*

3. *Remove any nicks or burrs from all mating surfaces on the power frame and the barrels.*
4. *Insert the barrels into the power frame, aligning the cooling water ports as shown below. The barrel should be positioned in the power frame with the cooling water port aligned with the relief in the power frame to permit the attachment of the cooling lines.*

   ⚠ CAUTION *Place a block of wood over the end of the barrel to prevent damage while tapping it into position.*



5. *Insert the o-ring and the compression seal into the appropriate grooves on the face of the barrel. Apply a light coat of FML-2 grease to the o-ring to hold it in position.*
6. *Install the suction manifold by carefully positioning the counter-bores on the manifold over each of the barrel pilots.*
7. *Apply Loctite 76764 anti-seize or equivalent to the threads on the cap screws and install the screws to secure the manifold to the power frame. Verify that none of the o-rings have shifted during the installation of the manifold. Cross torque the screws to the specifications in the above section, Torque Specifications.*

UHP Fluid End Assembly

Maintenance Overview

The following table provides a listing of low-pressure fluid end assemblies included in this portion of the manual.

ULTRA-HIGH PRESSURE FLUID END ASSEMBLIES		
PART NO.	PLUNGER SIZE	DESIGN PRESSURE*
25-540-008	1/2" (0.50)	40,000 PSI (2,758 BAR)
25-540-010	5/8" (0.63)	40,000 PSI (2,758 BAR)
25-540-011	11/16" (0.69)	40,000 PSI (2,758 BAR)

**Fluid end designed for stated pressure, rod load not to exceed 15,700 lbs for splash lubricated, 17,500 lbs for forced systems.*

Never perform any type of maintenance on the fluid end assembly while it is pressurized. Always turn the power off and bleed the high-pressure water before servicing.

Improper assembly can lead to the premature failure of components. Maintenance procedures must be followed carefully; components must be properly cleaned prior to assembly and tightened to the correct torque specifications.

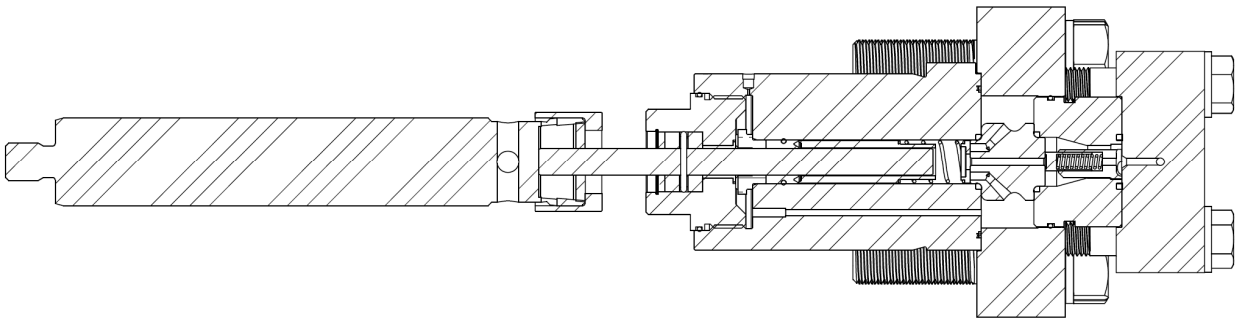


Figure 1: Fluid End Assembly

NOTICE *Refer to fluid end drawing for a complete listing of replacement parts and part numbers.*

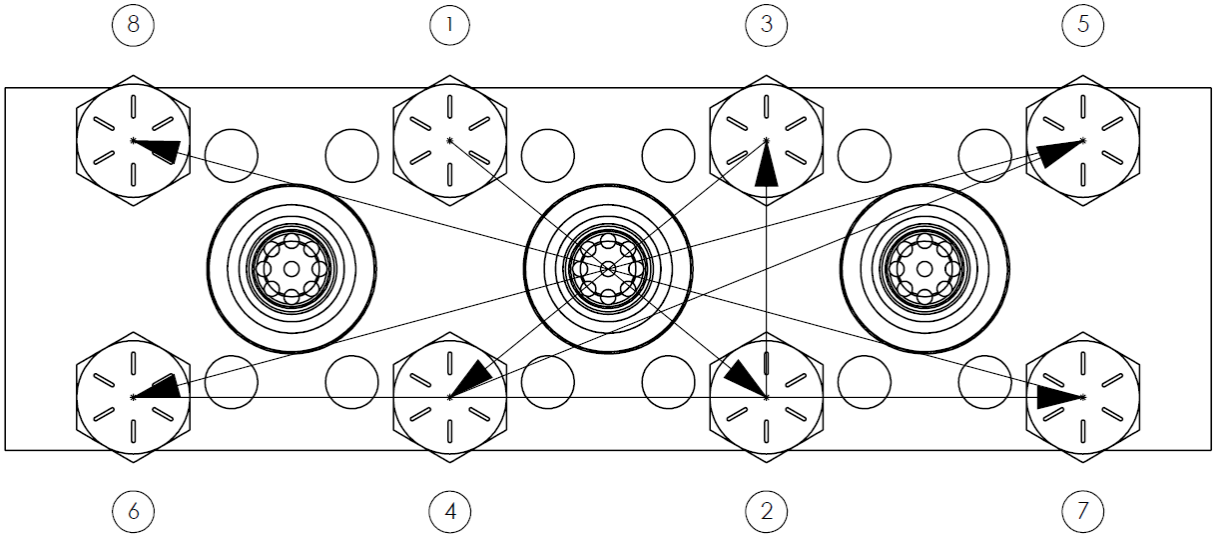
Specialized Maintenance Tools

Most of the tools required to maintain and adjust the Series 300 pump can be found in an ordinary set of mechanics hand tools.
APS has designed specialized tool kits to facilitate the removal and installation of some system components. These tool kits are supplied with each pump and are in the table below.

TOOL KIT	61109042
PACKING NUT WRENCH	61122702
PACKING CARTRIDGE REMOVAL TOOL	61121240

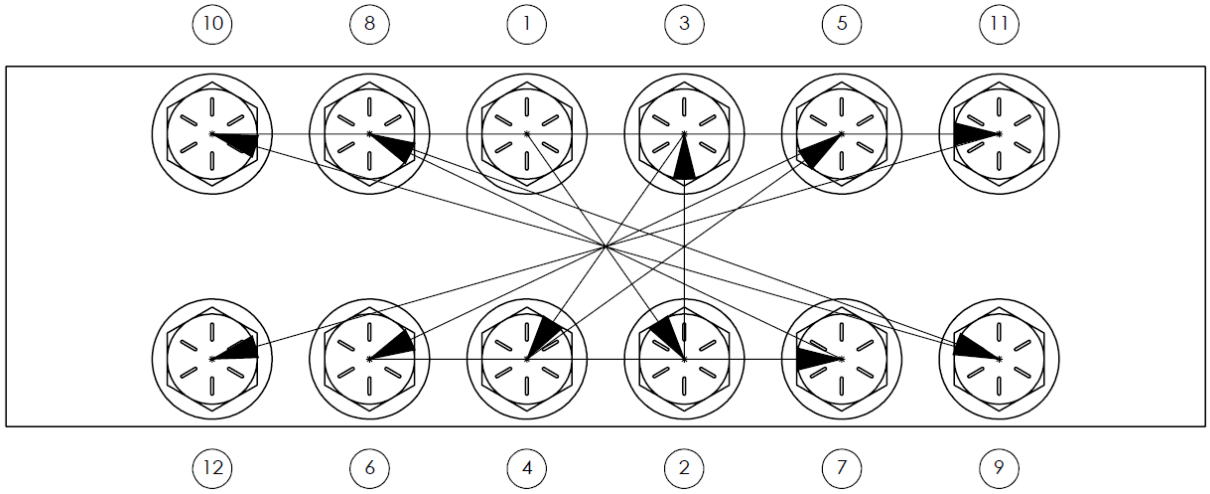
Torque Specification

- *Suction Manifold:*



1. *Apply silver grade anti-seize to threads and torque to 300 ft. lbs. in increments of 100 ft. lbs.*
2. *Tighten bolts in order indicated by numbers.*

- *Discharge Manifold:*



1. *Apply silver grade anti-seize to threads and torque to 300 ft. lbs. in increments of 100 ft. lbs.*
2. *Tighten bolts in order indicated by numbers.*

- *Plunger Collet Nut*

1. *Apply silver grade anti-seize to threads and torque to 60 ft. lbs.*

Valve Assemblies

The fluid end valves are spring loaded, flat disc and seat type. Both the discharge and suction valves and seat can be removed from the front of the fluid end.

Valves and seating surfaces encounter high wear during operation. Frequent inspection, maintenance and/or replacement are required to ensure proper operation. Poor suction and water quality can reduce valve life and result in rapid mechanical wear of the power end components.

- *Valve springs should be replaced after 2,000 hours of operation to reduce the possibility of a fatigue break; or when the coils have flat wear spots due to rubbing during normal operation.*
- *The valve seat provides a seating surface for both the discharge and suction valve. Valve seat surfaces are flat and can be restored by surface grinding to a 4 to 16 RMS surface finish.*
- *Mating surfaces of the valve seat and the valves must be smooth and free from nicks and scratches.*

DANGER *Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance.*

DANGER *Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.*

1. *Disconnect all piping to the discharge manifold.*
2. *Remove the cap screws and washers attaching the discharge manifold to the suction manifold. Lift and remove the discharge manifold, separating it from the discharge spacers.*

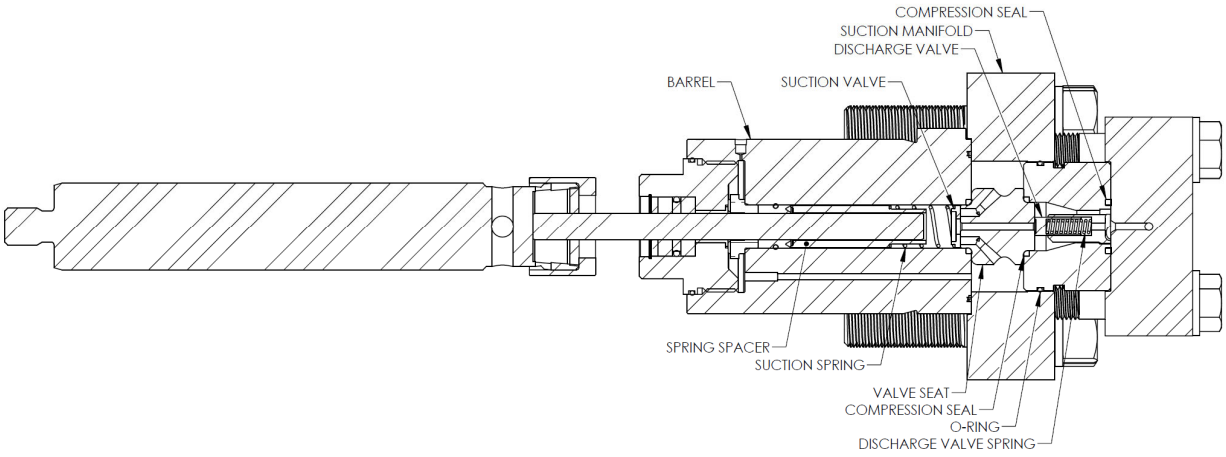


Figure 2: Valve Removal

3. *Remove the discharge valve guide, discharge valve and valve spring from the spacer.*
4. *Remove the discharge spacer by prying on the outside groove on the spacer. Inspect the o-ring and two compression seals installed on the spacer. Do not remove the components unless they are damaged and require replacement.*

5. *Remove the valve seat by inserting a small rod into the center bore and gently prying side to side.*
6. *Remove the suction valve, valve spring and spring spacer from the barrel by pulling the components out through the bore in the suction manifold.*
7. *Assemble a new suction valve, suction valve spring and spring spacer as one assembly and install in the barrel, spacer first.*
8. *Inspect the valve seat for damage and replace or rework if necessary. Install the valve seat in the barrel ensuring the suction side is installed first. The suction side includes a center hole with several smaller holes around the flat surface of the seat.*
9. *Apply a light coat of Loctite 76764 anti-seize or equivalent to the suction manifold bore and press the discharge spacer into the manifold until it contacts the valve seat. Tap into position with a rubber mallet.*
10. *Assembly a new discharge valve guide, discharge valve spring and discharge valve as one assembly and insert in the discharge spacer, valve first.*
11. *Lift the discharge manifold into position, ensuring the shoulders on the discharge spacers slip into the counter-bores in the manifold.*
12. *Apply Loctite 76764 anti-seize or equivalent to the threads on the cap screws and install the washers and screws. Torque the screws to the specifications above, Torque Specifications.*

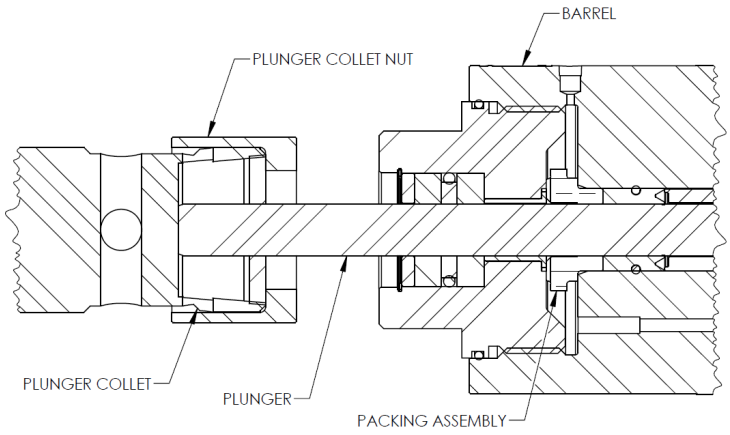
Packing Assemblies

Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance on the system components.

Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.

Packing Cartridge

1. *Use the packing nut wrench to loosen the plunger collet nut from the intermediate rod. Use a punch or screwdriver to remove the plunger collet. Insert the collet removal tool through the access hole in the rod and pry against the collet to loosen. If necessary, turn the pump crankshaft by hand to retract the rod and remove the collet and the collet nut.*
2. *Rotate the crankshaft to fully retract the intermediate rod. Use the packing nut wrench or large pipe wrench to unscrew the packing retainer from the barrel.*
3. *Place the collet nut and collet on the plunger. Rotate the crankshaft by hand until the intermediate rod contacts the plunger. Slide the collet and collet nut up to the rod. Tighten and torque to the specifications in the above section, Torque Specifications.*



4. *Start the engine and let it idle. Using the power take-off (PTO) lever, slip the clutch very slightly and rotate the pump slowly several revolutions. **Do not** engage the PTO.*

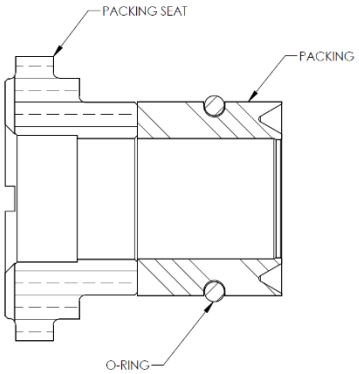
   After several revolutions the pressure inside the barrel should be sufficient to blow the packing out of the barrel.

5. *Remove the collet nut, collet, plunger, and old packing assembly.*

6. *Install the new o-ring on the packing. Apply a light coat of FML-2 grease to the o-ring and press the new packing into the barrel, grooved end first.*

7. *Insert the plunger into the packing and slide the packing seat onto the plunger.*

8. *Inspect the o-ring on the packing retainer and replace if necessary. Thoroughly coat the threads on the packing retainer and on the barrel with Loctite 76764 anti-seize or equivalent and position the retainer on the plunger. Use the packing nut wrench to screw the packing retainer into the barrel.*



   Continue turning until the retainer and packing seat make metal-to-metal contact against the barrel. Maintain pressure on the packing nut wrench and strike the wrench once with a hammer to complete.

9. *Place the collet nut and collet on the plunger. Rotate the crankshaft by hand until the intermediate rod contacts the plunger. Slide the collet and collet nut up to the rod. Tighten and torque to the specifications in the above section, Torque Specifications.*

   ⚠ CAUTION *The intermediate rod must contact the plunger before tightening. Failure to do so can result in damage to the plunger as the pump reaches full operating pressure.*

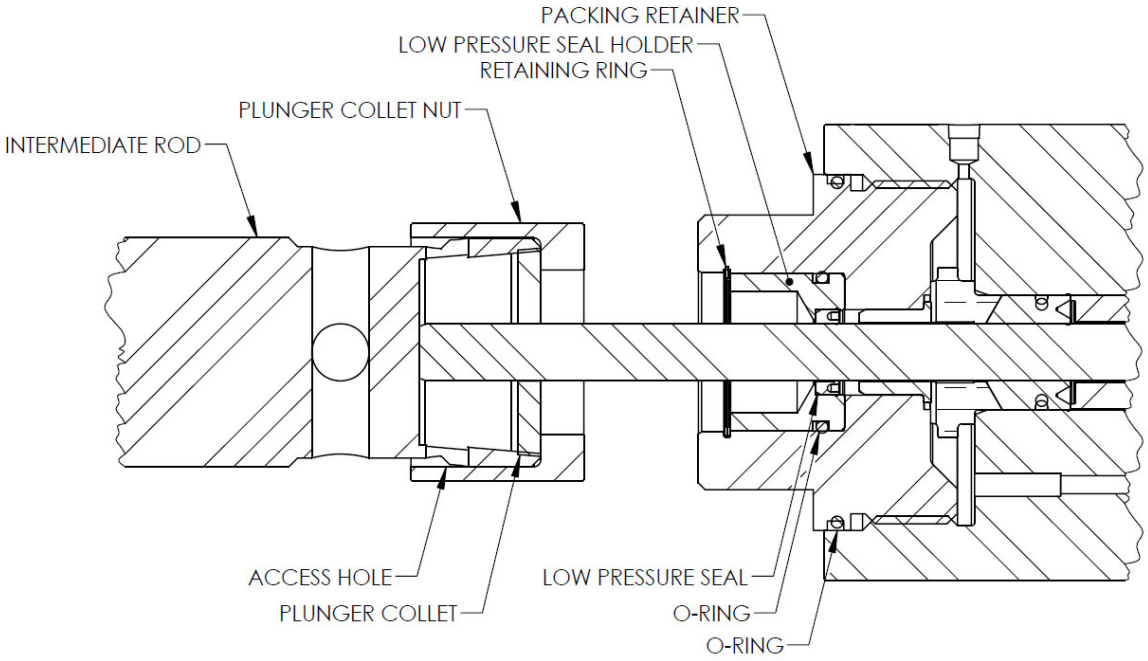
10. *When all three plungers are installed, turn the crankshaft one complete revolution by hand to ensure nothing interferes with the plunger's movement.*

Low Pressure Seal Assemblies

DANGER *Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance on the system components.*

DANGER *Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.*

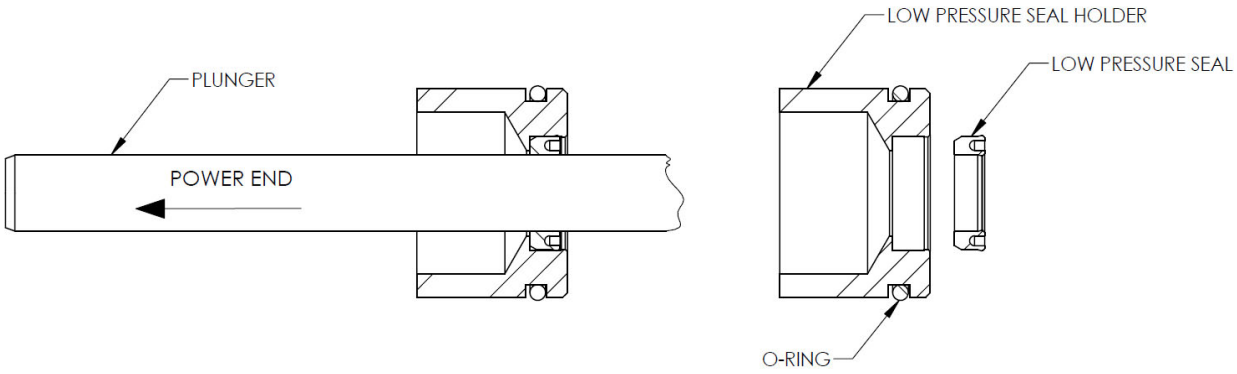
1. *Use the packing nut wrench to loosen the plunger collet nut from the intermediate rod. Use a punch or screwdriver to remove the plunger collet. Insert the punch or screwdriver through the access hole in the rod and pry against the collet to loosen. If necessary, turn the pump crankshaft by hand to retract the rod and remove the collet and the collet nut.*
2. *Rotate the crankshaft to fully retract the intermediate rod.*
3. *Use the packing nut wrench to unscrew the packing retainer.*
4. *Remove the retaining ring and then remove the low-pressure seal holder from the packing retainer.*



5. *Remove the low-pressure seal and the o-ring from the holder.*

NOTICE *Some plunger sizes do not utilize an o-ring on the low-pressure seal holder.*

6. *Install a new low-pressure seal in the seal holder and install a new o-ring on the holder, if applicable. Ensure the correct orientation of the seal as illustrated below.*



7. *Apply a small amount of FML-2 grease to the o-ring and insert the seal holder into the packing retainer. Secure the holder in position with the retaining ring.*
8. *Apply Loctite 76764 anti-seize or equivalent to the threads on the packing retainer and install the retainer on the plunger. Use the packing nut wrench to tighten the retainer into the barrel.*
9. *Place the collet nut and collet on the plunger. Rotate the crankshaft by hand until the intermediate rod contacts the plunger. Slide the collet and collet nut up to the rod. Tighten and torque to the specifications in the above section, Torque Specifications.*

   If the plunger is too far forward to contact the intermediate rod, tighten the collet nut, and rotate the pump by hand to withdraw the plunger. Then loosen the collet nut and advance the rod one more time before final tightening.

   ⚠ CAUTION *The intermediate rod must contact the plunger before tightening. Failure to do so can result in damage to the plunger as the pump reaches full operating pressure.*

10. *When all three plungers are installed, turn the crankshaft one complete revolution by hand to ensure nothing interferes with the plunger's movement.*

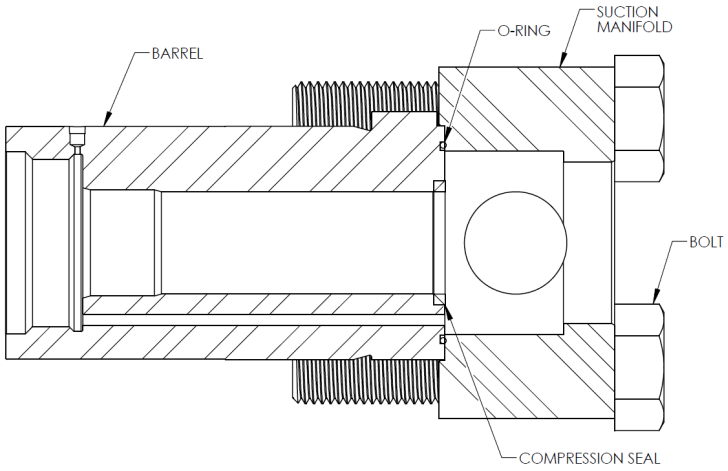
Barrel Assemblies

Before the barrels can be removed for service, the valve and packing assemblies must be removed. Follow the procedures detailed above for removing these assemblies and then proceed with Step 1 below.

⚠ DANGER *Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance on the system components.*

⚠ DANGER *Ensure all pressure is relieved or blocked from the hydraulic and high-pressure circuits before performing maintenance.*

1. *Remove the cap screws attaching the suction manifold to the power frame. Remove the suction manifold to expose the o-rings and compression seals in the barrels. Remove the o-rings and the seals.*

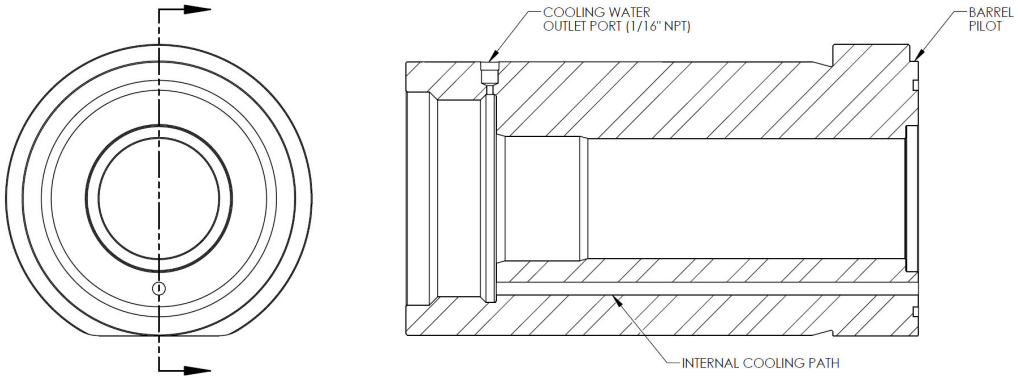


2. *Use a brass hammer to tap out the barrels. If removal by tapping is not possible, a hand operated hydraulic jack is recommended.*

   NOTICE *If using a hydraulic jack, reinforce the face of the power frame with a 6" x 14" x 1/2" steel plate.*

3. *Remove any nicks or burrs from all mating surfaces on the power frame and the barrels.*
4. *Insert the barrels into the power frame, aligning the cooling water ports as shown below. The barrel should be positioned in the power frame with the cooling water port aligned with the relief in the power frame to permit the attachment of the cooling lines.*

   ⚠ CAUTION *Place a block of wood over the end of the barrel to prevent damage while tapping it into position.*



5. *Insert the o-ring and the compression seal into the appropriate grooves on the face of the barrel. Apply a light coat of FML-2 grease to the o-ring to hold it in position.*
6. *Install the suction manifold by carefully positioning the counter-bores on the manifold over each of the barrel pilots.*
7. *Apply Loctite 76764 anti-seize or equivalent to the threads on the cap screws and install the screws to secure the manifold to the power frame. Verify that none of the o-rings have shifted during the installation of the manifold. Cross torque the screws to the specifications in the above section, Torque Specifications.*

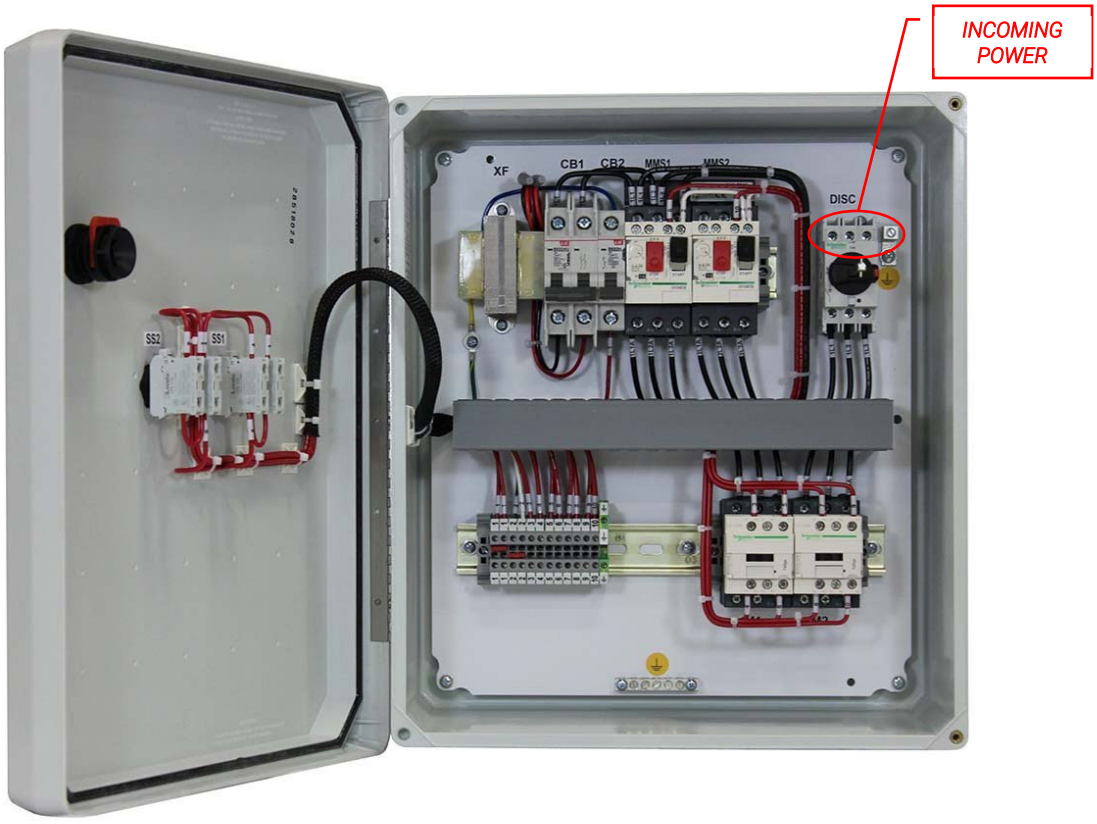
Motor Starters

Across-the-Line

The across-the-line starter is a common, general use motor starter. This starter connects the incoming power directly to the motor via contactor.

This starter features a thru-door disconnect to de-energize the internal components from the incoming power before opening the enclosure. A push button e-stop immediately cuts power to the motor and shuts down the pump. The start and stop push buttons are used to start and stop the pump under normal operation.

To install the starter, bring each of the three phases into the enclosure utilizing a strain relief device. Attach each phase of incoming power to the circuit breaker utilizing best practices and adhering to local codes. Be sure to check motor rotation. If the motor rotates in the wrong direction, switch two phases of incoming power.



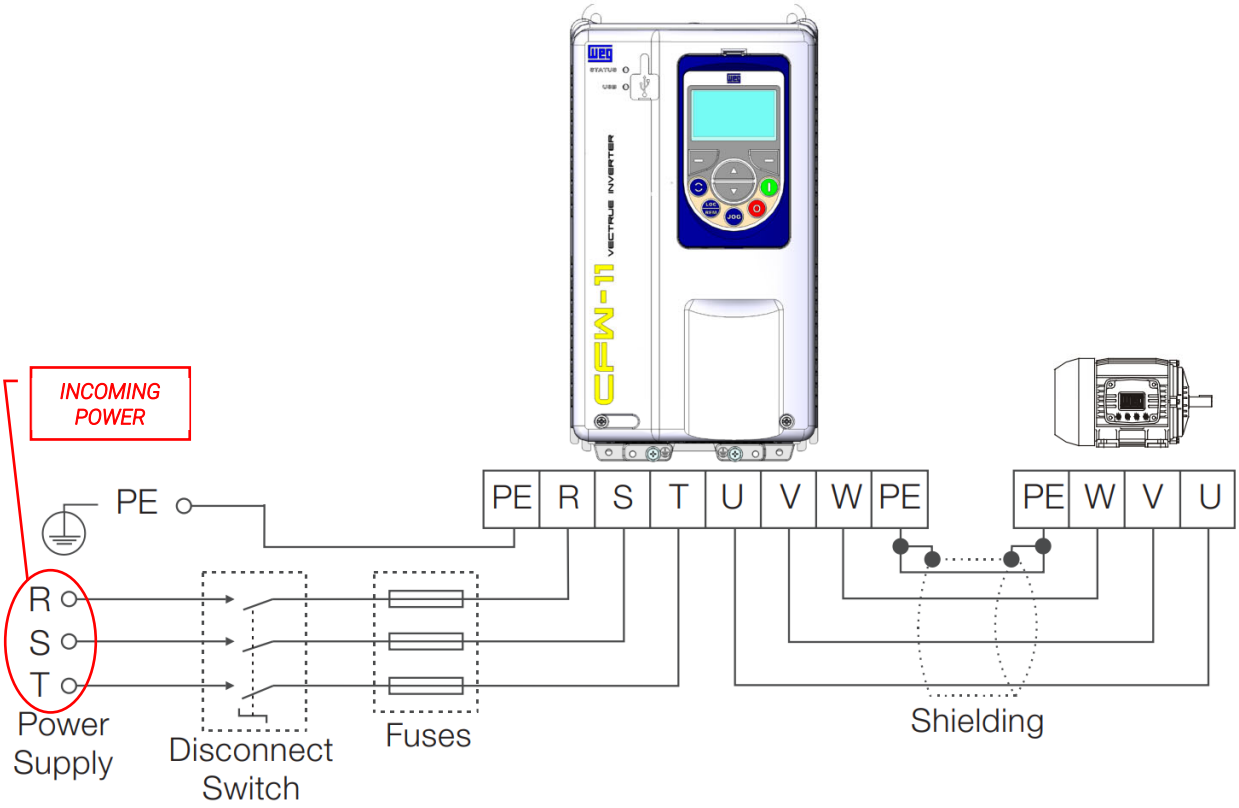
(Image used as reference only, actual item may vary)

Variable Frequency Drive (VFD)

The VFD is a type of motor starter that can safely start and stop the electric motor as well as fully control the speed of the motor during its operation. Since the speed of the motor depends on the supply frequency, the VFD is mostly used for varying the speed of the motor during operation.

When equipped, the remote pendant features a push button e-stop that immediately cuts power to the motor and shuts down the pump. The start and stop push buttons are used to start and stop the pump under normal operation. A speed dial allows for the control of the motor speed remotely. A green light indicates that the starter is active and energized. It is not recommended to maintain a zero speed input for extended periods when the starter is energized.

To install the starter, bring each of the three phases into the enclosure utilizing a strain relief device. Attach each phase of incoming power to the VFD utilizing best practices and adhering to local codes. For wiring details, see the figure below.



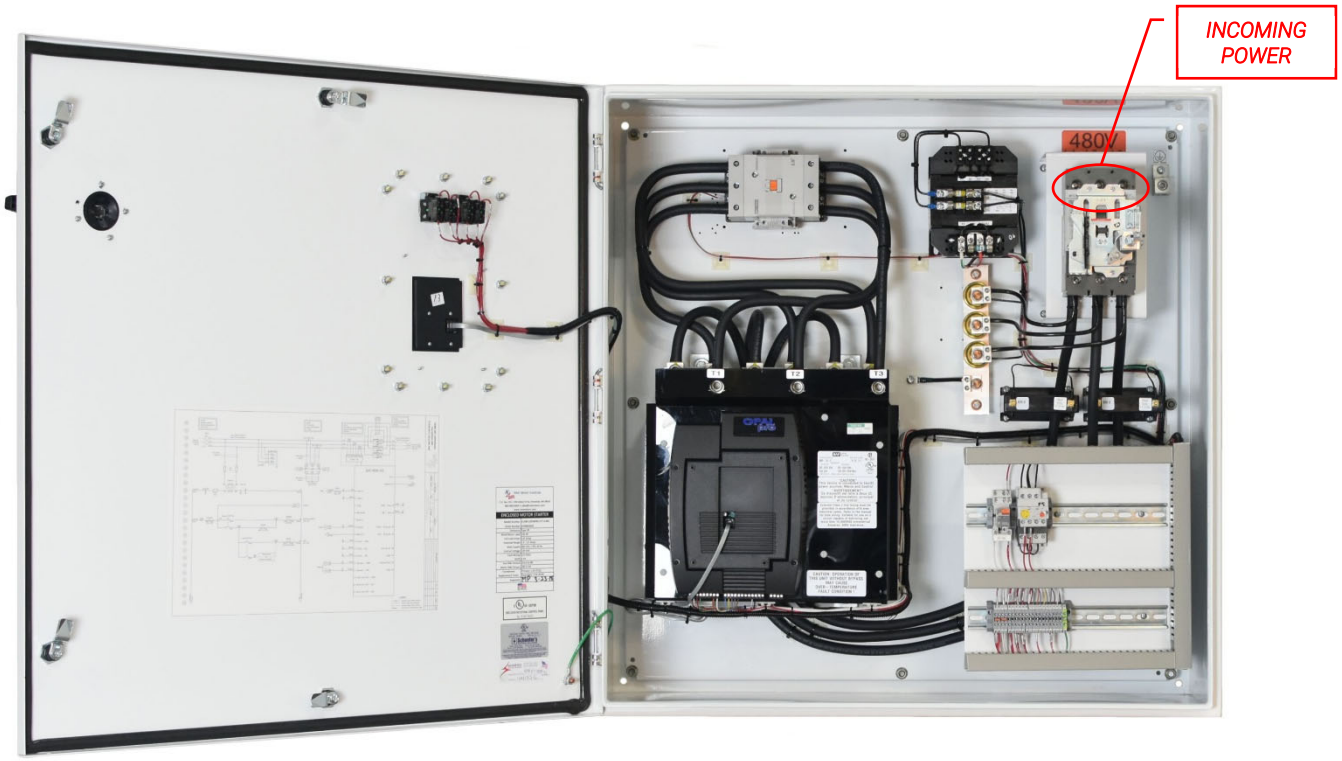
(Image used as reference only, actual item may vary)

Soft Start

The soft start is a type of motor starter that reduces the starting current or the high inrush current by reducing the voltage applied to the motor. Since the soft starter only reduces the supply voltage during starting & stopping of the motor, it cannot vary the speed of the motor during normal operation. Therefore, they are used for constant speed application.

This starter features a thru-door disconnect to de-energize the internal components from the incoming power before opening the enclosure. A push button e-stop immediately cuts power to the motor and shuts down the pump. The start and stop push buttons are used to start and stop the pump under normal operation. A display on the front of the enclosure allows for soft start parameters to be modified.

To install the starter, bring each of the three phases into the enclosure utilizing a strain relief device. Attach each phase of incoming power to the circuit breaker utilizing best practices and adhering to local codes. Be sure to check motor rotation. If the motor rotates in the wrong direction, switch two phases of incoming power.



(Image used as reference only, actual item may vary)

Troubleshooting

Overview

The troubleshooting guide will help identify the probable cause of a system malfunction and assist in providing corrective action. In addition to this manual, you may also need the manufacturer's manuals provided with your pump. The following symptoms are discussed in this section:

- *High pressure line pulsation*
- *Knock in power end*
- *Water hammer*
- *Valve wear*
- *Packing failure*
- *Plunger failure*
- *Oil wiper seal leakage*
- *Packing seal leakage*
- *Crankshaft oil seal leak*

Before doing any procedure:

- *Look for obvious problems.*
- *Read and understand each procedure.*
- *Make sure that you have the appropriate tools available.*
- *Make sure that you have the appropriate parts available.*

Troubleshooting Guide

Listen to the machine and observe it in operation. Learn to recognize the normal sounds and operating conditions of the system. Carefully define the symptom of the problem. Locate the symptom on the troubleshooting guide that most closely corresponds to the problem.

If the symptoms in the guide do not correspond to the malfunction, or if the problem is not resolved by the recommended corrective action, contact the APS Customer Service Department for assistance.

	Malfunction	Indication	Check
1.	High pressure line pulsation	Suction supply line has been affected	Debris or scale back
			Partially closed valve in suction line
			Air entering the suction supply line through a loose connection or a ruptures pipe
			Low supply line water pressure
		High pressure fluid loss	Worn or broken suction or discharge valves
			Loose packing retainer nut
			Damaged or broken plunger
			Damaged suction or discharge valve spring
			Damaged discharge valve guide
			Worn packing assembly and/or packing seat

	Malfunction	Indication	Check
2.	Knock in power end	Loosely connected components	Tightness of intermediate rod in crosshead
			Plunger collet is fully compressed
			Connecting rod wrist pin bearings
			Crankshaft journal bearing wear
			Crankshaft main roller bearings and shims
		Fluid end effects	Cavitation in fluid end
			Damaged suction or discharge valve or seats
			Damaged suction or discharge valve springs
			Damaged plunger
			Worn packing
3.	Water hammer/wheezing	Cavitation effects	Low supply line water pressure
			Stuck suction valve
		Plumbing design defects	Flow separation at elbows and fittings
			Variable fluid acceleration in the suction supply plumbing
4.	Valve wear	Contaminated supply water	Supply water quality or chemistry
			Filters are not correctly rated
		Cavitation effects	Worn valve guides
			Damaged valve springs
5.	Packing failure	Contaminated supply water	Supply water quality or chemistry
			Filters are not correctly rated
		Cavitation effects	Cavitation due to insufficient or low supply water pressure
		Installation damage	Packing installation
		Lack of cooling	Packing lubrication holes in barrel blocked
6.	Plunger failure	Cavitation effects	Low supply line water pressure
			Air entering supply water line
			Air entering the barrel through worn packing
		Mechanical damage	Chipping from physical impact of foreign material entering the pump well
		Contaminated supply water	Supply water quality or chemistry
			Filters are not correctly rated
		Contact with the packing seat	Deformation and wear of packing seat
7.	Oil wiper seal leakage	Foreign material entering the pump well	Pump well cover is kept closed
			Dirt does not settle on the intermediate rod
		Running the pump without oil	Oil level is correctly set
			Oil quality is correct
		Scored intermediate rod	Oil wiper seal is contacting a smooth surface
			Oil wiper seal is not nicked from intermediate rod damage
8.	Packing seal leakage	Pump run without water	Supply water pressure
			Plunger coolant holes in barrels are not blocked

		Dirt accumulation	*Packing damaged from dirt entering the pump well*
		Installation	*Packing installed backward*
9.	*Crankshaft oil seal leak*	*Dirt accumulation*	*Seal surface is clean*
			Crankshaft contact point for seal lip wear into the shaft
		High oil level in the power end	*Oil level is not over the high mark*
			Water or condensation has overfilled the power end

Diesel Engine

Refer to the Caterpillar manual for engine issues.

The display shows codes generated by the Caterpillar Engine Control Module. Refer to the Engine Diagnostics section of your Caterpillar manual for detailed information.

If the engine starts and then immediately shuts down, the cause can be difficult to diagnose correctly. One cause can be low starting battery voltage. Make sure that the starting battery is at 12.6 V and that the battery terminals are clean. Refer to the Caterpillar manual for further instructions on diagnosing engine starting, batteries, and charging system issues.

Specifications

General

DIMENSIONS	BASE UNIT 79" H x 132.5" W x 67.5" D
	FORK POCKETS + 4" H
	TRAILER + 26" H
DRY WEIGHT	8,000 LBS. (MAY VARY DEPENDING ON OPTIONS)
REQUIRED CLEARANCE	3 FT. ON ALL SIDES
SITE GRADE	LEVEL; SLOPE LESS THAN 8° FROM HORIZONTAL
MOUNTING TYPE	SKID FRAME
OIL CAPACITY	40 GALLONS
FUEL CAPACITY	225 GALLONS
DEF CAPACITY	8.5 GALLONS
NOISE EMMISSION	105 dBA @ 3 ft. @ 2100 ENGINE RPM

Standard Operating Parameters

OUTPUT PRESSURE	3,000 PSI TO 40,000 PSI
OUTPUT FLOW RATE (60HZ)	7.8 GPM TO 85 GPM

High Pressure Pump

TYPE	POSITIVE DISPLACEMENT TRIPLEX, BELT DRIVEN
HYDRAULIC LUBRICATION	SPLASH LUBRICATION / FORCE LUBRICATION
STROKE	3.5 IN.
PLUNGER DIAMETER	SEE 'LP, HP, UHP FLUID END ASSEMBLY' SECTION
OIL	SEE 'POWER END ASSEMBLY' SECTION
LUBRICANT CAPACITY	2.5 GALLON (9.5 LITERS)
RECOMMENDED OIL	SHELL MORLINA SD 100 OR EQUIVALENT SAE 30 NON-DETERGENT OIL

Diesel Engine

TYPE	Tier 3 CAT C7.1	Tier 4 CAT C7.1	Tier 3 CAT C9.3
BHP RATING	275	302	335
FUEL CONSUMPTION (EST.)	13 GAL/HR	13 GAL/HR	15 GAL/HR
ENGINE OIL	10w30	10w30	10w30
EMMISIONS	EXPORT ONLY	TIER 4 FINAL	EXPORT ONLY

Electric Motor

	WEG – W22 NEMA premium efficiency, 3PH										
HORSEPOWER (HP)	125	150		200	200		200	250	250	250	300
VOLTAGE (VAC)	380	230	460	380	230	460	380	230	460	380	460
FRQUENCY (Hz)	50	60		50	60		50	60		50	60
SPEED (RPM)	1480	1780		1475	1785		1490	1785		1480	1780
RATED CURRENT (A)	170	340	170	279	460	230	270	554	277	337	330
LOCKED ROTOR CURRENT (A)	1190	2244	1122	1423	3128	1564	1593	3601	1801	2056	2145
FRAME SIZE	444/5T			445/7T			504/5T			447/9T	
SAFETY FACTOR	1	1.15		1	1.15		1.15	1.15		1	1.15

Lubrication Specification

Series 250 pumps are splash lubricated by circulating oil or other specified lubricants in the power end. To ensure proper power end lubrication, the oil must pour freely at lowest ambient operating temperatures.

The recommended power end lubricant is Shell Morlina SD 100 or equivalent SAE 30 non- detergent oil. The pump oil capacity for Series 250 pumps is 2.5 gallons (9.5 liters). For system component lubrication refer to the engine, clutch and drive train manuals in the appendix.

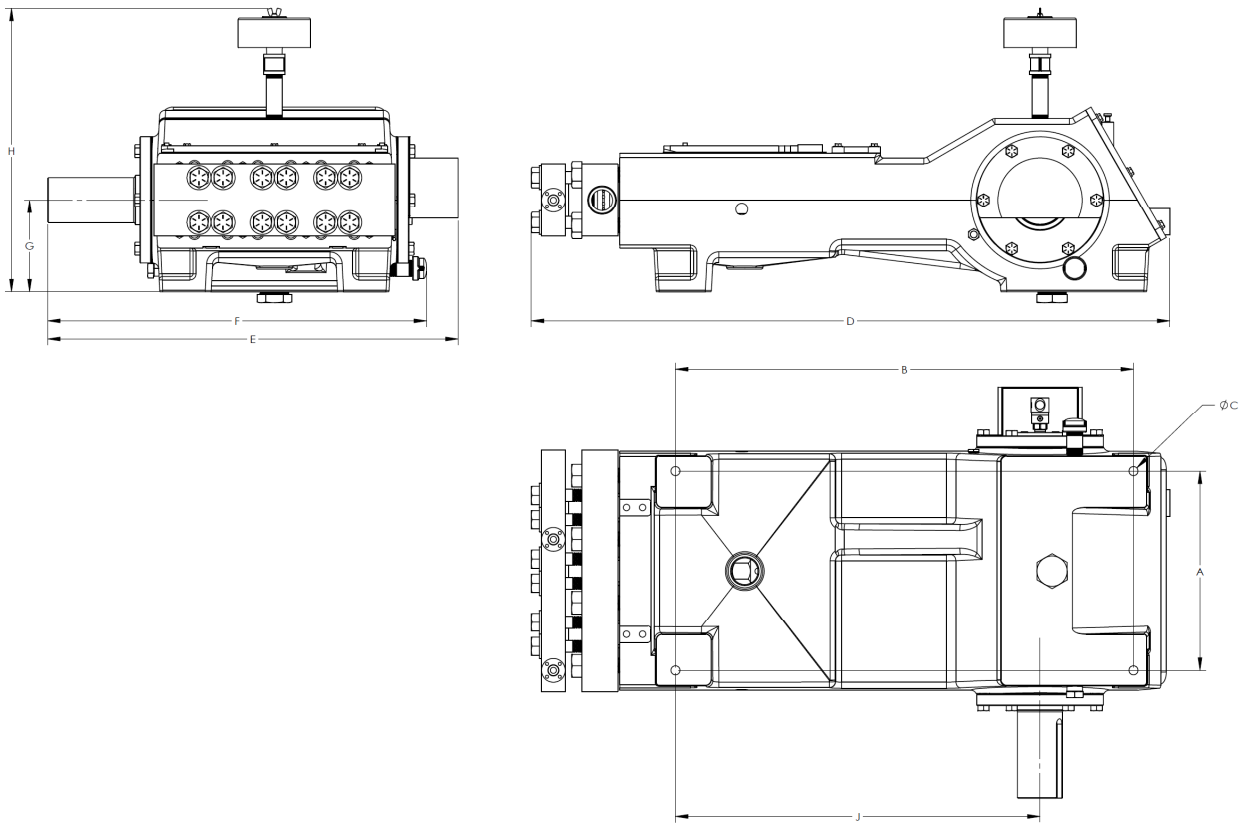
The use of quality lubricating oils combined with appropriate condensed water drain and oil filter change intervals are critical factors in maintaining performance and durability. Change the power end oil every 500 hours or six (6) months, or as frequently as operating conditions require to maintain clean, sludge and moisture free oil or proper viscosity.

Service Connections

	LOW PRESSURE (10,000 PSI)				HIGH PRESSURE (20,000 PSI)						ULTRA-HIGH PRESSURE (40,000 PSI)		
PART NO.	25-510-024	25-510-026	25-510-028	25-510-030	25-520-012	25-520-014	25-520-016	25-520-018	25-520-020	25-520-022	25-540-008	25-540-010	25-540-011
PLUNGER SIZE	1-1/2"	1-5/8"	1-3/4"	1-7/8"	3/4"	7/8"	1"	1-1/8"	1-1/4"	1-3/8"	1/2"	5/8"	11/16"
INLET	2" NPT				2" NPT						1" NPT		
OUTLET	(4X) SERIES 50				(6X) SERIES 50						(4X) SERIES 50		
OUTLET	(2X) SERIES 100				N/A						(2X) MULTI-CONNECTOR		

	CONNECTION TYPE					
SERIES 50	BLANK (61105026)	1/2" NPT (61105240)	3/4" NPT (61176229)	3/8" HP (61125727)	9/16" MP (61105248)	
SERIES 75	BLANK (61105281)	3/8" HP (61105256)	9/16" HP (61105273)			
SERIES 100	BLANK (61125230)	1/2" NPT (B1104312)	3/4" NPT (61105050)	1" NPT (61150772)	9/16" MP (61152484)	1" MP (61150616)

Installation Dimensions



	A	B	C	D	E*	F	G	H	J
10K	16.5	38	.75	52.88	34	31.5	7.63	23.5	30.25
20K	16.5	38	.75	53	34	31.5	7.63	23.5	30.25
40K	16.5	38	.75	51.63	34	31.5	7.63	23.5	30.25

** FOR FORCE LUBRICATED APPLICATIONS ONLY*

Inlet Water

The quality of the inlet water supply is one of the most important factors affecting component life and performance. Water treatment requirements can be determined by a water analysis.

The cutting water supply must meet the following standards. A high concentration of dissolved solids, especially calcium, silica and chlorides will affect high pressure component life.

Water Condition

The inlet water source must meet the minimum required levels for the following parameters.

GENERAL PROPERTIES		
CLARITY	-	CLEAR
COLOR	-	COLORLESS
ODOR	-	NONE PRESENT
ELECTRICAL CONDUCTIVITY	-	100-400 µS/cm
pH	-	6-8.5

WATER QUALITY GUIDELINES		
TDS	LOW TDS (<100 PPM)	GOOD QUALITY WATER (MAY USE SOFTENING)
TDS	MODERATE TDS (100-200 PPM)	CAN BE TREATED BY SOFTENING OR TDS REDUCTION (REVERSE OSMOSIS OR DEIONIZATION)
TDS	HIGH TDS (>200 PPM)	POOR QUALITY WATER, SHOULD BE TREATED WITH REVERSE OSMOSIS OR DEIONIZATION
SILICA	HIGH CONTENT (>15 PPM)	TREAT WITH DUAL STRING BASE DEIONIZATION

Inlet Water Temperature

Higher than specified water temperature causes more wear of internal seals and components.

Ideal inlet water temperature should not exceed 77˚F (25˚C).

If the temperature of the inlet water to the pump is not within the parameters as specified in this manual, a chiller may be required to achieve the expected pump maintenance cycles. Horsepower, application, and site-specific conditions determine the capacity of a chiller. Contact APS Technical Service for more information.

Inlet Water Pressure

WATER SUPPLY PRESSURE	100 PSI. MAX.
WATER SUPPLY FLOW RATE	10 GPM (HP & UHP FLUID ENDS) 25 GPM (LP FLUID ENDS)

Inlet Water Filtration

10 micron absolute

Carbide Nozzle Size Selector Chart

NOZZLE FLOW RATING IN GPM															
		ACTUAL NOZZLE PRESSURE [KSI (BAR)]													
NOZZLE #	ORIFICE IN (MM)	4 (276)	5 (345)	6 (414)	7 (483)	8 (552)	9 (621)	10 (689)	12 (827)	15 (1034)	20 (1379)	25 (1724)	30 (2068)	35 (2413)	40 (2758)
0.1	.008 (.207)	0.12	0.13	0.14	0.15	0.17	0.18	0.19	0.20	0.23	0.26	0.29	0.32	0.35	0.37
0.2	.012 (.293)	0.26	0.29	0.32	0.35	0.37	0.40	0.42	0.46	0.51	0.59	0.66	0.72	0.78	0.83
0.3	.014 (.358)	0.36	0.40	0.44	0.47	0.51	0.54	0.57	0.62	0.69	0.80	0.90	0.98	1.06	1.13
0.4	.016 (.414)	0.47	0.52	0.57	0.62	0.66	0.70	0.74	0.81	0.91	1.05	1.17	1.28	1.39	1.48
0.5	.018 (.463)	0.59	0.66	0.73	0.78	0.84	0.89	0.94	1.03	1.15	1.33	1.48	1.62	1.75	1.87
0.6	.020 (.507)	0.73	0.82	0.90	0.97	1.03	1.10	1.16	1.27	1.42	1.64	1.83	2.00	2.16	2.31
0.7	.022 (.547)	0.89	0.99	1.08	1.17	1.25	1.33	1.40	1.53	1.71	1.98	2.21	2.42	2.62	2.80
0.8	.023 (.585)	0.97	1.08	1.19	1.28	1.37	1.45	1.53	1.68	1.87	2.16	2.42	2.65	2.86	3.06
0.9	.024 (.621)	1.05	1.18	1.29	1.39	1.49	1.58	1.67	1.83	2.04	2.36	2.63	2.89	3.12	3.33
1.0	.026 (.654)	1.24	1.38	1.51	1.64	1.75	1.86	1.96	2.14	2.39	2.77	3.09	3.39	3.66	3.91
1.1	.027 (.686)	1.33	1.49	1.63	1.76	1.89	2.00	2.11	2.31	2.58	2.98	3.33	3.65	3.95	4.22
1.2	.028 (.717)	1.43	1.60	1.76	1.90	2.03	2.15	2.27	2.48	2.78	3.21	3.59	3.93	4.24	4.54
1.3	.029 (.746)	1.54	1.72	1.88	2.04	2.18	2.31	2.43	2.66	2.98	3.44	3.85	4.21	4.55	4.87
1.4	.030 (.774)	1.65	1.84	2.02	2.18	2.33	2.47	2.60	2.85	3.19	3.68	4.12	4.51	4.87	5.21
1.5	.032 (.801)	1.87	2.09	2.29	2.48	2.65	2.81	2.96	3.24	3.63	4.19	4.68	5.13	5.54	5.92
1.6	.033 (.827)	1.99	2.23	2.44	2.64	2.82	2.99	3.15	3.45	3.86	4.45	4.98	5.46	5.89	6.30
1.7	.034 (.853)	2.11	2.36	2.59	2.80	2.99	3.17	3.34	3.66	4.10	4.73	5.29	5.79	6.26	6.69
1.8	.035 (.878)	2.24	2.51	2.74	2.96	3.17	3.36	3.54	3.88	4.34	5.01	5.60	6.14	6.63	7.09
1.9	.035 (.902)	2.24	2.51	2.74	2.96	3.17	3.36	3.54	3.88	4.34	5.01	5.60	6.14	6.63	7.09
2.0	.036 (.925)	2.37	2.65	2.90	3.14	3.35	3.56	3.75	4.11	4.59	5.30	5.93	6.49	7.01	7.50
2.5	.041 (1.034)	3.08	3.44	3.77	4.07	4.35	4.61	4.86	5.33	5.96	6.88	7.69	8.42	9.10	9.73
3.0	.045 (1.133)	3.70	4.14	4.54	4.90	5.24	5.56	5.86	6.42	7.17	8.28	9.26	10.15	10.96	11.72
3.5	.048 (1.224)	4.22	4.71	5.16	5.58	5.96	6.32	6.66	7.30	8.16	9.43	10.54	11.54	12.47	13.33
4.0	.052 (1.308)	4.95	5.53	6.06	6.54	7.00	7.42	7.82	8.57	9.58	11.06	12.37	13.55	14.63	15.64
4.5	.055 (1.388)	5.53	6.19	6.78	7.32	7.83	8.30	8.75	9.59	10.72	12.37	13.84	15.16	16.37	17.50
5.0	.058(1.463)	6.15	6.88	7.54	8.14	8.70	9.23	9.73	10.66	11.92	13.76	15.39	16.85	18.21	19.46
5.5	.060 (1.534)	6.59	7.36	8.07	8.71	9.31	9.88	10.41	11.41	12.75	14.73	16.47	18.04	19.48	20.83
6.0	.063 (1.602)	7.26	8.12	8.89	9.61	10.27	10.89	11.48	12.58	14.06	16.24	18.15	19.89	21.48	22.96
6.5	.066 (1.668)	7.97	8.91	9.76	10.54	11.27	11.95	12.60	13.80	15.43	17.82	19.92	21.82	23.57	25.20
7.0	.068 (1.731)	8.46	9.46	10.36	11.19	11.96	12.69	13.38	14.65	16.38	18.92	21.15	23.17	25.02	26.75
7.5	.071 (1.791)	9.22	10.31	11.30	12.20	13.04	13.83	14.58	15.97	17.86	20.62	23.06	25.26	27.28	29.16
8.0	.073 (1.850)	9.75	10.90	11.94	12.90	13.79	14.62	15.42	16.89	18.88	21.80	24.37	26.70	28.84	30.83
8.5	.075 (1.907)	10.29	11.51	12.60	13.61	14.55	15.44	16.27	17.82	19.93	23.01	25.73	28.18	30.44	32.54
9.0	.077 (1.962)	10.85	12.13	13.28	14.35	15.34	16.27	17.15	18.79	21.01	24.25	27.12	29.71	32.09	34.30
9.5	.079 (2.016)	11.42	12.77	13.98	15.10	16.15	17.13	18.05	19.78	22.11	25.53	28.54	31.27	33.77	36.11
10.0	.081 (2.069)	12.00	13.42	14.70	15.88	16.98	18.01	18.98	20.79	23.24	26.84	30.01	32.87	35.51	37.96
11.0	.085 (2.170)	13.22	14.78	16.19	17.49	18.69	19.83	20.90	22.89	25.60	29.56	33.05	36.20	39.10	41.80
12.0	.089 (2.266)	14.49	16.20	17.75	19.17	20.49	21.74	22.91	25.10	28.06	32.40	36.23	39.69	42.87	45.83
12.5	.091 (2.313)	15.15	16.94	18.56	20.04	21.43	22.73	23.95	26.24	29.34	33.88	37.88	41.49	44.81	47.91
13.0	.093 (2.359)	15.82	17.69	19.38	20.93	22.38	23.74	25.02	27.41	30.64	35.38	39.56	43.33	46.81	50.04
14.0	.096 (2.448)	16.86	18.85	20.65	22.30	23.84	25.29	26.66	29.20	32.65	37.70	42.15	46.17	49.87	53.32
15.0	.100 (2.533)	18.30	20.45	22.41	24.20	25.87	27.44	28.93	31.69	35.43	40.91	45.74	50.10	54.12	57.85

References

Engineering Drawings

Engineering drawings are supplied with your pump in the appendix of this manual.

Spare Parts

Fluid End Parts

	LOW PRESSURE (10,000 PSI)				HIGH PRESSURE (20,000 PSI)						ULTRA-HIGH PRESSURE (40,000 PSI)			
PART NO.	25-510-024	25-510-026	25-510-028	25-510-030	25-520-012	25-520-014	25-520-016	25-520-018	25-520-020	25-520-022	25-540-008	25-540-010	25-540-011	
PLUNGER SIZE	1-1/2"	1-5/8"	1-3/4"	1-7/8"	3/4"	7/8"	1"	1-1/8"	1-1/4"	1-3/8"	1/2"	5/8"	11/16"	
PLUNGER	61115080	61115129	61115147	61115163	61115072	61114858	61115064	61115121	61115105	61109355	61115179	61115204	61152359	3*
HP PACKING	25-500-224	25-500-226	25-500-228	25-500-230	25-500-212	25-500-214	25-500-216	25-500-218	25-500-220	25-500-222	25-500-208	25-500-210	25-500-211	6*
LP PACKING	25-500-324	25-500-326	25-500-328	25-500-330	25-500-312	25-500-314	25-500-316	25-500-318	25-500-320	25-500-322	25-500-308	25-500-310	25-500-311	6*
SPRG SPACER	61137104	61137169	61125180	61120068	61119761	61119844	61119662	61119720	61119712	61119738	61119605	61120034	61152443	3*
SUCT MFLD	25-500-110				61102112						61102104			
DISCH MFLD	61137021				61102062						25-500-111			
BARREL	25-500-101				25-500-102						25-500-103			
VALVE SEAT	61119227				61119152						61152500			3*
SPCR CMP SEAL	61117217				61117350						61117491			3*
COMP SEAL	61117350										61117267			3*
COMP SEAL	61118677				61117350						61117316			3*
DISCH VALVE	61121984				61121942						61121927			3*
DISCH SPR	61137055				61120339						61120266			3*
DISCH GDE	61106138				61122760						61106164			3*
SUCT VALVE	61122348				61122827						61135748			3*
SUCT SPR	61120521				61120529						61120199			3*
RTN RNG	61115964				61115907						61115956			3*
PKG NUT	25-500-104				25-500-106				25-500-105		25-500-107			
PKG NUT O-RNG	30-002-150													6*
MFLD O-RNG	61118083				61117835									6*
SUCT BOLTS	25-500-116				90-028-550						90-028-500			
DISCH BOLTS	90-026-500										90-022-450			
COLLET NUT	61112944				61113085									
PLGR COLLET	61103054	61103187	61103062	61103070	61103137	61103153	61103088	61103111	61103104	61103119	61103096	61103145	61152492	
PONY ROD	61128832				25-500-108						25-500-109			

** Recommended spare parts quantities*

Lubricants

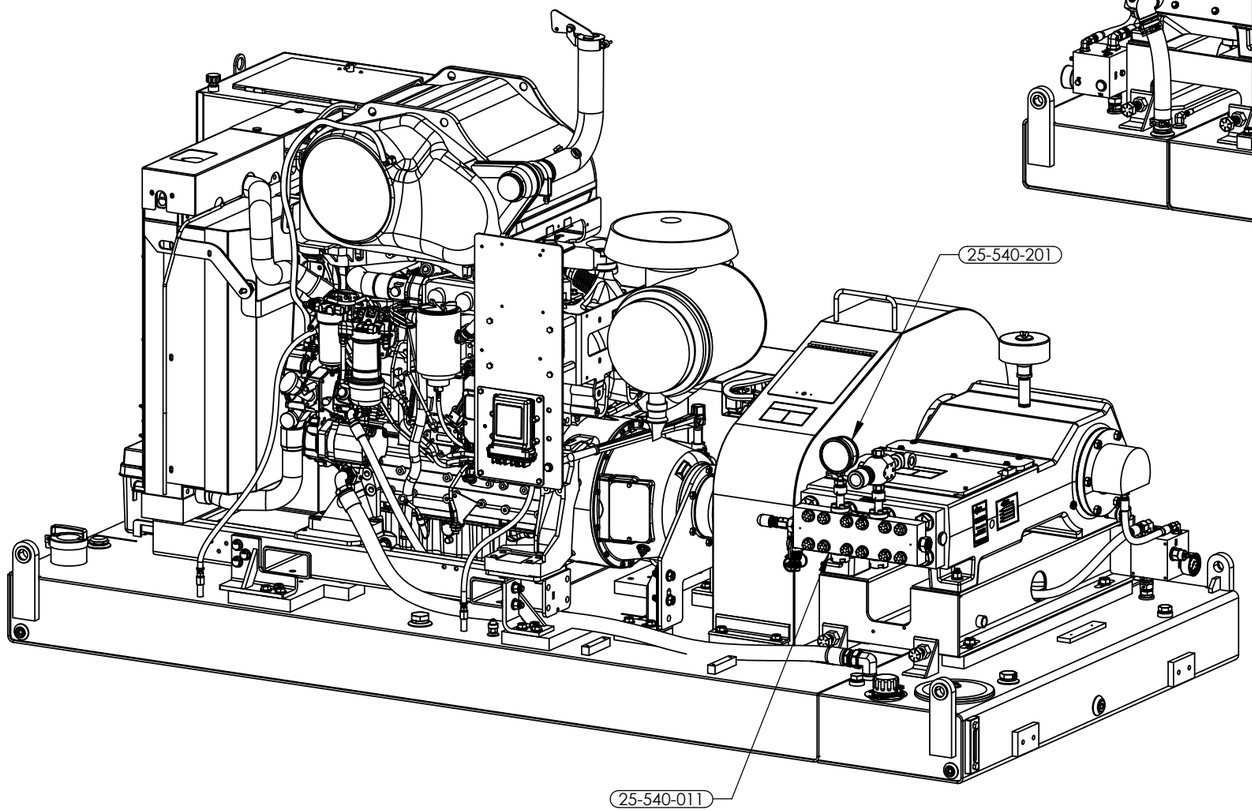
Silver Anti-Seize	Part # 24-002-001
Blue Lubricant	Part # 24-001-001
Loctite 242	Part # 24-001-026
LubriMatic® White Lithium Grease	Part # 24-001-016

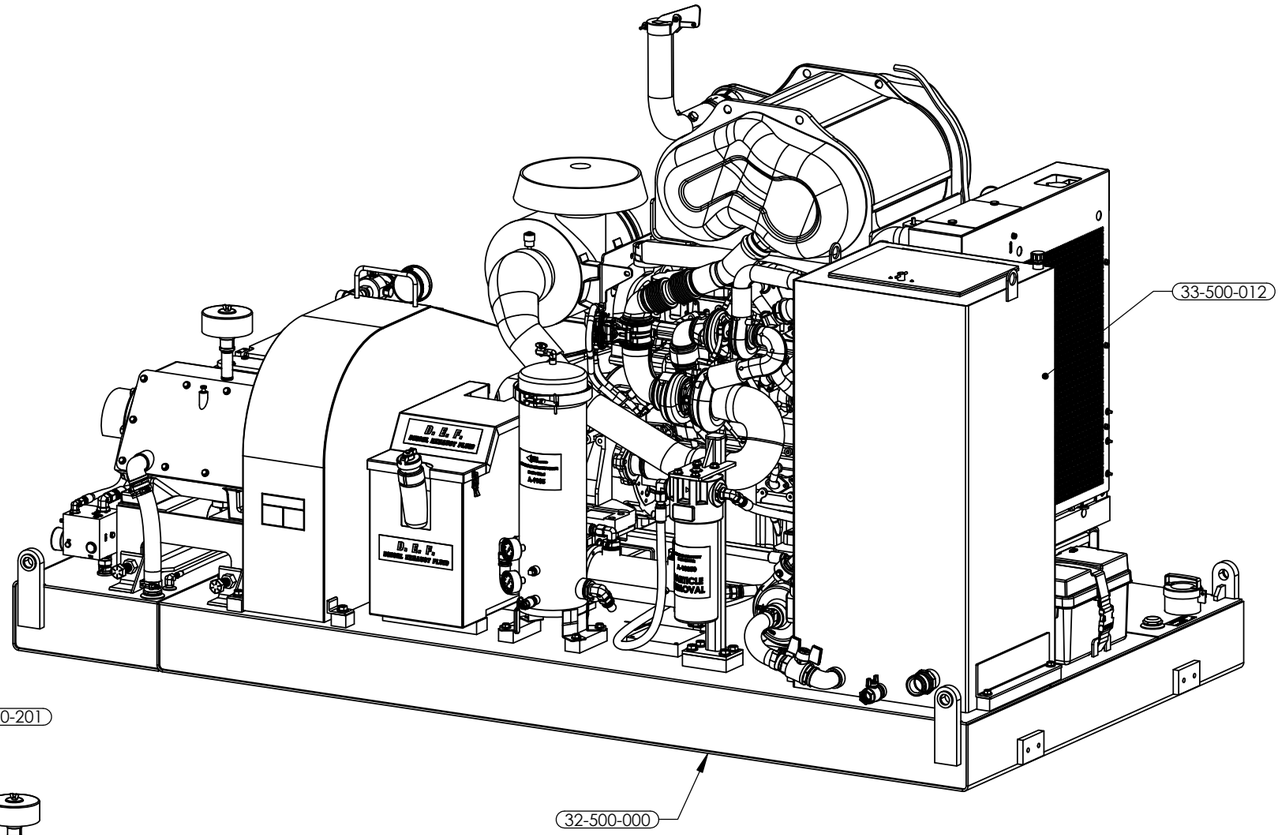
Water Quality Test Kit

Water Test Kit	Part # 007851-1

Appendix

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	32-500-000	TRPLX UNIT-S300, T4C7, BASE
2	1	25-540-011	FL END ASSY-SERIES 300, UHP, 40KSI, 0.69", AQD
3	1	25-540-201	KIT-FL END ACCESS, S300, 400R,4G60,4P,9H,P,P
4	1	33-500-012	KIT-WTR TNK, S300





REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	0	INITIAL RELEASE	11/10/2022	K. SMITH

APS SHAPE TECHNOLOGIES GROUP®

ADVANCED PRESSURE SYSTEMS
701 S. PERSIMMON DR. TOMBALL, TX 77375

UNLESS OTHERWISE SPECIFIED:
ALL DIMENSIONS ARE IN INCHES, INTERPRET PER ANSI Y14.5-2009
DIMS IN MM ARE FOR REFERENCE ONLY
BREAK SHARP EDGES AND DEBURR .015
TOLERANCES (EXCEPT AS NOTED)

MACHINE S.F.	√
MACHINE FILLETS	R.02
ANGLE	±1°

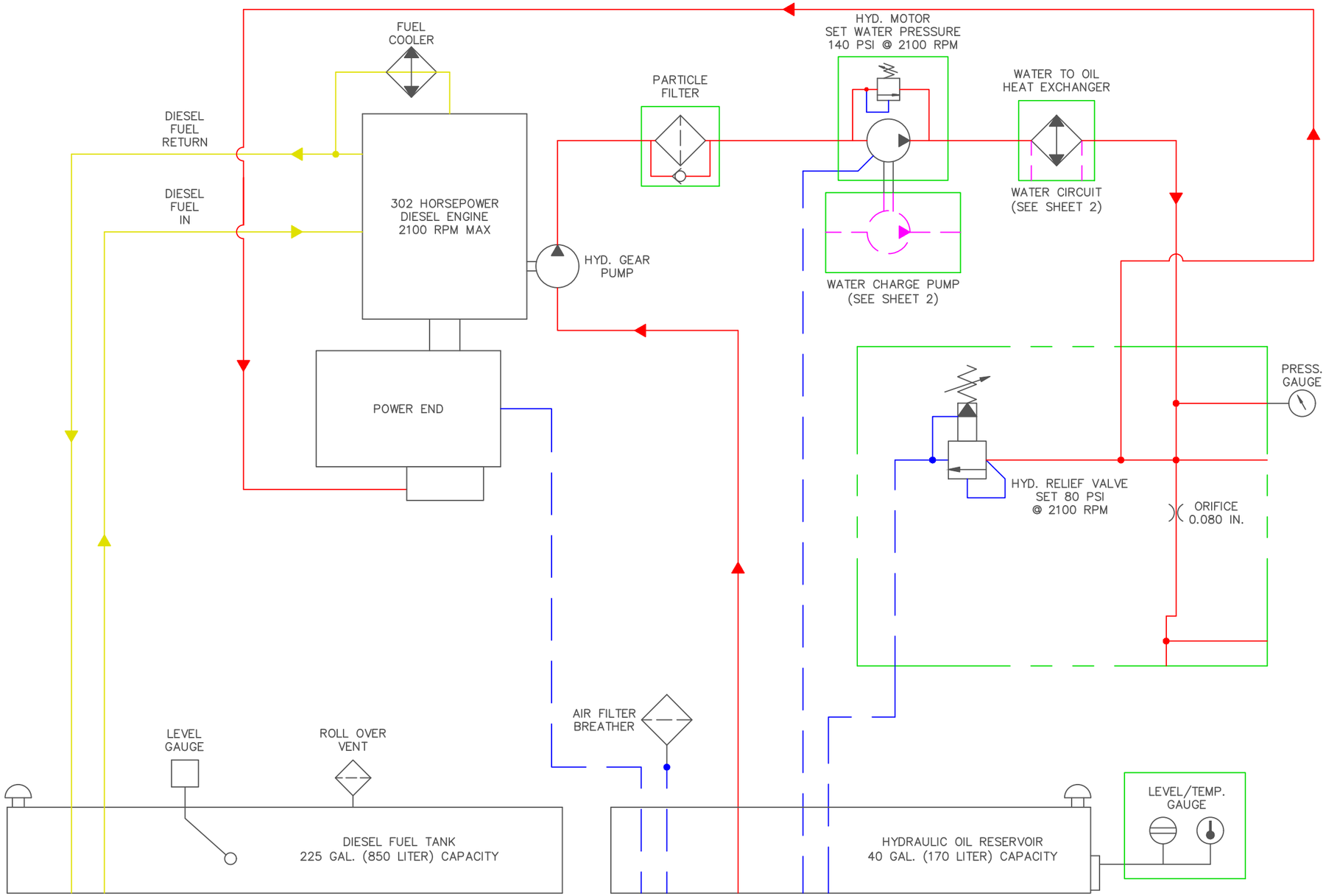
DIM TOLERANCES: (in)
.X = ± .063
.XX = ± .015
.XXX = ± .005
.XXXX = ± .0005

TITLE: TRPLX UNIT-S300, 40T4C7C.69WXXXP

THIRD ANGLE PROJECTION	
DWG BY	K. SMITH
APRVD BY	B. PARKER
MATERIAL	
HEAT TREAT.	

DWG. NO. 32-540-501 REV. 00

SHT 1 OF 1



REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	0	INITIAL RELEASE	5/28/20	K. SMITH

UNLESS OTHERWISE SPECIFIED
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INTERPRET PER ANSI Y14.5-2009
DIM'S IN [mm] ARE REFERENCE ONLY
BREAK SHARP EDGES & DEBURR .015

TOLERANCES (EXCEPT AS NOTED)

SURFACE FINISH	63√	DIM TOLERANCES: (in)	
MACHINE FILLETS	R.02	.X	= ± .063
ANGLE	±1°	.XX	= ± .015
		.XXX	= ± .005
		.XXXX	= ± .0005

TITLE: TRPLX UNIT-S300, TIER 4 C7.1, HYD. SCHEMATIC

ADVANCED PRESSURE SYSTEMS
701 S. PERSIMMON DR. TOMBALL, TX 77375

THIRD ANGLE PROJECTION

DWG BY: K. SMITH

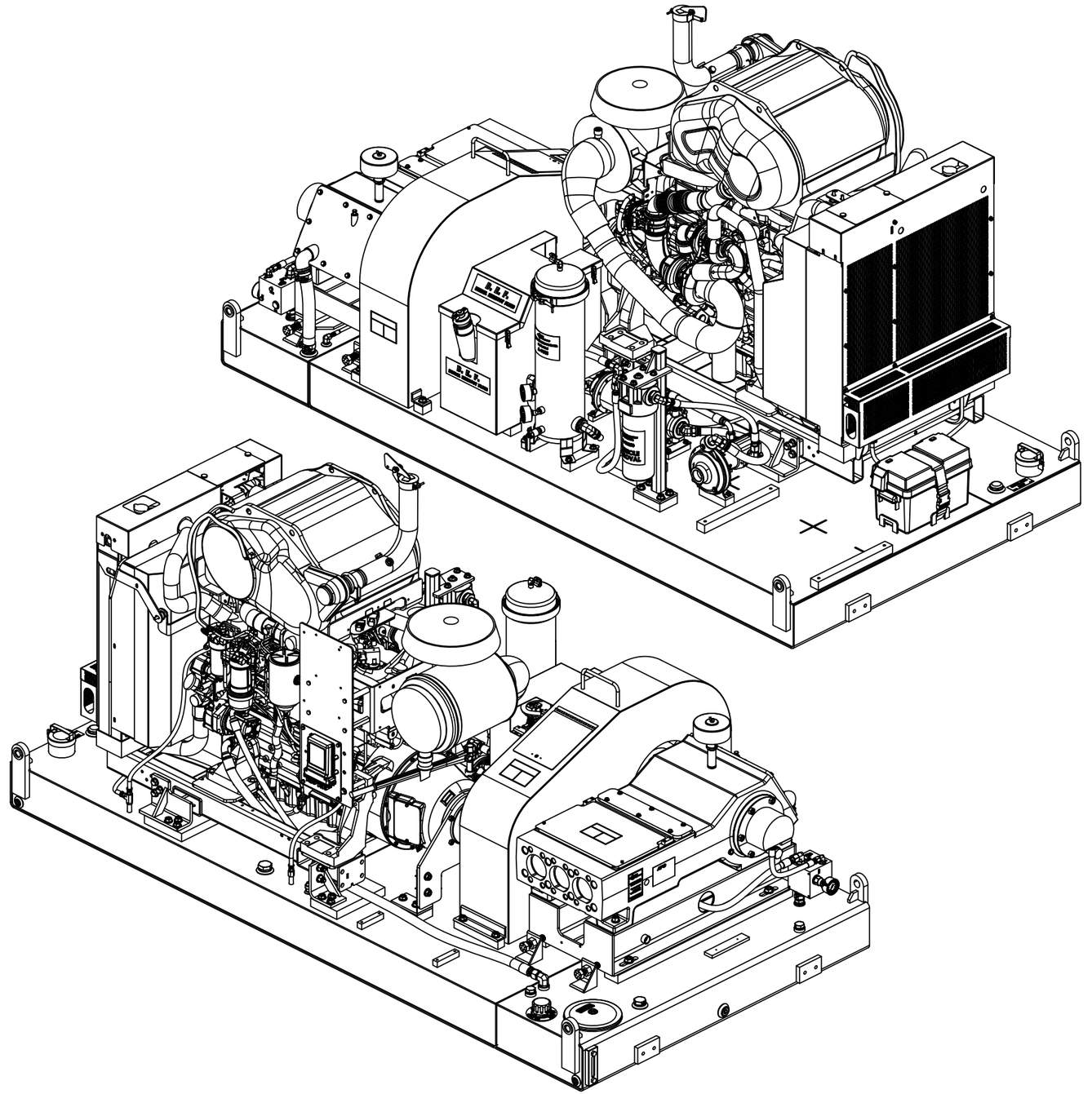
APRVD BY: B. PARKER

APS SHAPE TECHNOLOGIES GROUP³

DWG. NO. 32-500-000.HYD REV. 0

DRAWN IN AUTOCAD SHT 1 OF 2

ITEM NO.		PART NO.	DESCRIPTION	ITEM NO.		PART NO.	DESCRIPTION
1	1	31-500-006	WELDMENT, TANK, S-300, HYDRAULIC/DIESEL	51	24	90-020-175	BOLT, HEX, 5/8"-11 X 1-3/4"
2	1	A-7564	BREATHER, PRESSURIZED, 40 MICRON	52	8	90-020-225	BOLT, HEX, 5/8"-11 X 2-1/4"
3	1	200680-02	GAUGE, LIQUID LEVEL, ALUMINUM, 5 INCH	53	4	90-020-300	BOLT, HEX, 5/8"-11 X 3"
4	1	202281-01	COVER, ACCESS, TOP FRONT, TANK, HISKY, 1.625 INCH	54	4	90-022-175	BOLT, HEX, 3/4"-10 X 1-3/4"
5	1	202882-01	BREATHER, VENT, NON-SPLASH, 1/4" NPT	55	4	90-026-400	BOLT, HEX, 1"-8 X 4"
6	1	33-001-035	GAUGE, LIQUID LEVEL, DIESEL, 8" LG, 1-1/2" NPT	56	6	90-506-050.SS	BUTTON PHILIPS, #10-24 X 1/2" SS
7	1	31-500-002	WELDMENT, BRACKET, S-300, FILTER STAND	57	4	90-512-075.SS	BUTTON PHILIPS, 3/8"-16 X 3/4" SS
8	1	31-500-003	WELDMENT, BRACKET, S-300, TIER 4, PORT	58	12	90-720-000	NUT, NY-LOCK, 5/8"-11
9	1	31-500-004	WELDMENT, BRACKET, S-300, TIER 4, STARBOARD	59	6	90-812-000	FLAT WASHER, 3/8"
10	1	31-500-031	WELDMENT, BRACKET-MOD, S300, PORT	60	8	90-816-000	FLAT WASHER, 1/2"
11	1	31-500-032	WELDMENT, BRACKET-MOD, S300, STARBOARD	61	54	90-820-000	FLAT WASHER, 5/8"
12	1	31-500-007	WELDMENT, BELT GUARD, S-300	62	4	90-822-000	FLAT WASHER, 3/4"
13	1	31-500-010	WELDMENT, PUMP BASE, 8" HGT, S-300	63	1	33-001-016	ASSEMBLY, DEF TANK ENCLOSURE, HUSKY
14	1	31-500-014	PLATE, PTO SUPPORT, TWIN DISC	64	1	99-049-001	GASKET, FLAT, SAE-A 2-BOLT, N8090, 1/64"
15	1	31-500-015	WELDMENT, PTO SUPPORT PLATE, STARBOARD	65	1	33-001-021	PUMP, EXT GEAR, 33CC, SAE-A, 11 TH 16/32 PTCH
16	1	31-500-016	WELDMENT, PTO SUPPORT PLATE, PORT	66	1	33-500-001	ASSEMBLY, WATER FILTER, S-300
17	1	33-950-005	ENGINE, CAT, C7.1, TIER 4, 302 HP, BASE	67	1	33-500-002	ASSEMBLY, HYDRAULIC FILTER, S-300
18	1	61186988	CLUTCH-PTO,DBL PL, SP311,SAE NO. 3 HSG	68	1	33-500-003	ASSEMBLY, CHARGE PUMP, S-300
19	1	61102294	BSHG-SPLT,TPR,QD, 3.75 ID,M,AQD S25046-60	69	1	33-500-006	ASSEMBLY, RELIEF VLV MNFLD, S-300, NO ECV/PT
20	1	61102636	BSHG-SPLT,TPR,QD, 3.50 ID,F,AQD S25044-56	70	1	33-500-009	ASSEMBLY, HEAT EXCHANGER, HIGH FLOW, S300
21	1	61108870	KEY STK-SQ,.88,STL,PLTD,AQD S24453-14	71	1	33-995-001	LABEL, PLATE, WARNING, OIL ONLY
22	1	61135228	SPRKT-14MM PITCH,2.75 W,168 TEETH	72	1	33-995-003	LABEL, PLATE, SERVICE/SUPPORT
23	1	61166823	SPRKT-14MM PITCH,2.75W, 56 TEETH,F SERIES BSHG	73	1	33-995-020	LABEL, STICKER, DIESEL FUEL ONLY, 225 GAL
24	1	33-001-029	BELT-3136,14MM PITCH, 2.75 WIDE, CNTNTL	74	1	33-995-010	DECAL, VINYL, WATER FILTER TAG
25	1	25-500-004	PWR END ASSY- SERIES 300, APS & AQD	75	2	33-995-011	DECAL, VINYL, DEF FLUID
26	1	12-005-0808	FITTING, STRT, MNPT-MJIC, 08-08	76	1	33-995-014	DECAL, VINYL, FILTER, PARTICULATE REMOVAL
27	1	12-005-1616	FITTING, STRT, MNPT-MJIC, 16-16	77	1	33-995-019	LABEL, PLATE, MODEL/SERIAL, APS
28	2	12-007-2424.B	FITTING, STRT, MNPT-HOSE, 24-24.B	78	3	33-995-021	DECAL, VINYL, WARNING, PINCH POINT
29	1	12-011-0606	FITTING, STRT, FNPT-MJIC, 06-06	79	2	10-950-201	HOSE CLAMP, T-BOLT, STAINLESS, 2-1/8" OD
30	3	12-027-0606.B	FITTING, STRT, FJIC-HOSE, 06-06.B	80	3	10-960-006	HOSE CLAMP, WORM DR, 7/16 - 25/32, .5 IN WD
31	5	12-027-1616.B	FITTING, STRT, FJIC-HOSE, 16-16.B	81	1	99-013-020	ROUTING CLAMP, 1-5/16" ID, ZINC STEEL
32	1	12-030-2424.B	FITTING, 90, MNPT-FNPT, 24-24.B	82	1	99-013-021	ROUTING CLAMP, 11/16"ID, ZINC STEEL
33	1	12-033-0804	FITTING, 90, MNPT-MJIC, 08-04	83	1	11-001-011	ENCLOSURE, BATTERY, 31M, (ALSO A-9407)
34	1	12-033-1616	FITTING, 90, MNPT-MJIC, 16-16	84	1	11-001-016	BATTERY, 12V, 31M, 1000 CCA (A-9338)
35	1	12-044-1212	FITTING, 90, MSAE-MJIC, 12-12	85	1	99-050-005	STRAP, CINCH, SQZ BCKL, 2" WD, 8FT LG, NYLON
36	1	12-044-1616	FITTING, 90, MSAE-MJIC, 16-16	86	1	11-005-011	CABLE, BATTERY, BLK, 2/0, 3/8 RNG, 72" LG
37	1	12-102-0606	RUN TEE, MJIC-MJIC-FNPT, 06-06-06	87	1	11-005-012	CABLE, BATTERY, RED, 2/0, 3/8 RNG, 72" LG
38	2	12-250-1205	PLUG, MNPT, HOLLOW HEX, 12	88	1	11-005-013	CABLE, BATTERY, BLK, 4GA, 3/8 RNG, 108" LG
39	2	12-250-1600	PLUG, MNPT, 16	89	1	11-005-014	CABLE, BATTERY, RED, 4GA, 3/8 RNG, 108" LG
40	1	12-250-1605	PLUG, MNPT, HOLLOW HEX, 16	90	1	13-500-007	KIT-HOSE, S300, BASE, HYD, CRMP
41	1	12-250-2000	PLUG, MNPT, 20	91	44 IN	13-016-2000.BLU	HOSE, PUSH-LOK,-16, 175 PSI, BLU
42	1	12-250-2400	PLUG, MNPT, 24	92	95 IN	13-006-2000.YLW	HOSE, FUEL, PUSH-LOK, -6, 300 PSI, YLW
43	2	10-410-035	BOLT, HEX, M10X1.5MM X 35MM, 10.9 ALLOY				
44	6	10-416-050	BOLT, HEX HEAD, M16 X 2MM X 50MM, CLASS 10.9				
45	2	90-008-075	BOLT, HEX, 1/4"-20 X 3/4"				
46	6	90-012-100	BOLT, HEX, 3/8"-16 X 1"				
47	12	90-012-125	BOLT, HEX, 3/8"-16 X 1-1/4"				
48	4	90-016-100	BOLT, HEX, 1/2"-13 X 1"				
49	6	90-016-125	BOLT, HEX, 1/2"-13 X 1-1/4"				
50	4	90-017-125	BOLT, HEX, 1/2"-20 X 1-1/4"				



REVISIONS

ZONE	REV.	DESCRIPTION	DATE	APPROVED
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TOLERANCES (EXCEPT AS NOTED)

SURFACE FINISH	63
MACHINE FILLETS	R.02
ANGLE	±1°

DIM TOLERANCES: (in)

.X	= ±	.063
.XX	= ±	.015
.XXX	= ±	.005
.XXXX	= ±	.0005

TITLE: TRPLX UNIT-S300, BASE

ADVANCED PRESSURE SYSTEMS
701 S. PERSIMMON DR. TOMBALL, TX 77375

THIRD ANGLE PROJECTION

DWG BY K. SMITH

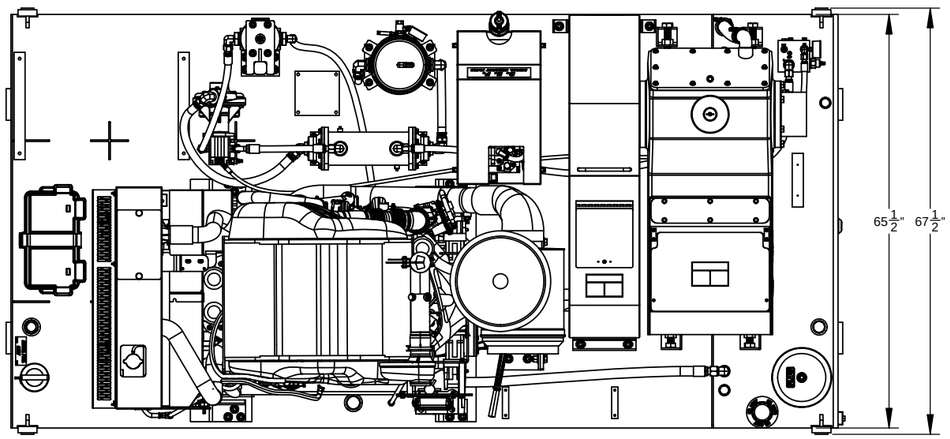
APRVD BY B. PARKER

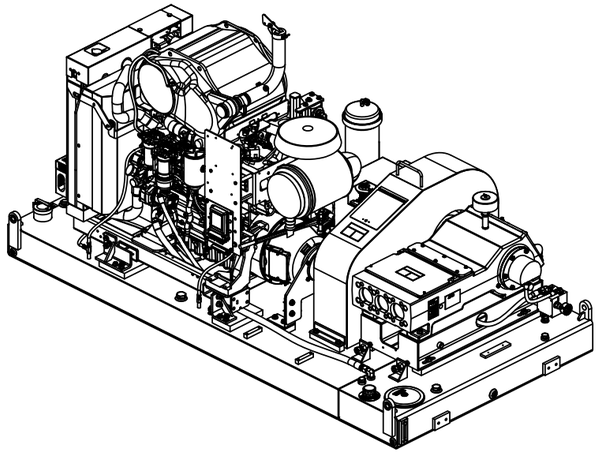
APS SHAPE TECHNOLOGIES GROUP

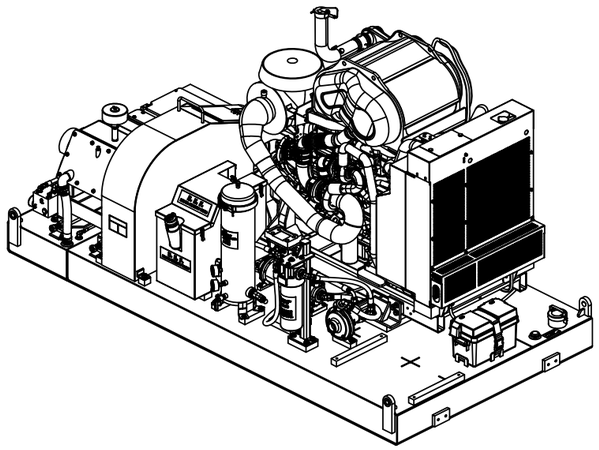
DWG. NO. 32-500-000 REV. 0

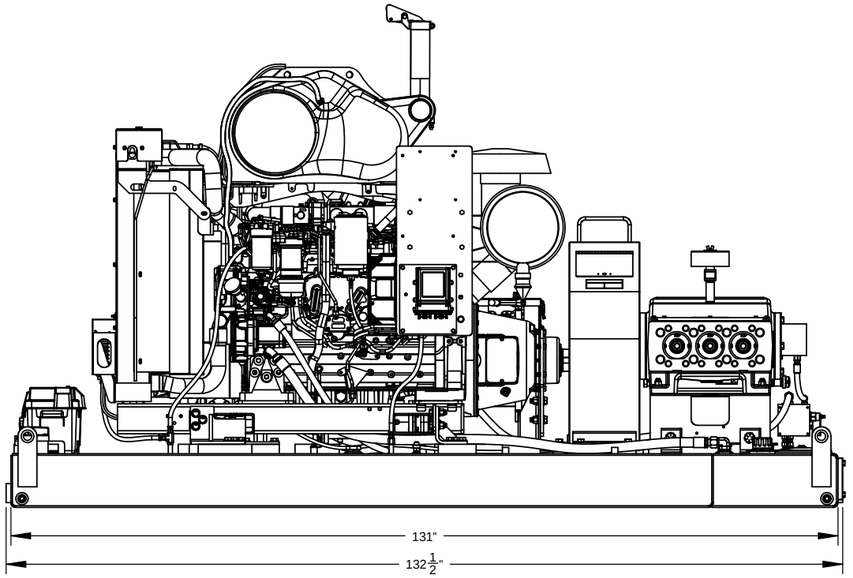
MATL.

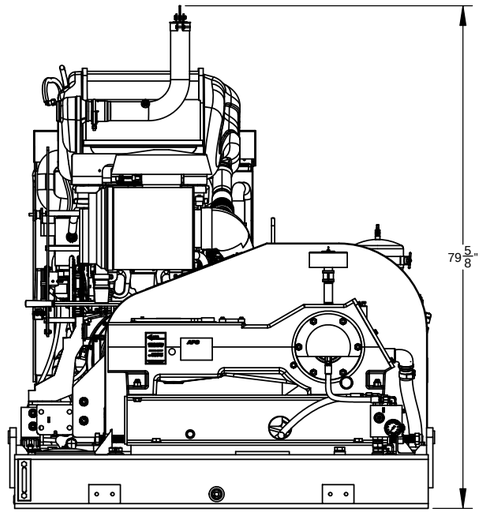
SHT 1 OF 7











APS S-300 - TIER 4 C7.1 (BASE UNIT)

PART NUMBER: 32-500-000
5,000 - 40,000 PSI FLUID END OPTIONS
ASSEMBLED BY ADVANCED PRESSURE SYSTEMS, TOMBALL, TX.
PRIME MOVER: CAT TIER 4 C7.1 DIESEL ENGINE
ESTIMATED WEIGHT: 8,000 LBS. (DRY)
NOISE EMMISSION: 105 dBA @ 3 FT. @ 2100 ENGINE RPM
OIL CAPACITY: 40 GALLONS
FUEL CAPACITY: 225 GALLONS / USE DIESEL FUEL ONLY
DEF CAPACITY: 8.5 GALLONS
MAX FUEL CONSUMPTION: 13 GAL./HOUR

REVISIONS

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TOLERANCES (EXCEPT AS NOTED)

SURFACE FINISH	63
MACHINE FILLETS	R.02
ANGLE	±1°

DIM TOLERANCES: (in)

.X	=	±	.063
.XX	=	±	.015
.XXX	=	±	.005
.XXXX	=	±	.0005

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ADVANCED PRESSURE SYSTEMS
701 S. PERSIMMON DR. TOMBALL, TX 77375

THIRD ANGLE PROJECTION

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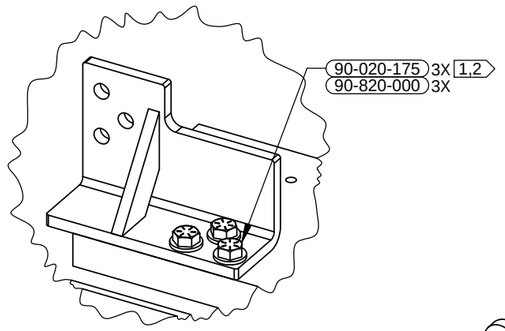
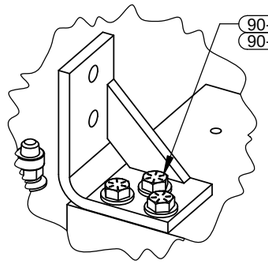
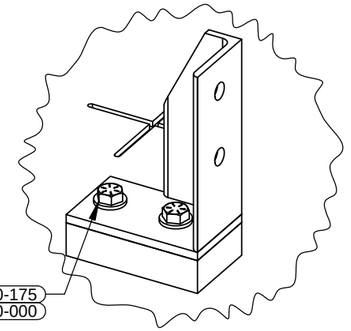
DWG. NO. 32-500-000 REV. 0
MATL.
SHT 2 OF 7



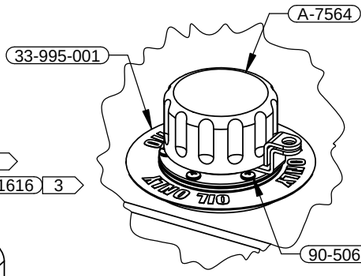
DETAIL A
SCALE 1 : 6
(TYP. BOTH SIDES)



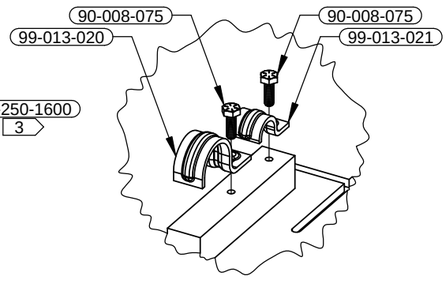
DETAIL B
SCALE 1 : 6
(TYP BOTH SIDES)



DETAIL C
SCALE 1 : 6
(TYP. BOTH SIDES)



DETAIL D
SCALE 1 : 4



DETAIL E
SCALE 1 : 4

NOTES:

1. APPLY LOCTITE THREADLOCKER BLUE 242 TO THREADS
2. TORQUE BOLTS TO 105 FT. LBS
3. APPLY THREAD SEALANT TO ALL TAPERED PIPE THREADS
4. ACCESS COVERS SHOULD BE INSTALLED PRIOR TO ASSEMBLY TO PREVENT CONTAMINATION OF HYDRAULIC TANK, GREASE O-RINGS PRIOR TO INSTALLATION

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	0	INITIAL RELEASE	5/1/2020	K. SMITH

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TOLERANCES (EXCEPT AS NOTED)

SURFACE FINISH	63
MACHINE FILLETS	R.02
ANGLE	±1°

DIM TOLERANCES: (in)

.X	= ±	.063
.XX	= ±	.015
.XXX	= ±	.005
.XXXX	= ±	.0005

TITLE: TRPLX UNIT-S300, BASE

ADVANCED PRESSURE SYSTEMS
701 S. PERSIMMON DR. TOMBALL, TX 77375

THIRD ANGLE PROJECTION

DWG BY: K. SMITH

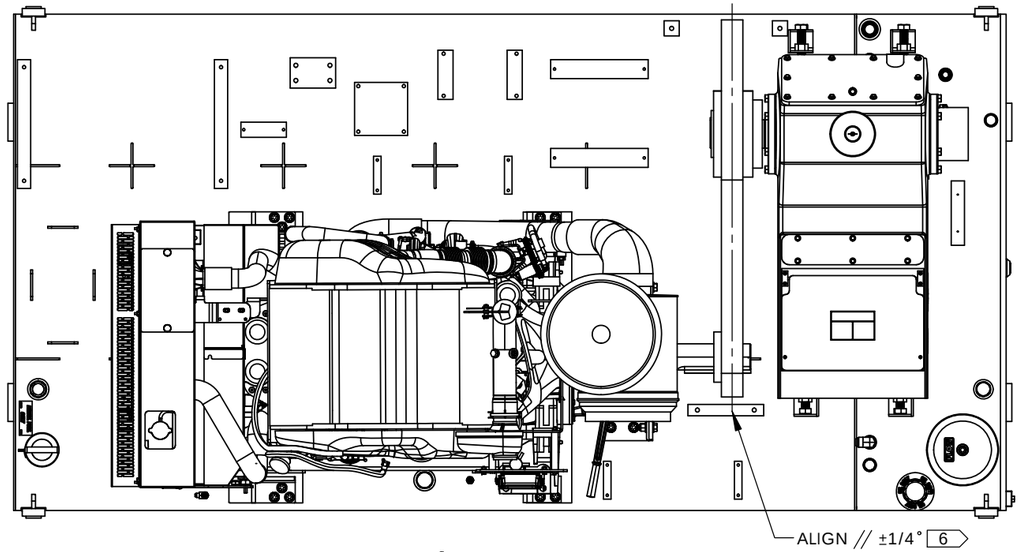
APRVD BY: B. PARKER

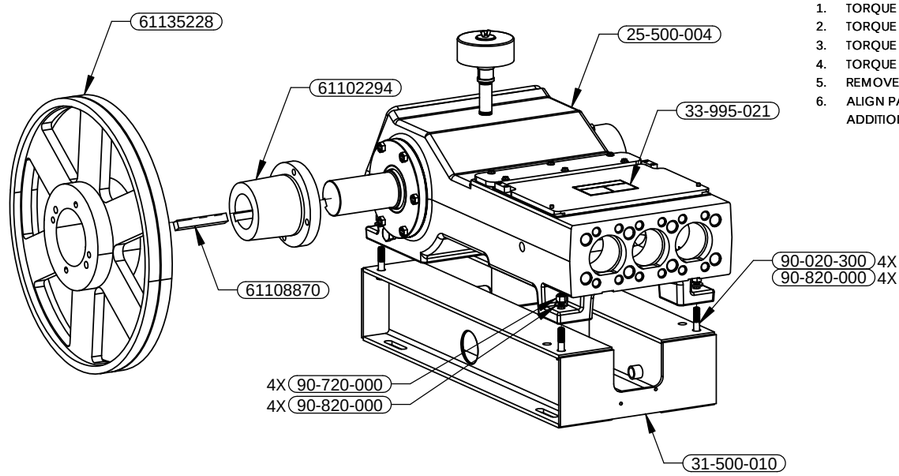
APS SHAPE TECHNOLOGY GROUP

DWG. NO. 32-500-000 REV. 0

MATL.

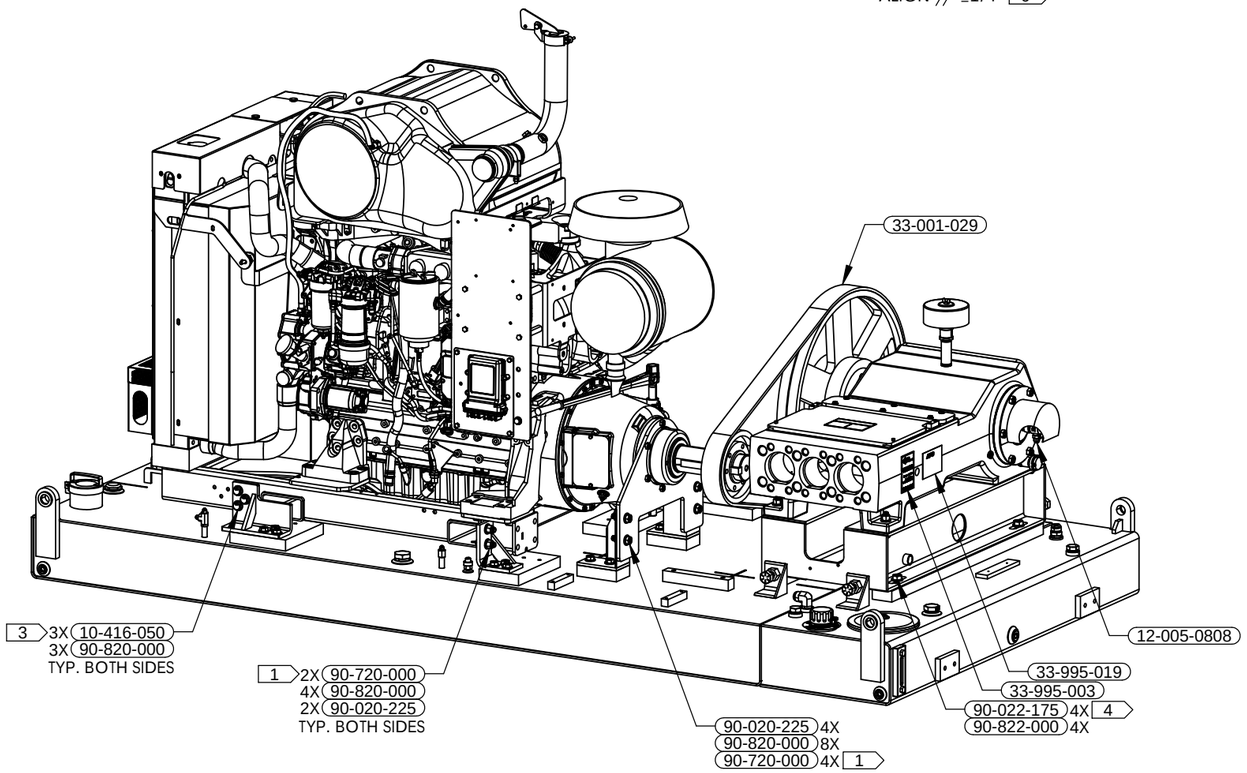
SHT 3 OF 7

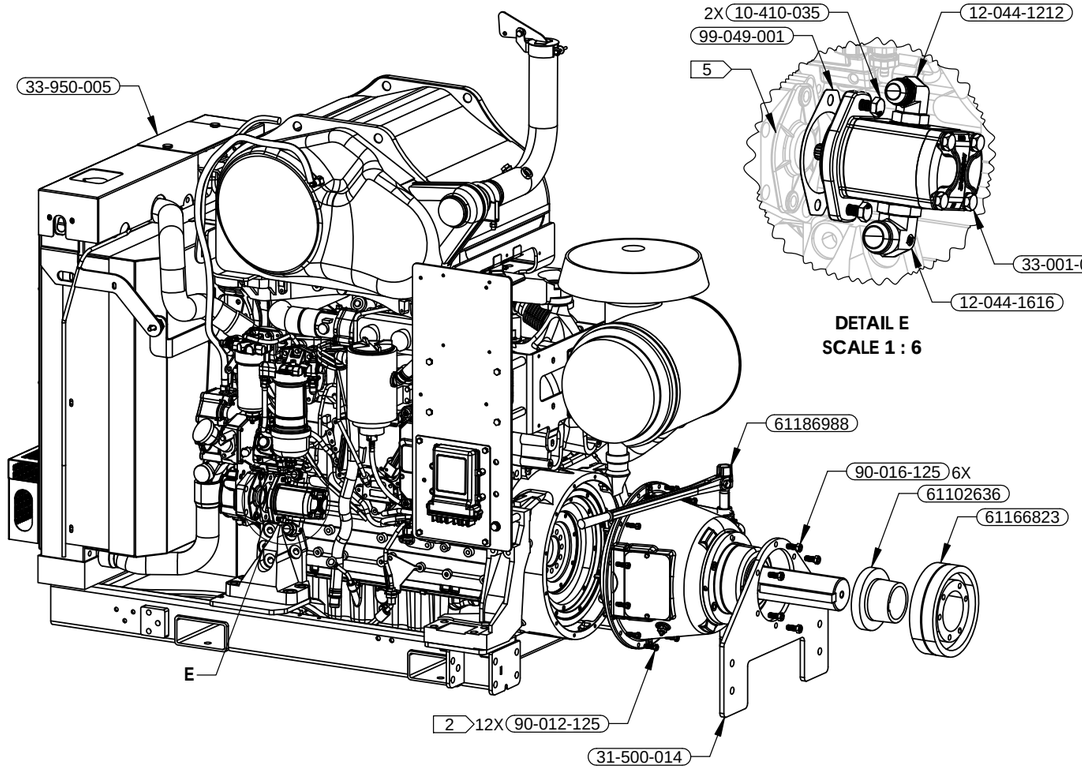




NOTES:

1. TORQUE TO 35 FT. LBS.
2. TORQUE TO 45 FT. LBS.
3. TORQUE TO 200 FT. LBS.
4. TORQUE TO 185 FT. LBS. AFTER PUMP ALIGNMENT
5. REMOVE PROTECTIVE COVER AND DISCARD
6. ALIGN PARALLEL WITHIN 1/4°, BELT SHOULD RESONATE AT 94.7 Hz, ADDITIONAL INSTRUCTIONS IN DOCUMENT ES-10007





DETAIL E
SCALE 1 : 6

REVISIONS				
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TOLERANCES (EXCEPT AS NOTED)

SURFACE FINISH	63	DIM TOLERANCES: (in)
MACHINE FILLETS	R.02	.X = ± .063
ANGLE	±1°	.XX = ± .015
		.XXX = ± .005
		.XXXX = ± .0005

TITLE: TRPLX UNIT-S300, BASE

ADVANCED PRESSURE SYSTEMS
701 S. PERSIMMON DR. TOMBALL, TX 77375

THIRD ANGLE PROJECTION

DWG BY K. SMITH

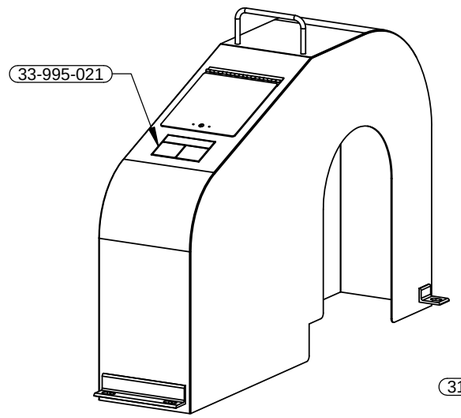
APRVD BY B. PARKER

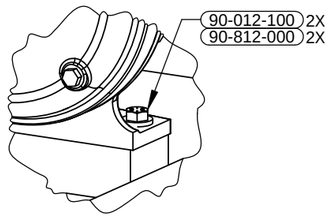
APS SHAPE TECHNOLOGIES GROUP

DWG. NO. 32-500-000 REV. 0

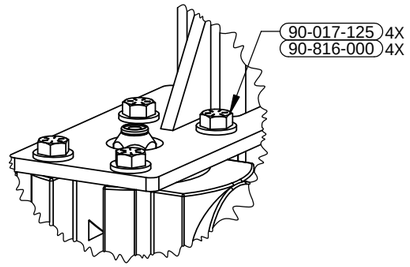
MATL.

SHT 4 OF 7





DETAIL F
SCALE 1 : 4



DETAIL G
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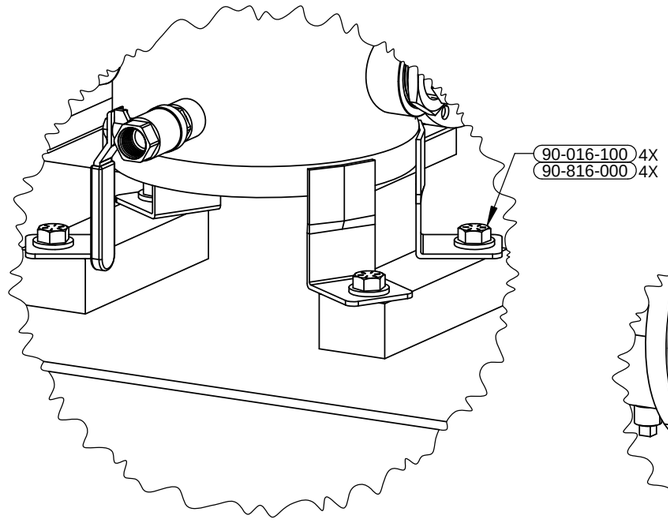
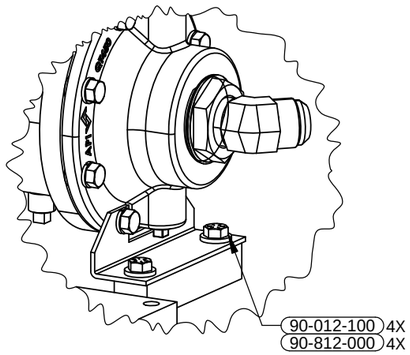


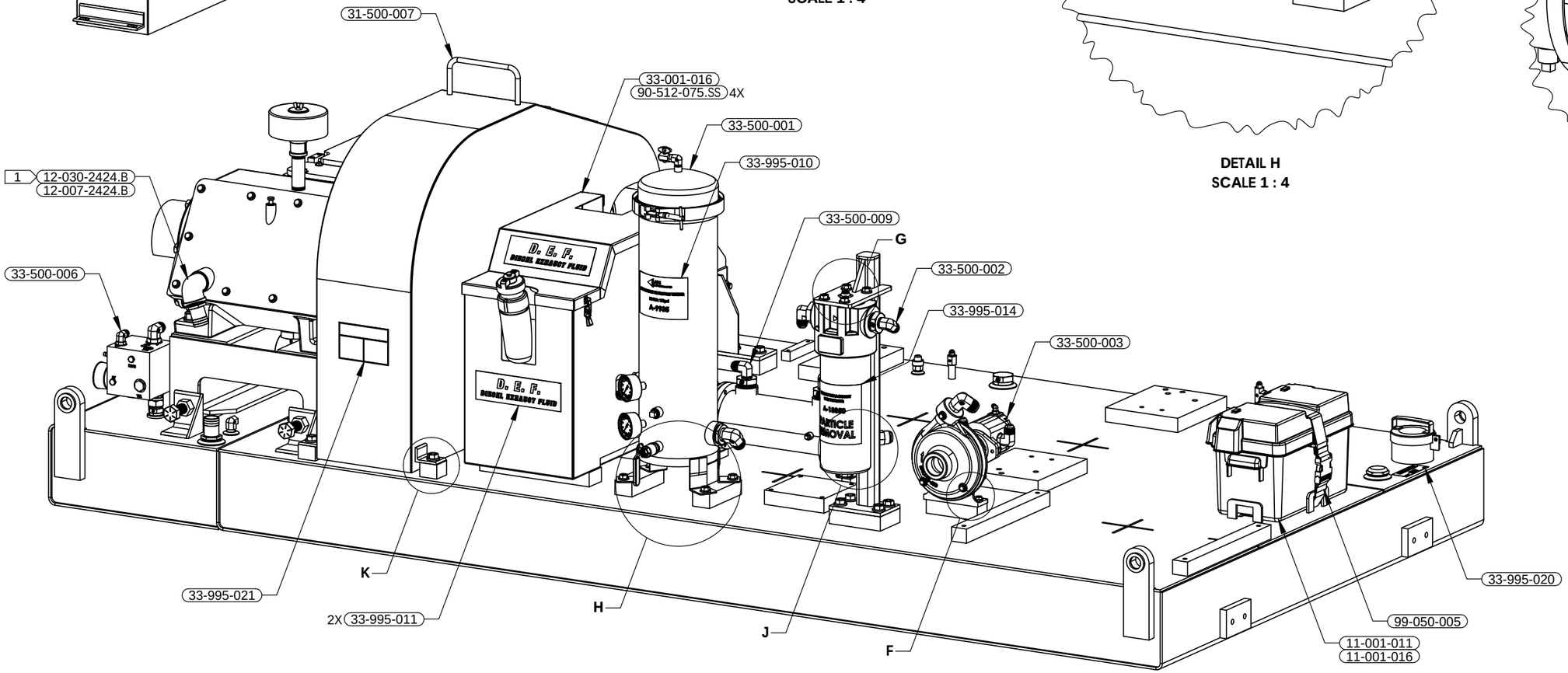
DETAIL H
SCALE 1 : 4

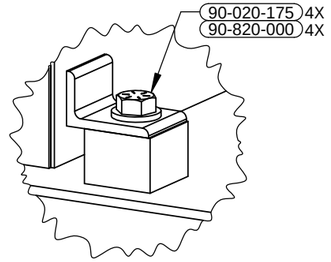
NOTES:

1. APPLY THREAD SEALANT TO ALL TAPERED PIPE THREADS



DETAIL J
SCALE 1 : 4





DETAIL K
SCALE 1 : 4

REVISIONS				
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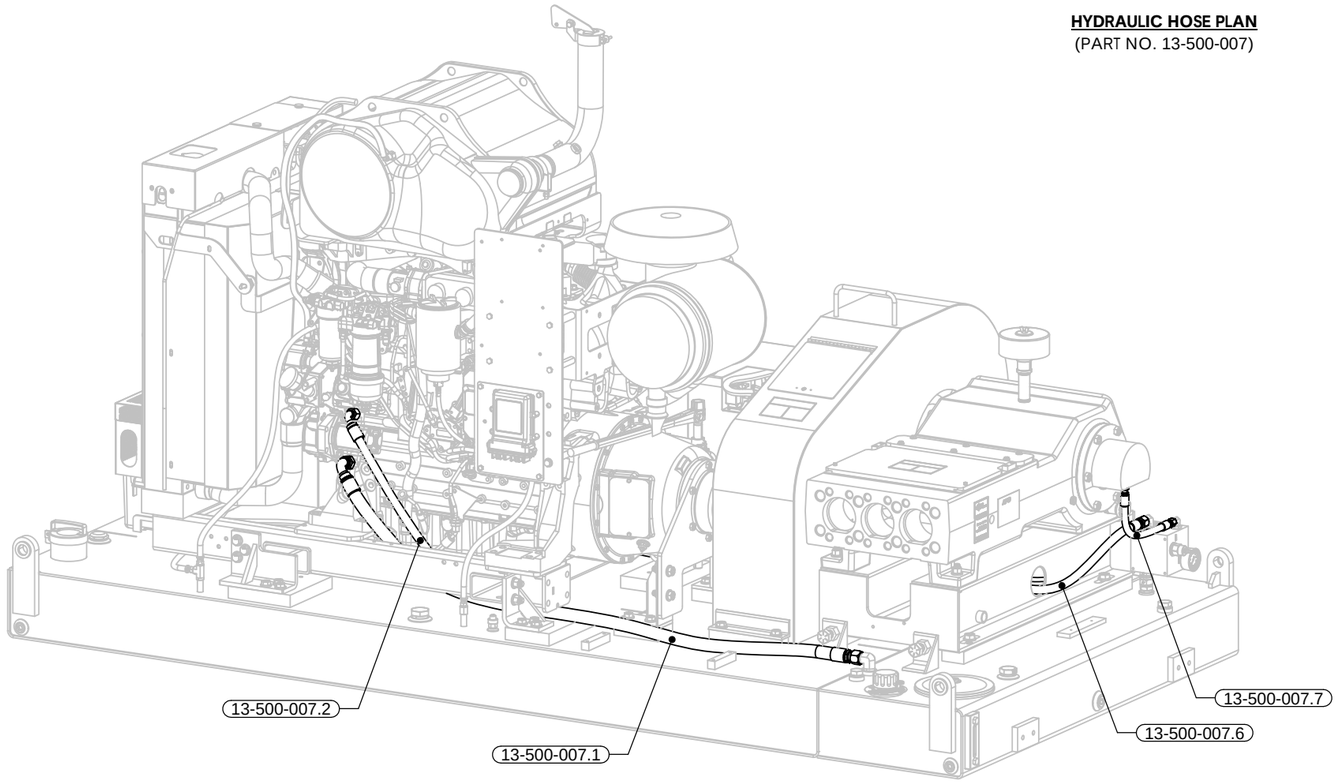
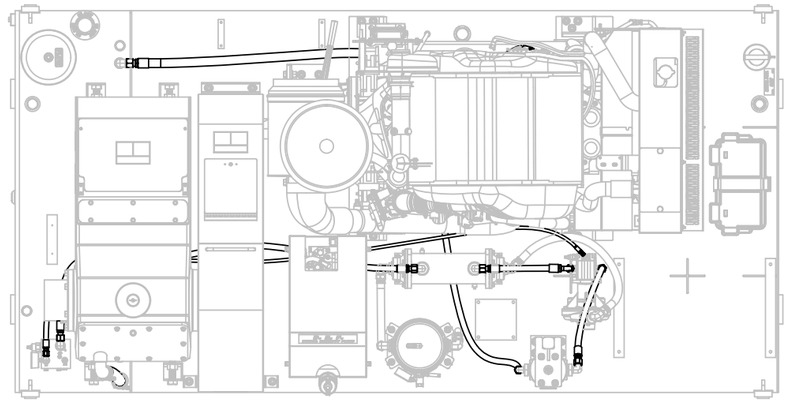
APRVD BY: B. PARKER

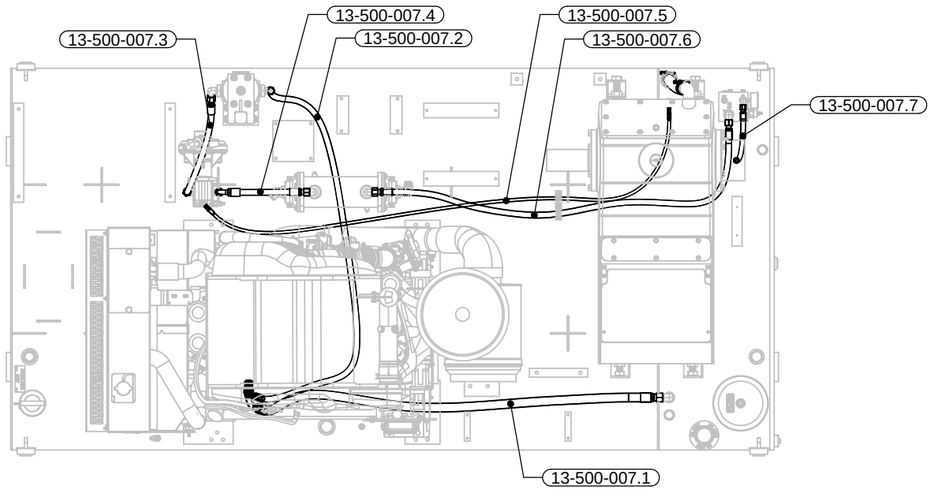
APS SHAPE TECHNOLOGIES GROUP

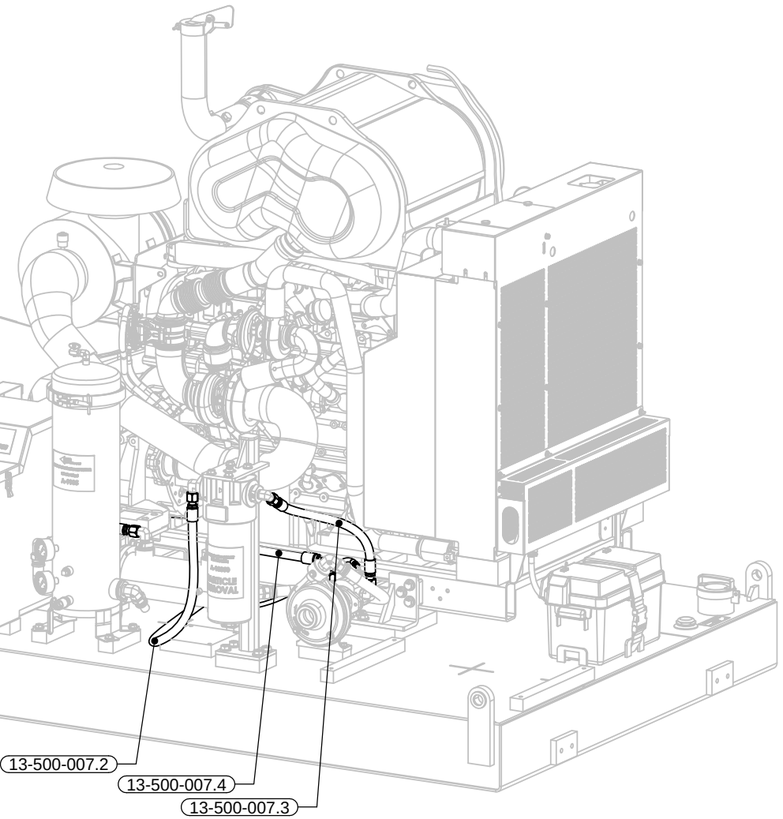
DWG. NO. 32-500-000 REV. 0
MATL.
SHT 5 OF 7

HYDRAULIC HOSE PLAN
(PART NO. 13-500-007)









REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	0	INITIAL RELEASE	5/1/2020	K. SMITH

UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS ARE IN INCHES
INTERPRET PER ANSI Y14.5-2009
DIM'S IN [mm] ARE REFERENCE ONLY
BREAK SHARP EDGES & DEBURR .015

TOLERANCES (EXCEPT AS NOTED)

SURFACE FINISH	63
MACHINE FILLETS	R.02
ANGLE	±1°

DIM TOLERANCES: (in)
.X = ± .063
.XX = ± .015
.XXX = ± .005
.XXXX = ± .0005

TITLE: TRPLX UNIT-S300, BASE

ADVANCED PRESSURE SYSTEMS
701 S. PERSIMMON DR. TOMBALL, TX 77375

THIRD ANGLE PROJECTION

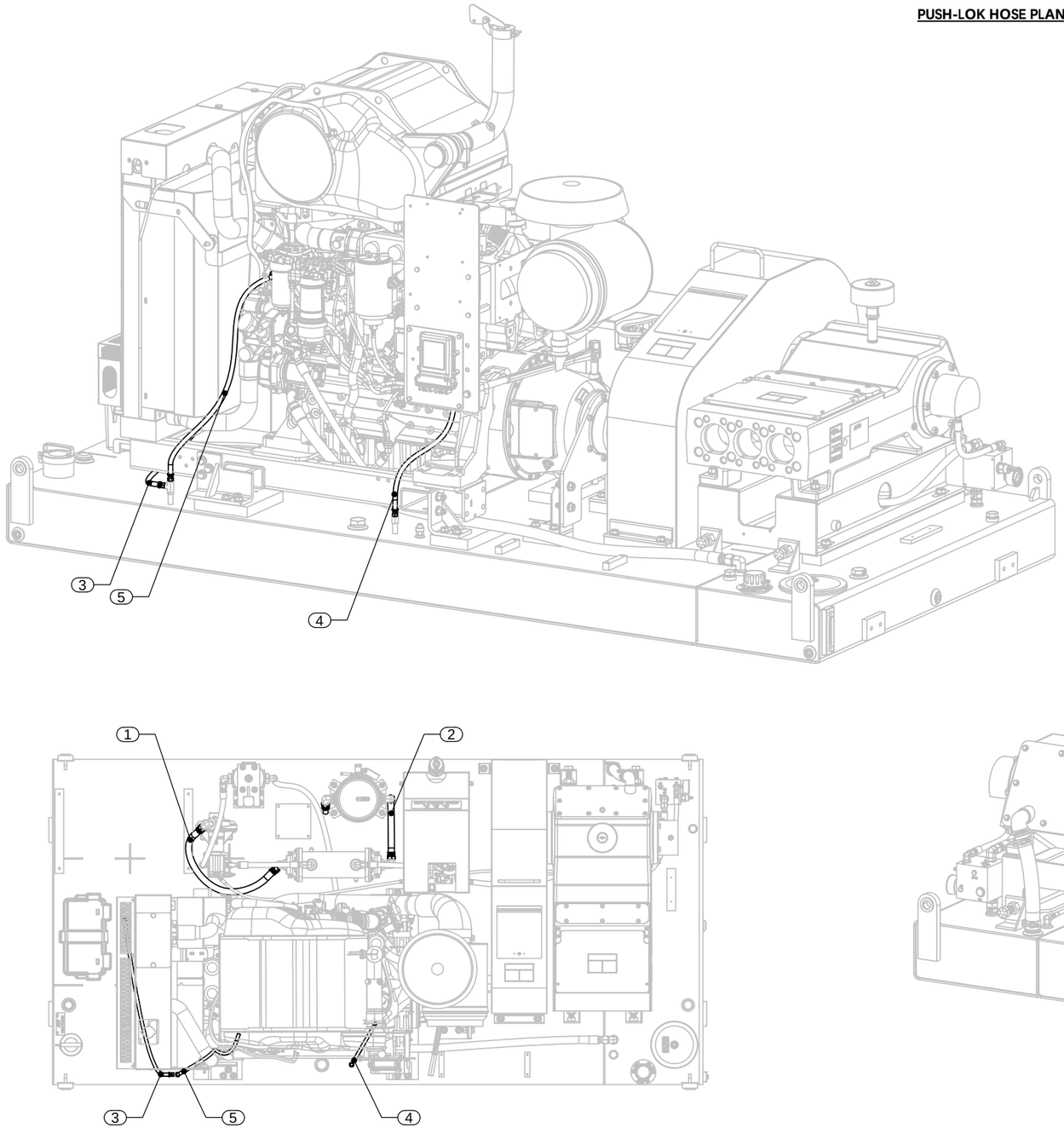
DWG BY: K. SMITH
APRVD BY: B. PARKER

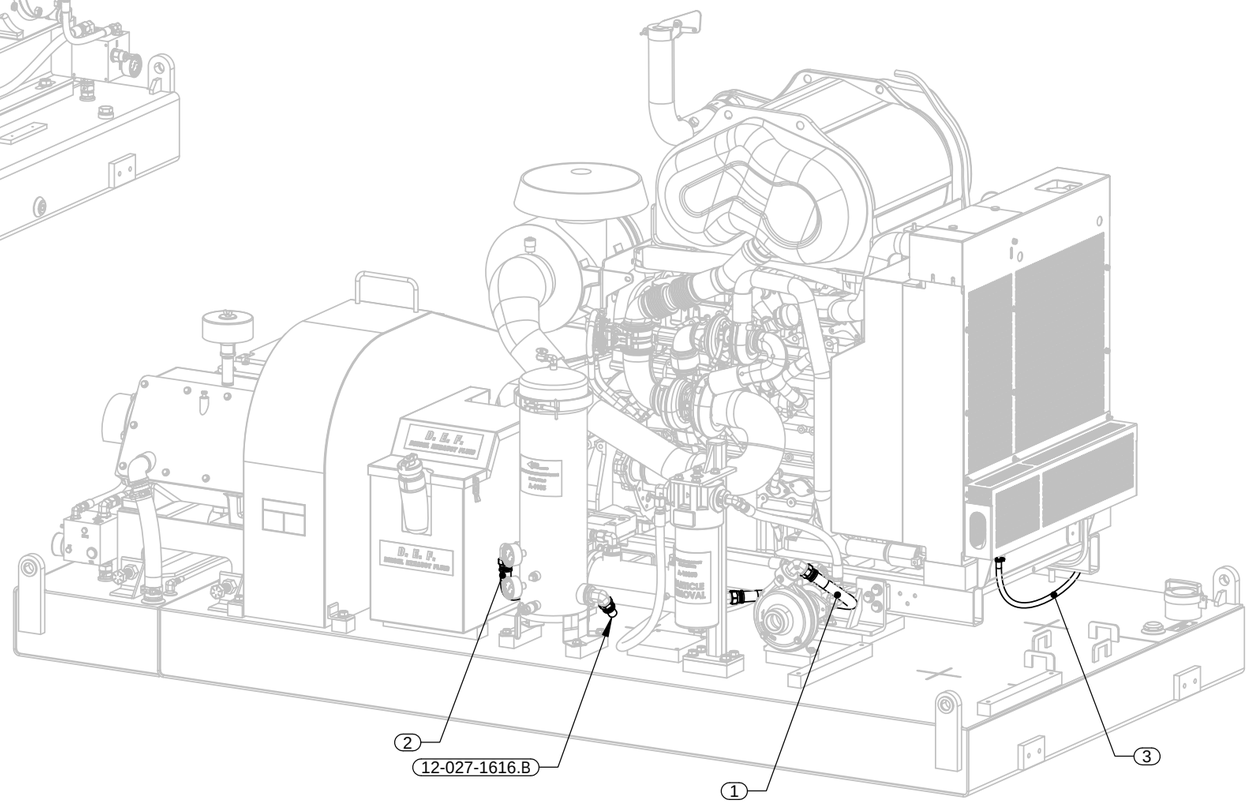
APS SHAPE TECHNOLOGIES GROUP

DWG. NO. 32-500-000 REV. 0
MATL.
SHT 6 OF 7

PUSH-LOK HOSE PLAN

REF. NO	HOSE SIZE	FITTING 1	LOCATION FROM	FITTING 2	LOCATION TO	EST. OAL	COLOR
WATER HOSE PLAN							
[1]	-16	12-027-1616.B	CHARGE PUMP OUTLET	12-027-1616.B	HEAT EXCHANGER INLET	30 IN.	BLUE
[2]	-16	12-027-1616.B	HEAT EXCHANGER OUTLET	12-027-1616.B	WATER FILTER INLET	15 IN	BLUE
DIESEL HOSE PLAN							
[3]	-6	10-960-006	DIESEL COOLER	12-027-0606.B	DIESEL TANK	40 IN.	YELLOW
[4]	-6	10-960-006	DIESEL RETURN	12-027-0606.B	DIESEL TANK	35 IN.	YELLOW
[5]	-6	10-960-006	DIESEL SUCTION	12-027-0606.B	DIESEL TANK	20 IN.	YELLOW





REVISIONS				
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	0	INITIAL RELEASE	5/1/2020	K. SMITH

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TOLERANCES (EXCEPT AS NOTED)

SURFACE FINISH	63
MACHINE FILLETS	R.02
ANGLE	±1°

DIM TOLERANCES: (in)

.X	= ±	.063
.XX	= ±	.015
.XXX	= ±	.005
.XXXX	= ±	.0005

TITLE: TRPLX UNIT-S300, BASE

ADVANCED PRESSURE SYSTEMS
701 S. PERSIMMON DR. TOMBALL, TX 77375

THIRD ANGLE PROJECTION

DWG BY: K. SMITH

APRVD BY: B. PARKER

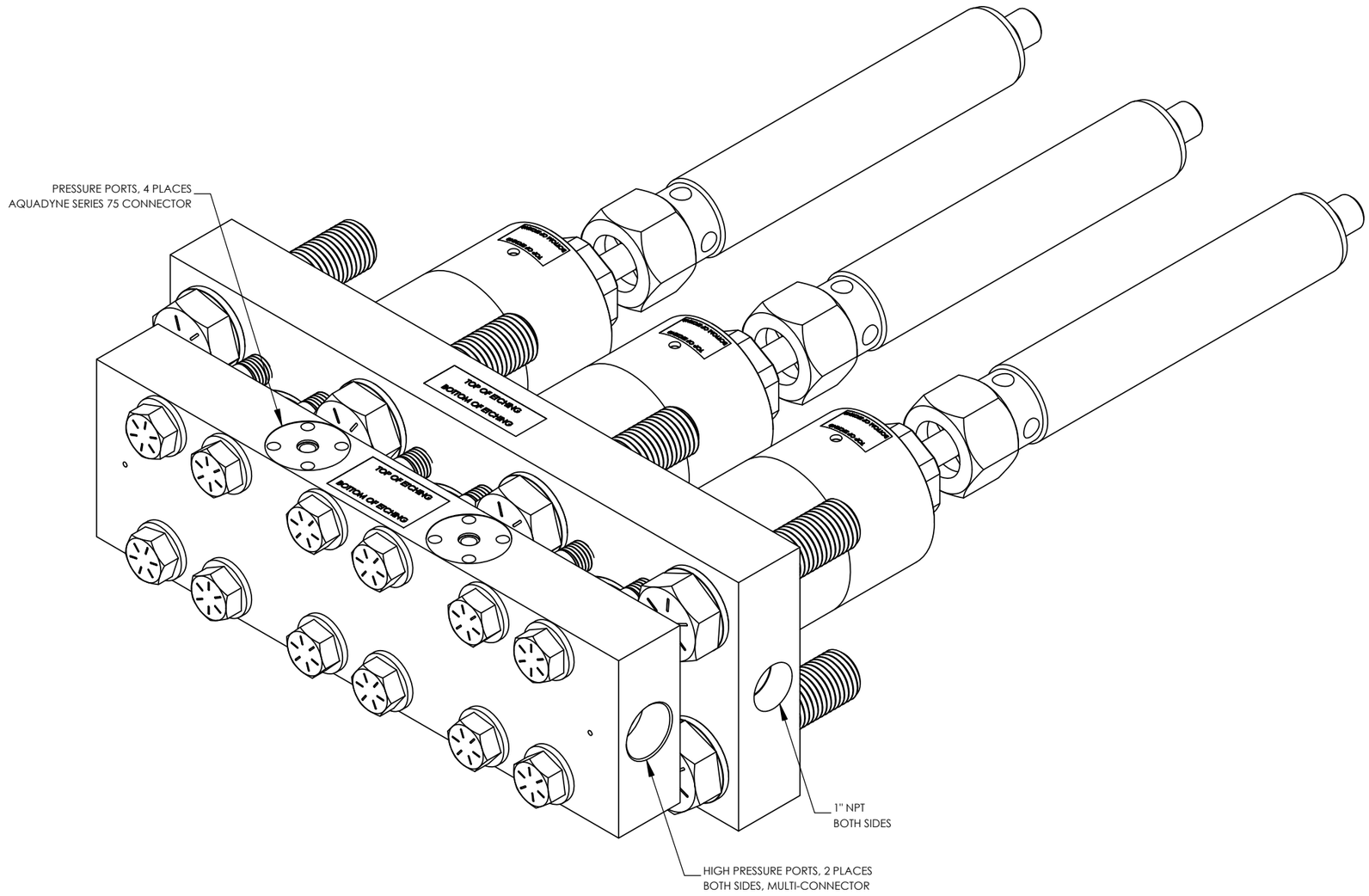
APS SHAPE TECHNOLOGIES GROUP

DWG. NO. 32-500-000 REV. 0

MATL.

SHT 7 OF 7

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	61102104	BLK-SUCT, SERIES 250
2	1	25-500-111	BLK-DISCH, S300, UHP, W/ FLOW DISCH PORT
3	12	90-022-450	BOLT, HEX, 3/4"-10 X 4 1/2"
4	8	90-028-500	BOLT, HEX, 1-1/4"-7 X 5"
5	3	25-500-311	ASSY-LP PKG, UHP, 0.69"
6	3	61113085	NUT-INTER ROD, SERIES 250 , NEW STYLE
7	3	61152492	CLT-PLGR, .69, 2.0 THD
8	3	25-500-109	ROD-PONY, S300, 0.50"-0.69" PLGR
9	3	61119605	SPCR-DISCH, GA SERIES, VHP
10	3	25-500-107	RTNR-PKG, S300, 0.50"-0.69"
11	3	25-500-211	ASSY-HP PKG, UHP, 0.69"
12	3	A29012-33	SEAL-CPRSN,1.00X1.25
13	3	A29012-34	SEAL-CPRSN,1.125ID,GA SER,VHP
14	3	25-500-103	BARL-S300, UHP, 0.50"-0.69"
15	3	61152359	PLGR-PMP, .69X8.75, CERAMIC
16	3	61152443	SPCR-SPR, SERIES 250, 40KSI, .69
17	3	61120199	SPR-CPRSN,.975X.074X1.50,SST
18	3	40019-00	VLV-SUCT,SERIES 50,HP,20KSI
19	3	61117491	SEAL-CPRSN, SEAT, VLV, 1.25 X 1.0 X .125
20	3	61106164	GDE-VLV, DISCH, SERIES 250, UHP
21	3	61118609	RNG-QUAD, 152, 3.25X3.44X.09, BN-N, AQD S29152-02
22	3	61152500	SEAT-VLV, SERIES 250, 40KSI, HI FLOW
23	8	61122463	WSHR-FLAT, 1.25 BLT, SPCL, HRDND
24	12	90-822-000	FLAT WASHER, 3/4"
25	3	B19414-24	VLV-DISCH,SERIES 250,UHP
26	3	61120266	SPR-CPRSN, .36X.059X1.125, SST, AQD S24103-23
27	3	61117835	O RNG-145, 2.56X2.75X.09, BN-N, D-70, AQD S29145-00
28	3	61115956	RNG-RTNG, INT, 1.437, SST, 2-TURN SPI, AQD S29450-31
29	3	30-002-150	O-RING, 2-150 BUNA-N 70 DURO
30	3	25-500-143	BRG-SLVE, FLNG, .69 PLGR, PLSTC



REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	0	INITIAL RELEASE	3/18/2020	K. SMITH
	1	ADDED PART 25-500-143	11/10/2022	K. SMITH

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BREAK SHARP EDGES & DEBURR .015

TOLERANCES (EXCEPT AS NOTED)

SURFACE FINISH	63
MACHINE FILLETS	R.02
ANGLE	±1°

DIM TOLERANCES: (in)

.X	= ±	.063
.XX	= ±	.015
.XXX	= ±	.005
.XXXX	= ±	.0005

TITLE: FL END ASSY-SERIES 300, UHP, 40KSI, 0.69", AQD

ADVANCED PRESSURE SYSTEMS
701 S. PERSIMMON DR. TOMBALL, TX 77375

THIRD ANGLE PROJECTION

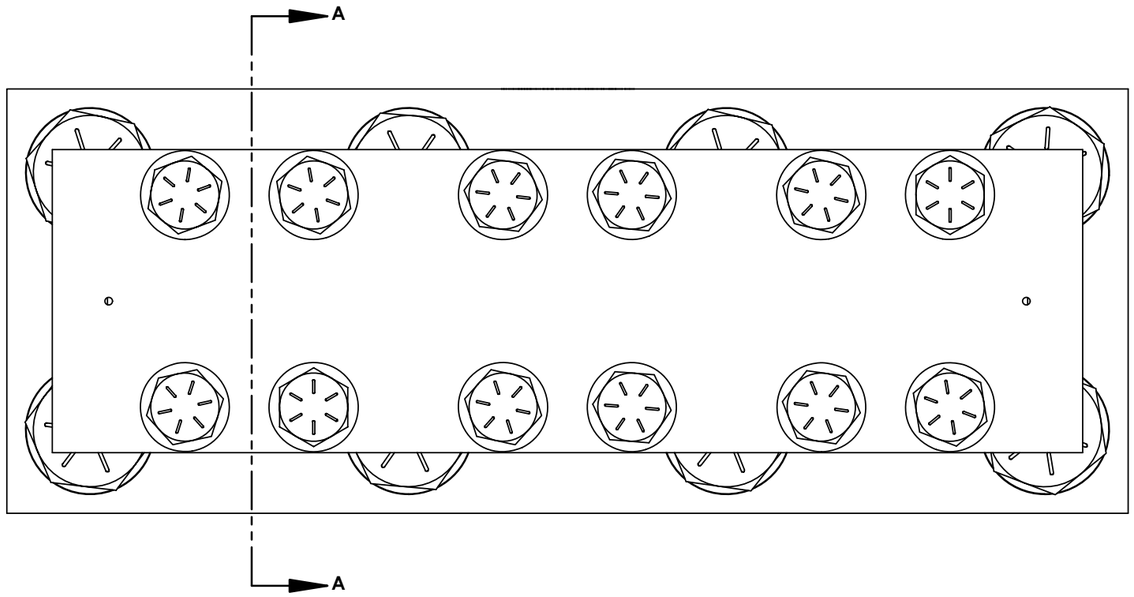
DWG BY: K. SMITH

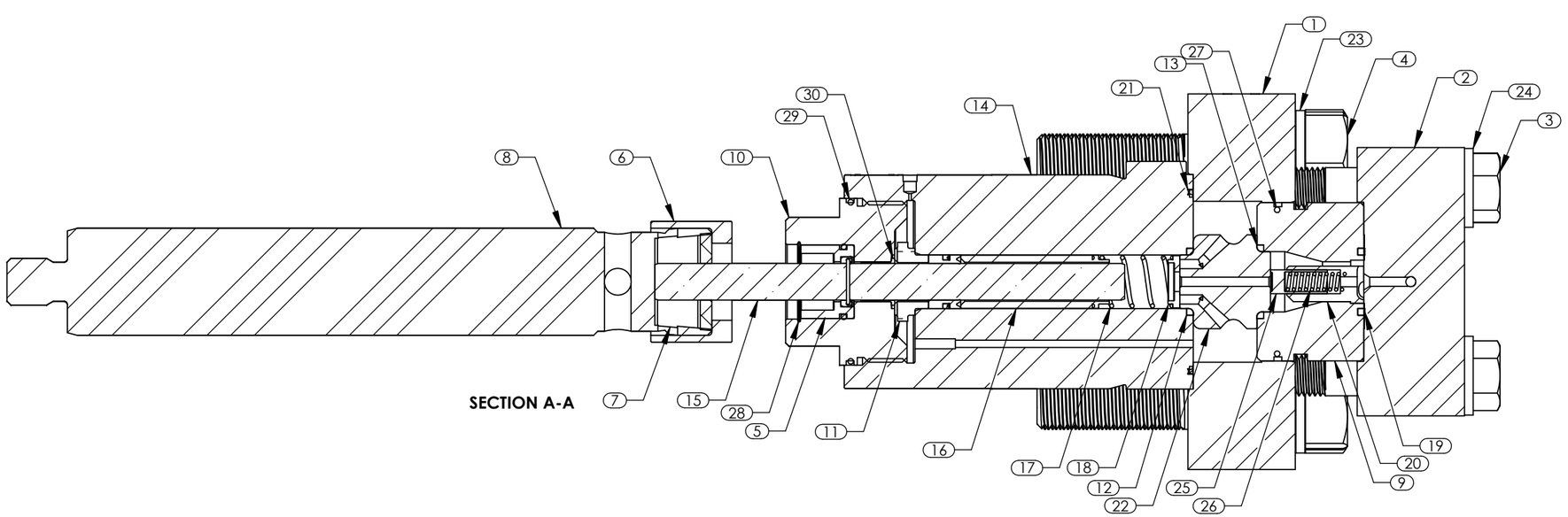
APRVD BY: B. PARKER

APS SHAPE TECHNOLOGIES GROUP

DWG. NO. 25-540-011 REV. 01

REF. DWG. 61152045 SHT 1 OF 6





SECTION A-A

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
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TOLERANCES (EXCEPT AS NOTED)

SURFACE FINISH	63
MACHINE FILLETS	R.02
ANGLE	±1°

DIM TOLERANCES: (in)

.X	= ±	.063
.XX	= ±	.015
.XXX	= ±	.005
.XXXX	= ±	.0005

TITLE: FL END ASSY-SERIES 300, UHP, 40KSI, 0.69", AQD

ADVANCED PRESSURE SYSTEMS
701 S. PERSIMMON DR. TOMBALL, TX 77375

THIRD ANGLE PROJECTION

DWG BY: K. SMITH

APRVD BY: B. PARKER

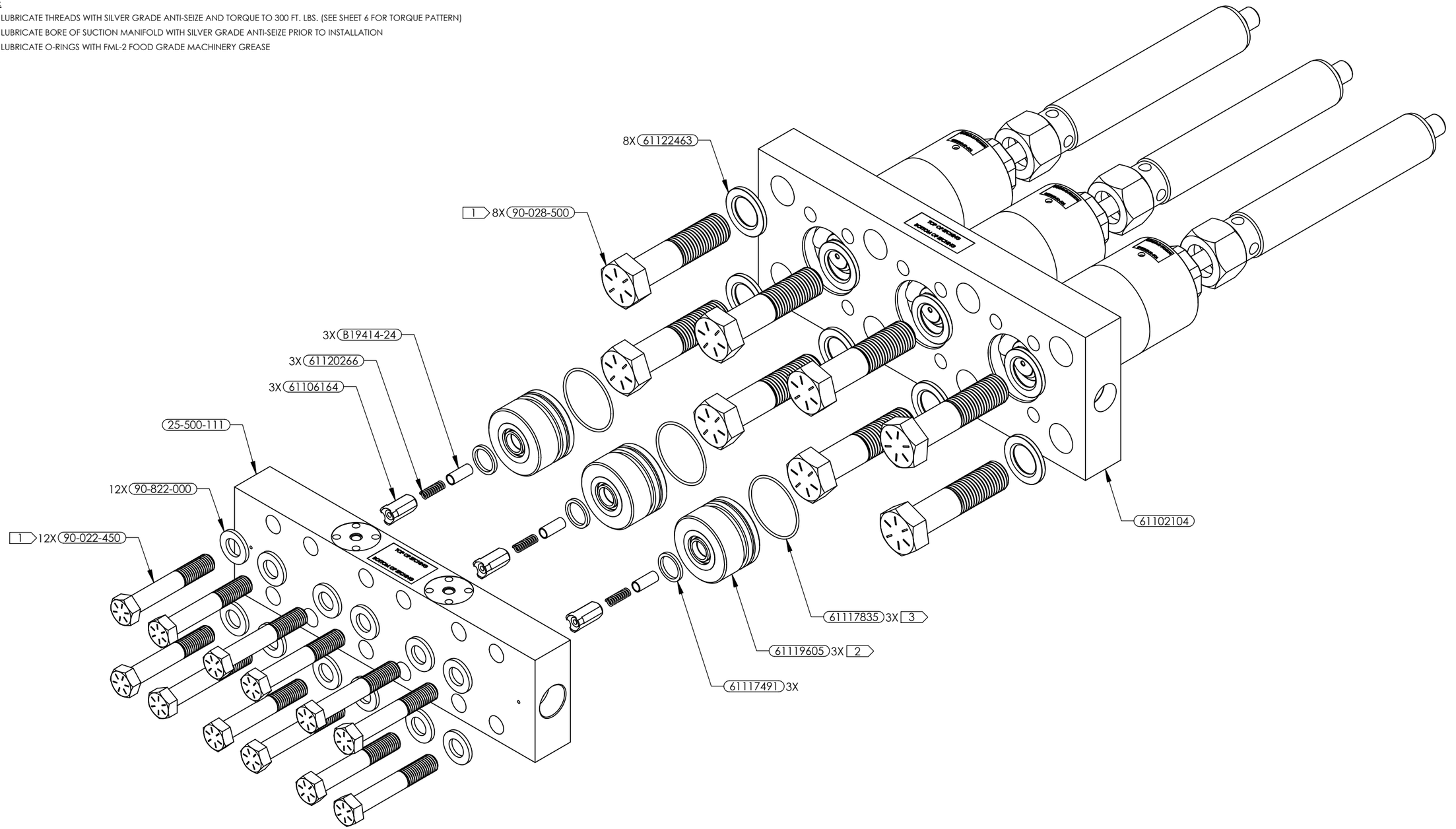
APS SHAPE TECHNOLOGIES GROUP

DWG. NO. 25-540-011 REV. 01

REF. DWG. 61152045 SHT 2 OF 6

NOTES:

1. LUBRICATE THREADS WITH SILVER GRADE ANTI-SEIZE AND TORQUE TO 300 FT. LBS. (SEE SHEET 6 FOR TORQUE PATTERN)
2. LUBRICATE BORE OF SUCTION MANIFOLD WITH SILVER GRADE ANTI-SEIZE PRIOR TO INSTALLATION
3. LUBRICATE O-RINGS WITH FML-2 FOOD GRADE MACHINERY GREASE



REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
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	1	ADDED PART 25-500-143	11/10/2022	K. SMITH

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DIM'S IN [mm] ARE REFERENCE ONLY
BREAK SHARP EDGES & DEBURR .015

TOLERANCES (EXCEPT AS NOTED)

SURFACE FINISH	63
MACHINE FILLETS	R.02
ANGLE	±1°

DIM TOLERANCES: (in)
.X = ± .063
.XX = ± .015
.XXX = ± .005
.XXXX = ± .0005

TITLE: FL END ASSY-SERIES 300, UHP, 40KSI, 0.69", AQD

ADVANCED PRESSURE SYSTEMS
701 S. PERSIMMON DR. TOMBALL, TX 77375

THIRD ANGLE PROJECTION

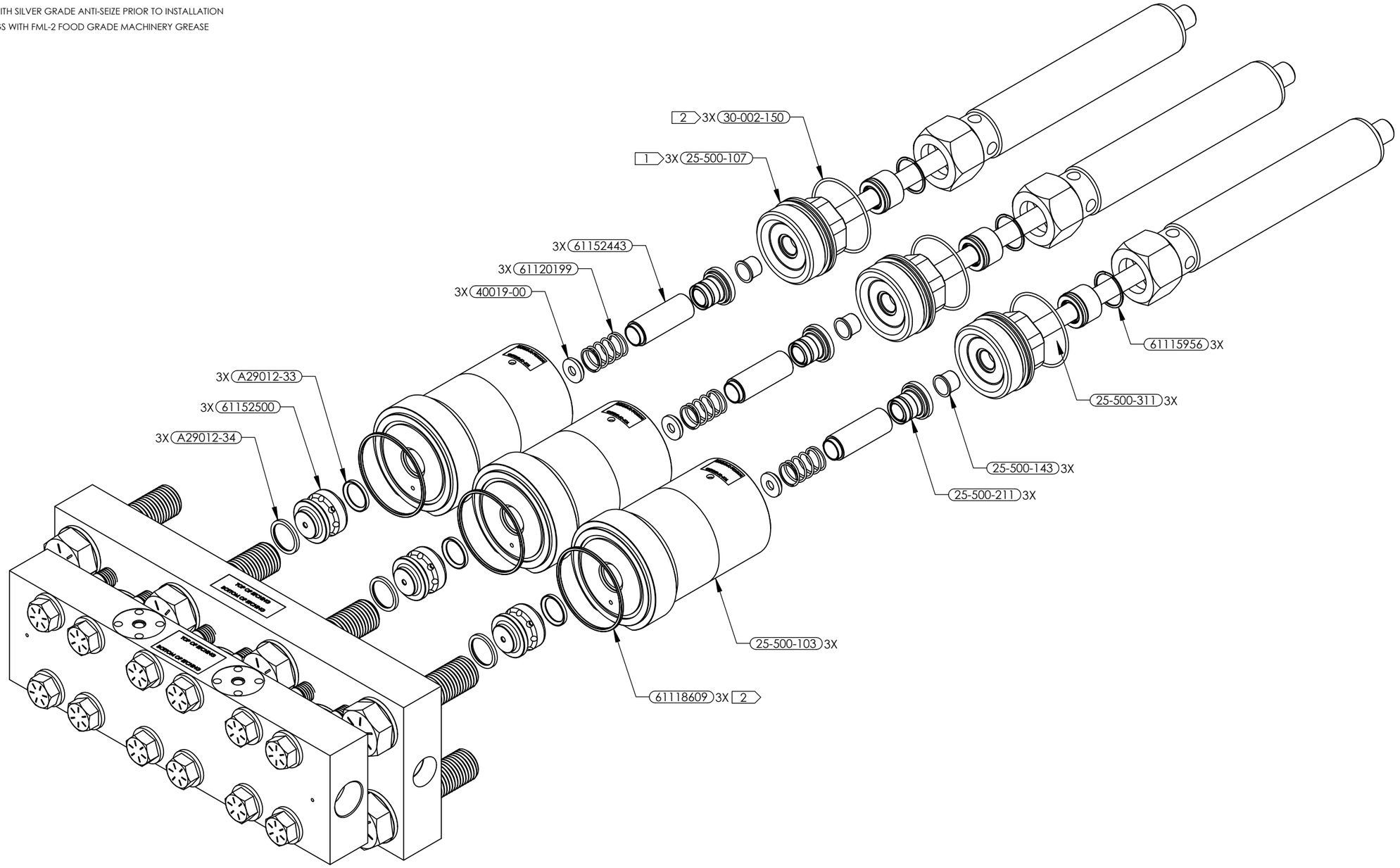
DWG BY: K. SMITH
APRVD BY: B. PARKER

APS SHAPE TECHNOLOGIES GROUP

DWG. NO. 25-540-011 REV. 01
REF. DWG. 61152045 SHT 3 OF 6

NOTES:

1. LUBRICATE THREADS WITH SILVER GRADE ANTI-SEIZE PRIOR TO INSTALLATION
2. LUBRICATE ALL O-RINGS WITH FML-2 FOOD GRADE MACHINERY GREASE



REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	0	INITIAL RELEASE	3/18/2020	K. SMITH
	1	ADDED PART 25-500-143	11/10/2022	K. SMITH

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DIM'S IN [mm] ARE REFERENCE ONLY
BREAK SHARP EDGES & DEBURR .015

TOLERANCES (EXCEPT AS NOTED)

SURFACE FINISH	63
MACHINE FILLETS	R.02
ANGLE	±1°

DIM TOLERANCES: (in)
.X = ± .063
.XX = ± .015
.XXX = ± .005
.XXXX = ± .0005

TITLE: FL END ASSY-SERIES 300, UHP, 40KSI, 0.69", AQD

ADVANCED PRESSURE SYSTEMS
701 S. PERSIMMON DR. TOMBALL, TX 77375

THIRD ANGLE PROJECTION

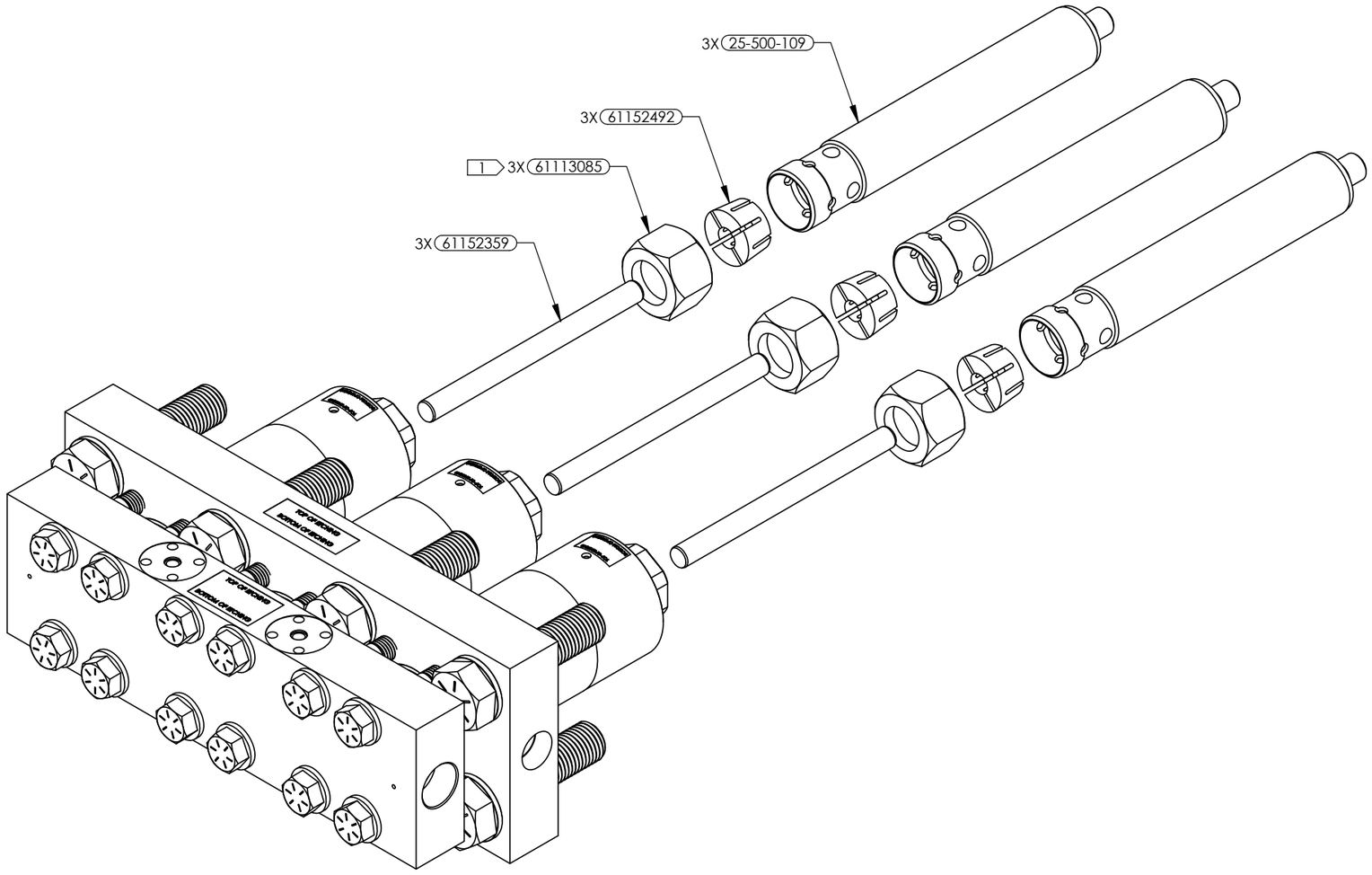
DWG BY: K. SMITH
APRVD BY: B. PARKER

APS SHAPE TECHNOLOGIES GROUP

DWG. NO. 25-540-011 REV. 01
REF. DWG. 61152045 SHT 4 OF 6

NOTES:

1. LUBRICATE THREADS WITH SILVER GRADE ANTI-SEIZE AND TORQUE TO 60 FT. LBS.



REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	0	INITIAL RELEASE	3/18/2020	K. SMITH
	1	ADDED PART 25-500-143	11/10/2022	K. SMITH

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INTERPRET PER ANSI Y14.5-2009
DIM'S IN [mm] ARE REFERENCE ONLY
BREAK SHARP EDGES & DEBURR .015

TOLERANCES (EXCEPT AS NOTED)

SURFACE FINISH	63
MACHINE FILLETS	R.02
ANGLE	±1°

DIM TOLERANCES: (in)
.X = ± .063
.XX = ± .015
.XXX = ± .005
.XXXX = ± .0005

TITLE: FL END ASSY-SERIES 300, UHP, 40KSI, 0.69", AQD

ADVANCED PRESSURE SYSTEMS
701 S. PERSIMMON DR. TOMBALL, TX 77375

THIRD ANGLE PROJECTION

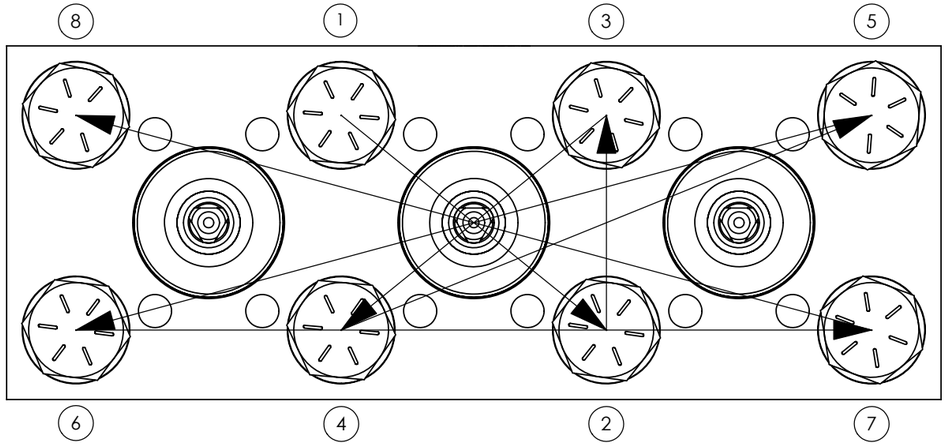
DWG BY: K. SMITH

APRVD BY: B. PARKER

APS SHAPE TECHNOLOGIES GROUP

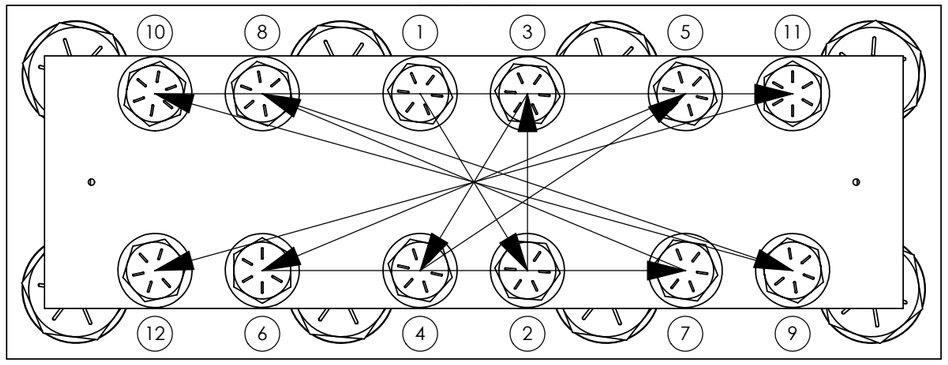
DWG. NO. 25-540-011 REV. 01

REF. DWG. 61152045 SHT 5 OF 6



TORQUE PROCEDURES

1. TIGHTEN BOLTS IN ORDER INDICATED BY NUMBERS AND ARROWS
2. LUBRICATE THREADS WITH SILVER GRADE ANTI-SEIZE AND TORQUE TO 300 FT. LBS. IN INCREMENTS OF 100 FT. LBS



TORQUE PROCEDURES

1. TIGHTEN BOLTS IN ORDER INDICATED BY NUMBERS AND ARROWS
2. LUBRICATE THREADS WITH SILVER GRADE ANTI-SEIZE AND TORQUE TO 300 FT. LBS. IN INCREMENTS OF 100 FT. LBS.

REVISIONS

ZONE	REV.	DESCRIPTION	DATE	APPROVED
	0	INITIAL RELEASE	3/18/2020	K. SMITH
	1	ADDED PART 25-500-143	11/10/2022	K. SMITH

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DIM'S IN [mm] ARE REFERENCE ONLY
BREAK SHARP EDGES & DEBURR .015

TOLERANCES (EXCEPT AS NOTED)

SURFACE FINISH	63
MACHINE FILLETS	R.02
ANGLE	±1°

DIM TOLERANCES: (in)

.X	=	±	.063
.XX	=	±	.015
.XXX	=	±	.005
.XXXX	=	±	.0005

TITLE: FL END ASSY-SERIES 300, UHP, 40KSI, 0.69", AQD

ADVANCED PRESSURE SYSTEMS
701 S. PERSIMMON DR. TOMBALL, TX 77375

THIRD ANGLE PROJECTION

DWG BY K. SMITH

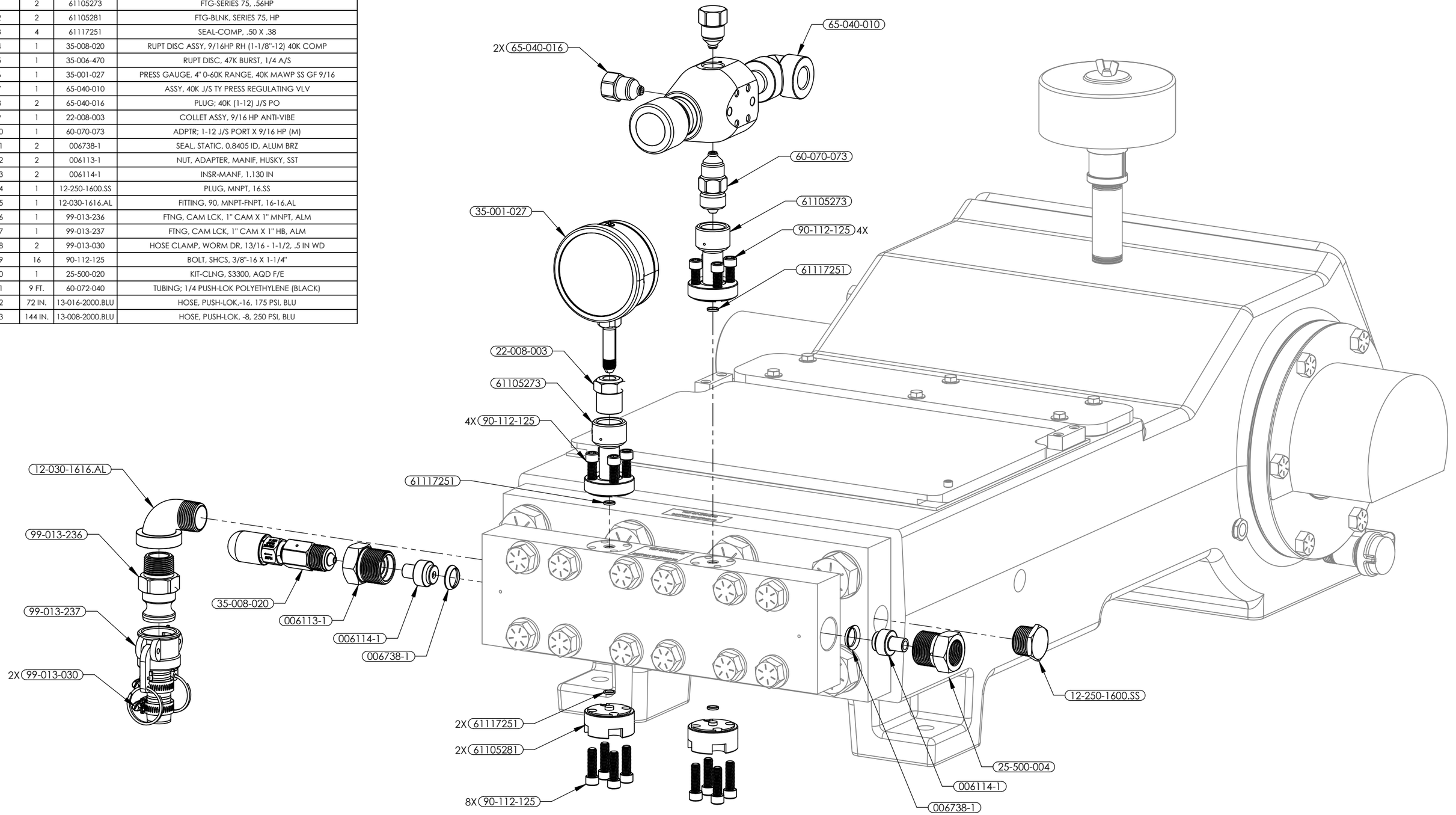
APRVD BY B. PARKER

APS SHAPE TECHNOLOGIES GROUP

DWG. NO. 25-540-011 REV. 01

REF. DWG. 61152045 SHT 6 OF 6

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	2	61105273	FTG-SERIES 75, .56HP
2	2	61105281	FTG-BLNK, SERIES 75, HP
3	4	61117251	SEAL-COMP, .50 X .38
4	1	35-008-020	RUPT DISC ASSY, 9/16HP RH (1-1/8"-12) 40K COMP
5	1	35-006-470	RUPT DISC, 47K BURST, 1/4 A/S
6	1	35-001-027	PRESS GAUGE, 4" 0-60K RANGE, 40K MAWP SS GF 9/16
7	1	65-040-010	ASSY, 40K J/S TY PRESS REGULATING VLV
8	2	65-040-016	PLUG; 40K (1-12) J/S PO
9	1	22-008-003	COLLET ASSY, 9/16 HP ANTI-VIBE
10	1	60-070-073	ADPTR; 1-12 J/S PORT X 9/16 HP (M)
11	2	006738-1	SEAL, STATIC, 0.8405 ID, ALUM BRZ
12	2	006113-1	NUT, ADAPTER, MANIF, HUSKY, SST
13	2	006114-1	INSR-MANF, 1.130 IN
14	1	12-250-1600.SS	PLUG, MNPT, 16.SS
15	1	12-030-1616.AL	FITTING, 90, MNPT-FNPT, 16-16.AL
16	1	99-013-236	FTNG, CAM LCK, 1" CAM X 1" MNPT, ALM
17	1	99-013-237	FTNG, CAM LCK, 1" CAM X 1" HB, ALM
18	2	99-013-030	HOSE CLAMP, WORM DR, 13/16 - 1-1/2, .5 IN WD
19	16	90-112-125	BOLT, SHCS, 3/8"-16 X 1-1/4"
20	1	25-500-020	KIT-CLNG, S3300, AQD F/E
21	9 FT.	60-072-040	TUBING; 1/4 PUSH-LOK POLYETHYLENE (BLACK)
22	72 IN.	13-016-2000.BLU	HOSE, PUSH-LOK,-16, 175 PSI, BLU
23	144 IN.	13-008-2000.BLU	HOSE, PUSH-LOK, -8, 250 PSI, BLU



REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	0	INITITAL RELEASE	10/24/2022	K. SMITH

APS SHAPE TECHNOLOGIES GROUP®

ADVANCED PRESSURE SYSTEMS
701 S. PERSIMMON DR. TOMBALL, TX 77375

UNLESS OTHERWISE SPECIFIED:
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DIMS IN MM ARE FOR REFERENCE ONLY
BREAK SHARP EDGES AND DEBURR .015
TOLERANCES (EXCEPT AS NOTED)

MACHINE S.F.	∜
MACHINE FILLETS	R.02
ANGLE	±1°

DIM TOLERANCES: (in)
.X = ± .063
.XX = ± .015
.XXX = ± .005
.XXXX = ± .0005

TITLE: KIT-FL END ACCESS, S300, 400R,4G60,4P,9H,P,P

THIRD ANGLE PROJECTION

DWG BY K. SMITH

APRVD BY B. PARKER

MATERIAL

DWG. NO. 25-540-201 REV. 00

HEAT TREAT. SHT 1 OF 1

Cat® C7.1 ACERT™ Industrial Power Unit
Industrial

U.S. EPA Tier 4 Final and EU Stage V
151 bkW/202 bhp @ 2200 rpm

Image shown may not reflect actual engine configuration.

Specifications

Cat® C7.1 ACERT Industrial Power Unit	Metric	Imperial (English)
Configuration	I-6, 4-Stroke	
Bore	105 mm	4.13 in
Stroke	135 mm	5.31 in
Displacement	7.01 L	402.8 in^3
Aspiration	Series Turbocharged-Aftercooled (TTA)	
Compression Ratio	16.5:1	
Combustion System	Direct Injection	
Rotation (from flywheel end)	Counterclockwise, viewed on flywheel	
Total Coolant Capacity	24.25 L	6.4 U.S. gal
Total Lubricating Capacity	17.9 L	4.72 U.S. gal
Total DEF Capacity	32 L*	8.45 U.S. gal*
Cooling System	Liquid	
Estimated total weight including radiator support brackets Dry Wet	 1087 kg 1124 kg	 2396 lbs 2478 lbs
Firing Order	1, 5, 3, 6, 2, 4	
Lifting Points Location	Baseframe	
Mobile Used G-load Limitations	6 g	

*Usable volume needs to take into account gradient capability and DEF expansion.

For additional information on all your power requirements, visit www.cat.com/industrial

Technical Data

Overall Dimensions

Height, including radiator support brackets . . 1461 mm
Length, front of radiator to rear of air cleaner . . . . . 1769 mm
Width . . . . . 916 mm

Moments of Inertia (GD²)

Engine rotational components . . . . . 0.18255 kgm²
Crank pulley . . . . . 0.01555 kgm²
Flywheel (D0004) SAE 3 . . . . . 1.2 kgm²
Flywheel (D0094) SAE 2 . . . . . 0.89 kgm²
Flywheel (D0093) SAE 1 . . . . . 2.05 kgm²

Center of Gravity

Forward from rear of block (wet) . . . . . 445.3 mm
Above crankshaft centerline (wet) . . . . . 253.2 mm
Offset to RHS of crankshaft centerline (wet). . 8.8 mm

Center of Gravity (Engine)

Forward from rear of block (wet) . . . . . 393 mm
Above crankshaft centerline (wet) . . . . . 182 mm
Offset to RHS of crankshaft centerline (wet). . 30 mm

Performance

All ratings certified to within . . . . . ± 3%

Note: All data based on operation to ISO/TR14396 standard reference conditions.

Test Conditions

Air Temperature . . . . . 25°C
Barometric Pressure.. . . . . 100 kPa
Relative Humidity 10.7%
Air Inlet Restriction at Maximum Power (Nominal) . . . . . 5 kPa
Exhaust Backpressure at Maximum Power (Nominal) . . . . . 35 kPa
Fuel Temperature (Inlet Pump) . . . . . 80°C

Noise Data

Average Sound Power Level for Bare Engine Without Inlet and Exhaust at 1 m	@ 2200 rpm	@ 1400 rpm
At Rated Speed With Suction Fan	113 dB(A)	104 dB(A)
Rated Speed With Blower Fan	117 dB(A)	107 dB(A)

Note: If the engine is to operate in ambient conditions other than those of the test conditions, suitable adjustments must be made for these changes.

General Installation

Designation	Units	Engine speed rpm					
		1200	1400	1600	1800	2000	2200
Gross Engine Power[3]	kWm	116.9	144.1	151	151	151	150.9
Brake Mean Effective Pressure	kPa	1668	1763	1616	1436	1293	1175
Cooling Fan Airlflow at Zero Duct – Suction	(m³/s)	3	3.5	4.1	4.6	5.2	5.7
Radiator Core Resistance	kPa	0.15	0.2	0.25	0.31	0.38	0.45
Fan Power Absorption – Suction	kWm	2	3.2	4.8	6.8	9.3	12.4
Net Power at Flywheel[1]	kWm	115	141	146	144	142	139
Torque (gross)	kWm	930	983	901	801	721	655
Engine Coolant Flow Against 35 kPa Restriction	L/min	197	230	262	294	326	360
Inlet Air Flow Volume (Wet)	m³/min	7.3	8.5	9	9.6	10.3	11.5
Exhaust Gas Flow (Wet)	m³/min	6.8	7.9	8.3	8.8	9.5	10.5
Exhaust Gas Mass Flow (Wet)	kg/min	8.8	10.2	10.7	11.4	12.2	13.5
Exhaust Gas Temperature (Exhaust Manifold/Turbo Outlet)	°C	448	439	425	437	448	441
Specific Fuel Consumption (SFC) Gross	g/kWhr	210	202	203	210	217	227
Fuel Consumption[2]	L/hour	29.3	34.9	36.5	37.8	39.1	40.9

1. Gross power less auxiliaries. 2. Figures given for 100% net engine power. 3. Refer to Performance Curve T 4888.

Cautions:

- All engines are to operate between sea level and 1676 m and in ambient temperatures between -40°C and +48°C if a canopy is fitted with a 200 Pa air flow restriction without de-rating or specification change (excluding customer-fit cold start aid).
- Maximum ambient temperature increases to +55°C if the canopy air flow restriction does not exceed 120 Pa.

Energy Balance

Designation	Units	Engine speed rpm					
		1200	1400	1600	1800	2000	2200
Energy in (Heat of Combustion)	kWt	335	398	417	433	451	475
Energy to Power (Gross)	kWm	116.9	144.1	151	151	151	150.9
Energy to Cooling Fan – Suction	kWm	1.5	2.3	3.5	4.9	6.8	9.1
Energy to Power Net	kWm	114.9	140.9	146.2	144.2	141.7	138.5
Energy to (Coolant and Lubricating Oil) Radiator	kWt	86	96	98	105	108	117
Energy to Exhaust	kWt	117	133	137	148	162	178
Energy to Charge Cooler	kWt	13	16	16	16	16	19
Energy to Radiation	kWt	15	18	18	19	20	20

Cooling System

Cooling Pack

Overall Weight (Wet) . . . . . 101.7 kg
Overall Face Area . . . . . 0.6646 m²
Width . . . . . 875.8 mm
Height . . . . . 1088.5 mm

Radiator

Maximum Load on Rad Assembly
from Stone Guard Mounts.. . . . . 2.8 kg
Face Area... . . . . 0.444 m²
Number of Rows 57
Matrix Density . . . . . 10 fins/inch
Width of Matrix . . . . . 555 mm
Height of Matrix . . . . . 800 mm
Pressure Cap Setting . . . . . 1 bar

Charge Cooler

Face Area... . . . . 0.203 m²
Number of Rows 2
Matrix Density . . . . . 13 fins/inch
Width of Matrix . . . . . 257.8 mm
Height of Matrix . . . . . 789 mm

Fan

Type.. . . . . Suction
Diameter . . . . . 724 mm
Drive Ratio 1:1
Number of Blades 7
Material . . . . . Composite

Coolant

Total System Capacity . . . . . 24.25 liters
Bare Engine Capacity . . . . . 12.25 liters
Maximum Top Tank Temperature . . . . . 108°C
Thermostat Operation Range . . . . . 82-94°C

Recommended Coolant

The following coolant should be used:

Acceptable – A commercial heavy-duty antifreeze that meets “ASTM D6210” specifications.

1. The C7.1 industrial engines must be operated with a 1:1 mixture of water and glycol. This concentration allows the NOx reduction system to operate correctly at high ambient temperatures.
2. Do not use a commercial coolant/antifreeze that only meets the ASTM D3306 specification. This type of coolant/antifreeze is made for light automotive applications.

Duct allowance – Maximum Additional Restriction to Cooling Airflow and Resultant Minimum Airflow					
Description	Units	Engine Speed – rpm			
		1800	2200	1800	2200
Ambient Clearance	°C	55	55	55	55
Duct Allowance	kPa	120	120	200	200
Cooling Fan Airflow	m^3/min	4.62	5.8	4.27	5.42
Radiator Core Resistance	kPa	553	791	609	871

Electrical System

Engine Stop Method . . . . . ECM controlled

Alternator Model	Unit	Remy 13SI	Remy 13SI
Alternator Voltage	Volts	12	24
Alternator Output	Amps	120	80

Starter model	Unit	Iskra AZF	Remy iMT	Denso P5
Starter Motor Voltage	Volts	12	24	12
Starter Motor Power	kW	4	8.5	5
Number of Teeth on Flywheel	SAE 1 D0093	156		
	SAE 2 D0094	134		
	SAE 3 D0094	126	126[1]	126
Number of Teeth on Starter Pinion		10	12	13
Minimum Cranking Speed	rpm	100		
Starter Solenoid – Maximum Pull-in Current @ 0°C	Amps	68	2	41
Starter Solenoid – Maximum Hold-in Current @ 0°C	Amps	20	2	11

[1] 24V SAE 3 options only compatible with C0067 LHS starter.

Fuel Injection System

Fuel Pump Type/Model. . . . . Denso HP4
Injection System. . . . . Electronic
Injector Type . . . . . Common rail
Injector Pressure . . . . . 200 MPa

Fuel Feed

Fuel Lift Pump Type . . . . . Gerotor
Maximum Fuel Supply Restriction at Primary Filter. . . . . -30 kPa
Maximum Fuel Return Restriction at Low Idle. . . . . 20 kPa
Maximum Fuel Return Flow. . . . . 2.5 m³/min
Maximum Fuel Flow Through Inlet Connection . . . . . 3.7 l/min
Maximum Lift Pump Delivery Flow Rate . . . 3.7 l/min
Maximum Pump Delivery Pressure . . . . . 8500 kPa
Maximum Suction Head At Fuel Pump Inlet. . . . . 50 KPa
Maximum Static Pressure Head.. . . . . 20 kPa
Maximum Fuel Temperature at Lift Pump Inlet . . . . . 80°C
Maximum Fuel Filter Service Interval . . . . . 500 hrs

Fuel Specification

BS2869 Class 2 (off highway, gas oil); DIN EN590 DERV (Class A to F and 0 to 4)

Density . . . . . 0.840-0.865 (kg/liters @ 15°C)
Viscosity . . . . . 2-3.2 (mm²/s @ 40°C)
Sulfur Content . . . . . 0.0007-0.0015 (% mass)
Cetane No. . . . . 40 - 0

Induction System

Maximum Air Intake Restriction

Clean Filter . . . . . 5 kPa
Dirty Filter. . . . . 8 kPa
Induction Indicator Setting . . . . . 8 kPa
Air Filter Type . . . . . 125 pm

Cold Start Recommendations

Minimum Battery Cold Cranking Amps

Air Temp. Oil Viscosity Limit	With Glow Plugs 12V AZF & P5 Bare Engine		Without Glow Plugs 12V AZF Bare Engine		With Glow Plugs 24V IMT Bare Engine		Without Glow Plugs 24V IMT Bare Engine		With Glow Plugs 24V AZF hp Bare Engine		Without Glow Plugs 24V AZF hp Bare Engine	
-5°C	15W40	950	15W40	950	15W40	525	15W40	525	15W40	525	15W40	525
-10°C	15W40	950	15W40	950	15W40	525	15W40	525	15W40	525	15W40	525
-15°C	15W40	1650	15W40	(1)	15W40	680	15W40	(1)	15W40	680	15W40	(1)
-20°C	10W40	1650	10W40	(1)	10W40	680	10W40	(1)	10W40	680	10W40	(1)
-25°C	5W30	1900	5W30	(1)	5W30	750	5W30	(1)	5W30	680	5W30	(1)
Maximum Battery CCA.		2400		2400		1400		1400		1200		1200

(1) Must use glow plugs.

Lubrication System

Total System Capacity (to Include Filter, Rail, and Cooler) . . . . . 17.9 liters
Maximum Sump Capacity . . . . . 16 liters
Minimum Sump Capacity . . . . . 13 liters
Maximum Oil Temperature Continuous Operation . . . . . 125°C
Maximum Oil Temperature Intermittent Operation . . . . . 135°C

Lubricating Oil Pressure

At Rated Speed . . . . . 400-520 kPa
Minimum . . . . . 220 kPa
Oil Relief Valves Opens at . . . . . 520 kPa
Sump Drain Plug Tapping Size or Hose Connection Size . . . . . 3/4 UNF STOR port
Oil Pump Speed/Drive Method . . Gerotor (gear-driven off crankshaft)
Lubricating Oil Flow at Rated Speed . . . . . 60 l/min
Lubricating Oil Pressure at Rated Speed . . . . . 400-520 kPa
Oil Consumption at Full Load Rated Speed . . . . . 0.08% of fuel

Exhaust System

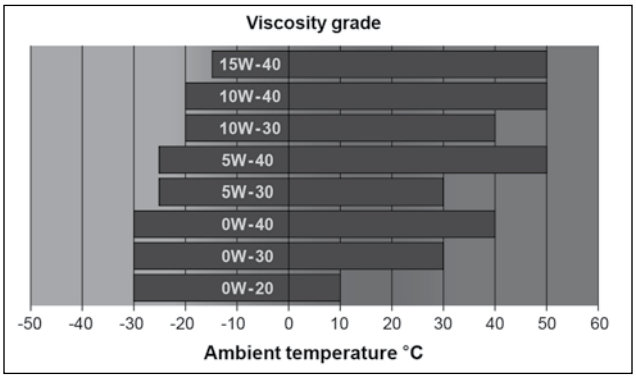
Aftertreatment System Type . . . . . DOC, DPF, SCR/AMOX+DEF System
Type of Regeneration (High/Low Temperature) . . . . . Low
Aftertreatment Height . . . . . 455 mm
Aftertreatment Length . . . . . 733 mm
Aftertreatment Width . . . . . 769 mm
Aftertreatment Weight . . . . . 107 Kg
Aftertreatment Skin Temperature . . . . . 250°C
Maximum Temp. for Electronic Components on Aftertreatment . . . . . 120°C
Maximum Temp. for External Electronic Components for Aftertreatment (Soot Sensor Box) . . . . . 85°C
Typical Maximum Temperature Exhaust Out . . . . . 475°C
Maximum System Backpressure Limit for hp 175-275/130-205 kW . . . . . 49.1 kPa
Aftertreatment Exhaust Outlet Connection . . 76.2 mm
Aftertreatment Exhaust Outlet Connection Load Limit . . . . . 60 N•m
Attenuation of the DPF . . . . . 25 dB(A)
Ash Service . . . . . NA
Maximum Backpressure for Customer-installed Pipe Work . . . . . 5.3 kPa

Normal Operating Angles

Front and Rear . . . . . 25°
Side . . . . . 25°

Recommended SAE Viscosity

A multigrade oil which conforms to API-CJ4 (ACEA-E9) must be used.



PTO Capabilities

Flange Type (N•m)	Standard Various Refer to ESM	Heavy Duty SAE "B" 13-tooth Spline
Torque Capability Intermittent	142	210
Torque Capability Continuous	99	147
Maximum Bending Moment at Flange	0	15

Note: Refer to "Applications and Installation Manual" for "PTO approval requirements."

Mountings

Maximum Static Bending Moment at Rear Face of Block	1130 N•m	
Maximum Permissible Overhung Load on the Flywheel	See Polar Diagram Chapter 6 of the ESM	
	Dynamic Vertical BM	Dynamic Lateral BM
Maximum Bending Moment at Rear of Flywheel Housing – SAE 3	±3000 N•m	±1700 N•m
Maximum Bending Moment at Rear of Flywheel Housing – SAE 2	±5600 N•m	±2800 N•m
Maximum Bending Moment at Rear of Flywheel Housing – SAE 1	±8200 N•m	±5750 N•m

Note: Refer to "Applications and Installation Manual" for "Bending Moment approval requirements."

Features

Emissions
Meets U.S. EPA Tier 4 Final and EU Stage V emission standards.

Compliance
The engine meets the European Machinery Directive, 2006/42/EC, with each engine supplied with a Declaration of Incorporation.

Reliable, Quiet, and Durable Power
World-class manufacturing capability and processes coupled with proven core engine designs assure reliability, quiet operation, and many hours of productive life.

High Performance
Series turbocharging with smart wastegate available on all ratings for fast response, high power, and increased torque.

Fuel Efficiency
Fluid consumption optimized to match operating cycles of a wide range of equipment and applications.

Fuel & Oil
Tier 4 Final/Stage V engines require ultra-low sulfur diesel fuel (ULSD with 15 ppm of sulfur or less) and new oil formulations to support the new technology. Cat® engines are designed to accommodate B20 biofuel. Your Cat dealer can provide more information regarding fuel and oil.

Broad Application Range
Industry leading range of factory configurable ratings and options for agricultural, materials-handling, construction, mining, aircraft ground support, and other industrial applications.

Package Size
Exceptional power density enables standardization across numerous applications. Multiple installation options minimize total package size. Ideal for equipment with narrow engine compartments.

Low-Cost Maintenance
Worldwide service delivers ease of maintenance and simplifies the servicing routine. Hydraulic tappets, multi-vee belts, service free DPF and 500-hour oil change intervals enable low-cost maintenance. Many service items have a choice of location on either side of the engine to enable choice of service access. The S•O•S℠ program is available from your Cat dealer to determine oil change intervals and provide optimal performance.

Quality
Every Cat engine is manufactured to stringent standards in order to assure customer satisfaction.

World-class Product Support Offered Through Global Cat Dealer Network
- Scheduled maintenance, including S•O•S sample
- Customer Support Agreements (CSA)
- Cat Extended Service Coverage (ESC)
- Superior dealer service network
- Extended dealer service network through the Cat Industrial Service Distributor (ISD) program

Standard Engine Equipment

Air Inlet
Standard air cleaners

Control System
Full electronic control system, all connectors and wiring looms waterproof and designed to withstand harsh off-highway environments, flexible and configurable software features and well supported SAE J1939 CAN bus enables highly integrated machines

Cooling System
Top tank temperature 108°C (226°F) as standard to minimize cooling pack size, 50:50 water glycol mix, detailed guidance on cooling system design and validation available to ensure machine reliability

Exhaust System
Diesel Oxidation Catalyst, Diesel Particulate Filter, and Selective Catalytic Reduction system supplied installed on engine. Zero downtime due to regeneration.

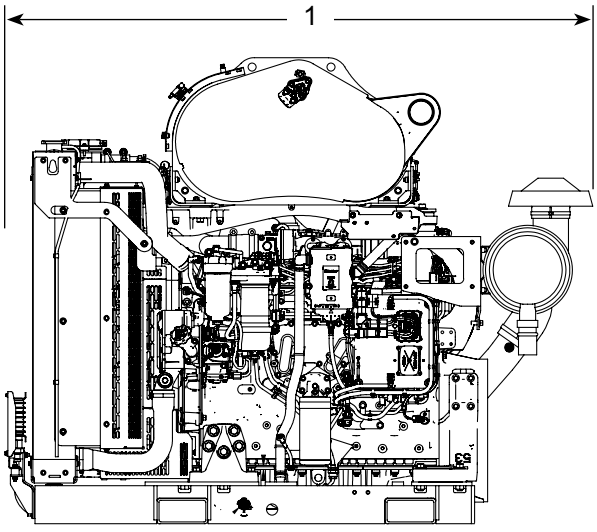
Flywheels and Flywheel Housing
Fitted with SAE 3, SAE 2, or SAE 1 flywheel housing configuration as standard – for use with a variety of flywheels.

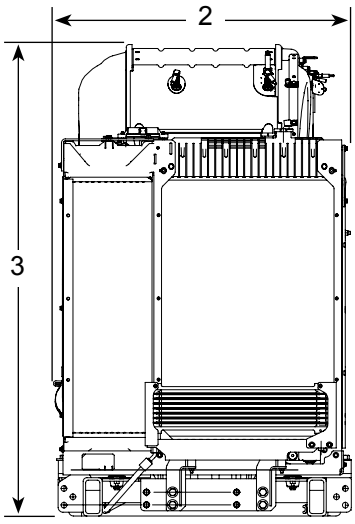
Fuel System
Electronic high pressure common rail, ACERT™ Technology, innovative filter design to ensure maximum protection of the engine.

Lube System
Wide choice of sumps for different applications

Power Take Off
SAE A or SAE B flanges on left-hand side, engine power can also be taken from the front of the engine on some applications, compressors are also available

Dimensions





(1) Length
1769 mm (69.6 in)

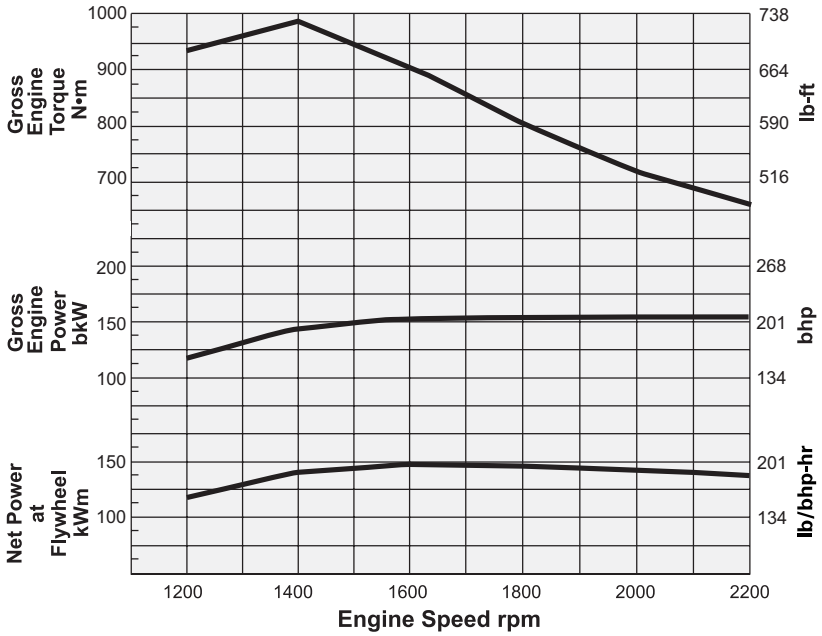
(2) Width
916 mm (36.1 in)

(3) Height (including radiator support brackets)
1461 mm (57.5 in)

Note: Final dimensions dependent on selected options

Performance Data

Series Turbocharged-Aftercooled – 2200 rpm **151 bkW/202 bhp**



Rating	Rated Speed rpm	Max Gross Power bkW	Max Gross Power bhp	Peak Torque Speed rpm	Peak Torque N•m	Peak Torque lb-ft	Max Net Power Speed rpm	Max Net Power at Flywheel kWm	Max Net Power at Flywheel hp
C	1800-2200	151	202	1400	983	725	1600	146	196

Rating Definitions and Conditions

IND-C (Intermittent) is the horsepower and speed capability of the engine where maximum power and/or speed are cyclic (time at full load not to exceed 50%).

Additional ratings are available for specific customer requirements. Consult your Cat dealer.

Rating Conditions are based on SAE J1995, inlet air standard conditions of 99 kPa (29.31 in Hg) dry barometer and 25ºC (77ºF) temperature. Performance measured using a standard fuel with fuel gravity of 35º API having a lower heating value of 42 780 kJ/kg (18,390 btu/lb) when used at 29ºC (84.2ºF) with a density of 838.9 g/L.

Aftertreatment Features

Regeneration: Passive regeneration completely transparent to the operator.

Service: Service-free DPF for the emissions life of the engine

Available in 12V or 24V systems

Standard Emissions Control Equipment

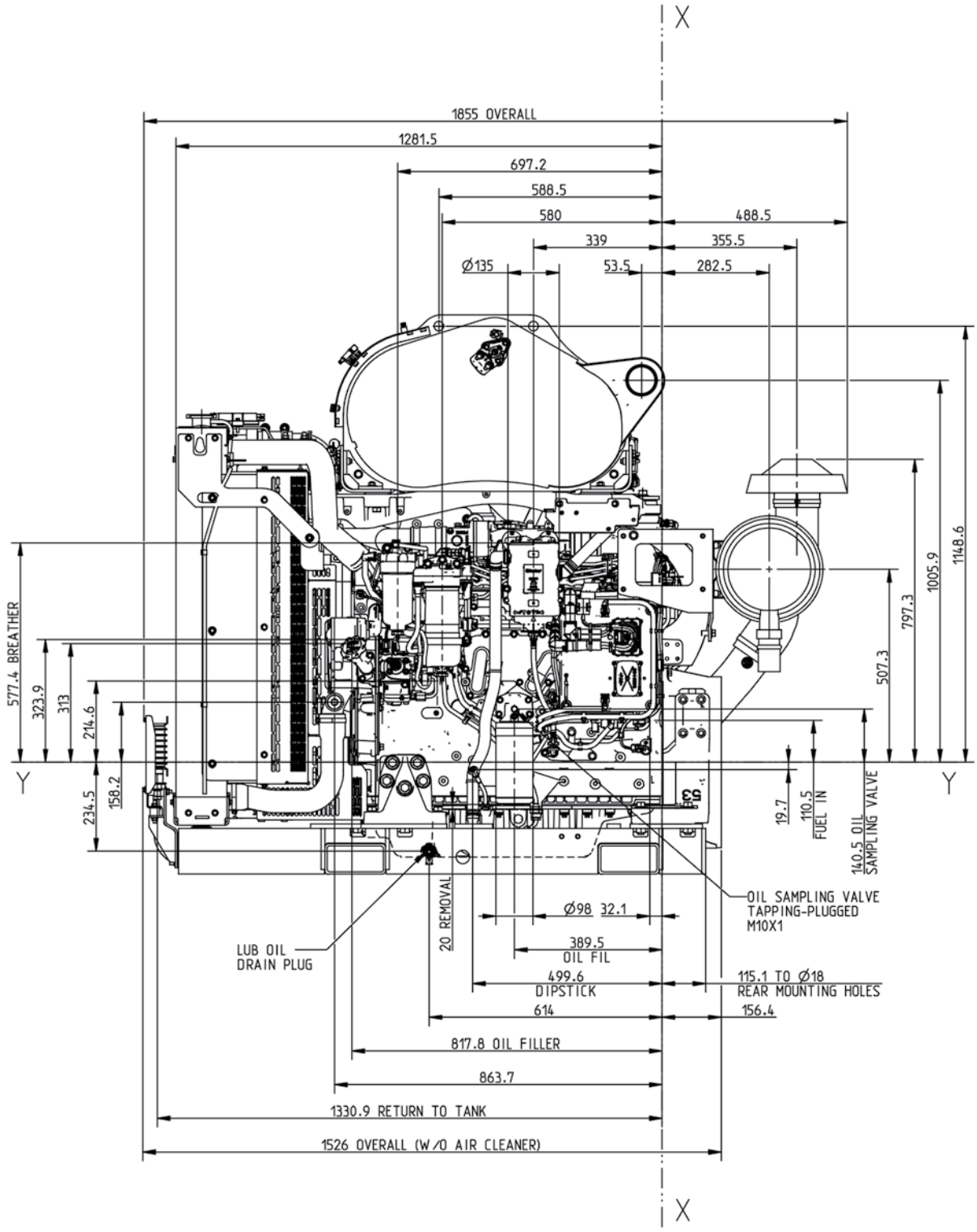
DOC: Diesel Oxidation Catalyst

DPF: Diesel Particulate Filter

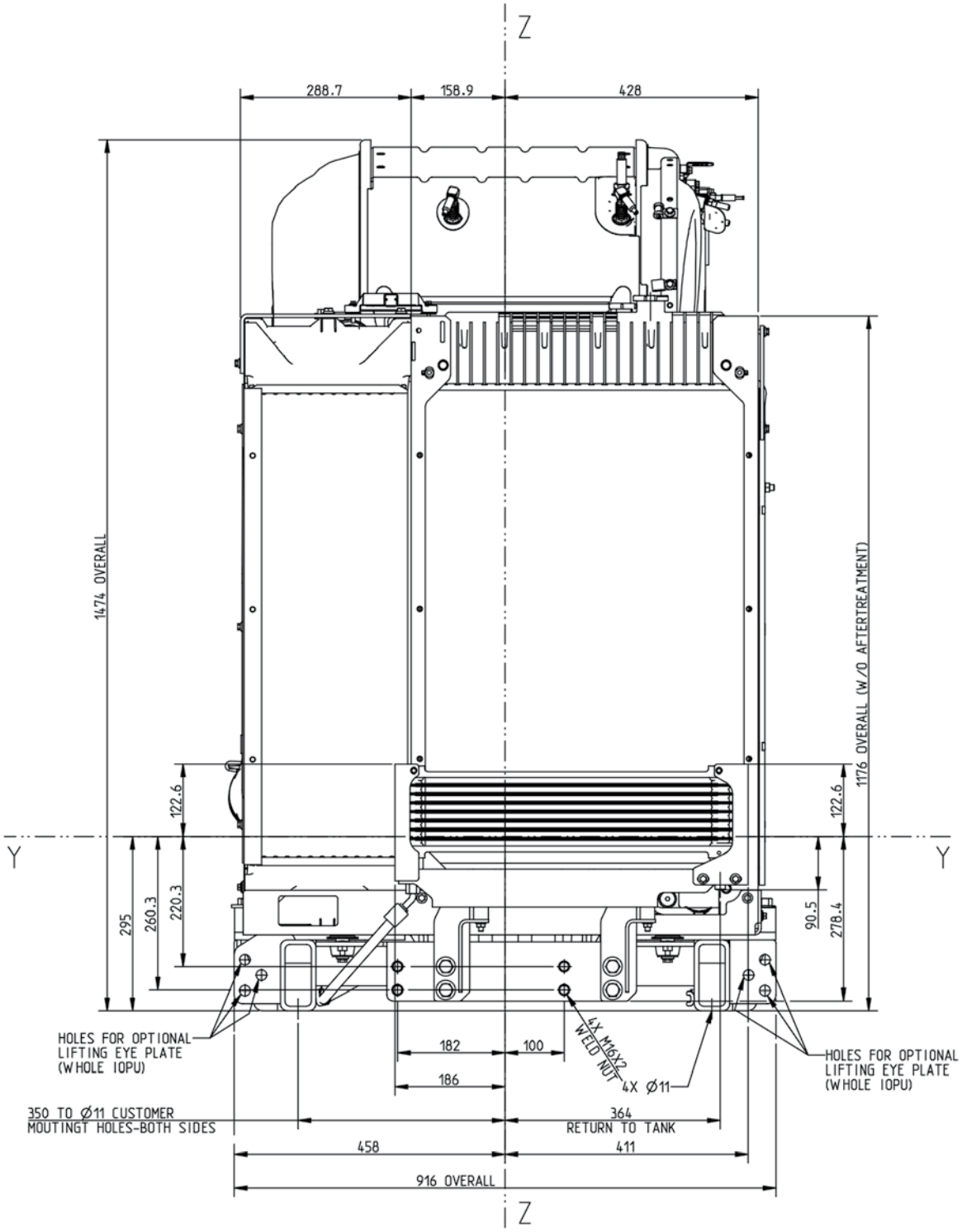
SCR: Selective Catalytic Reduction

A range of SCR system components, including pump, tanks, and lines

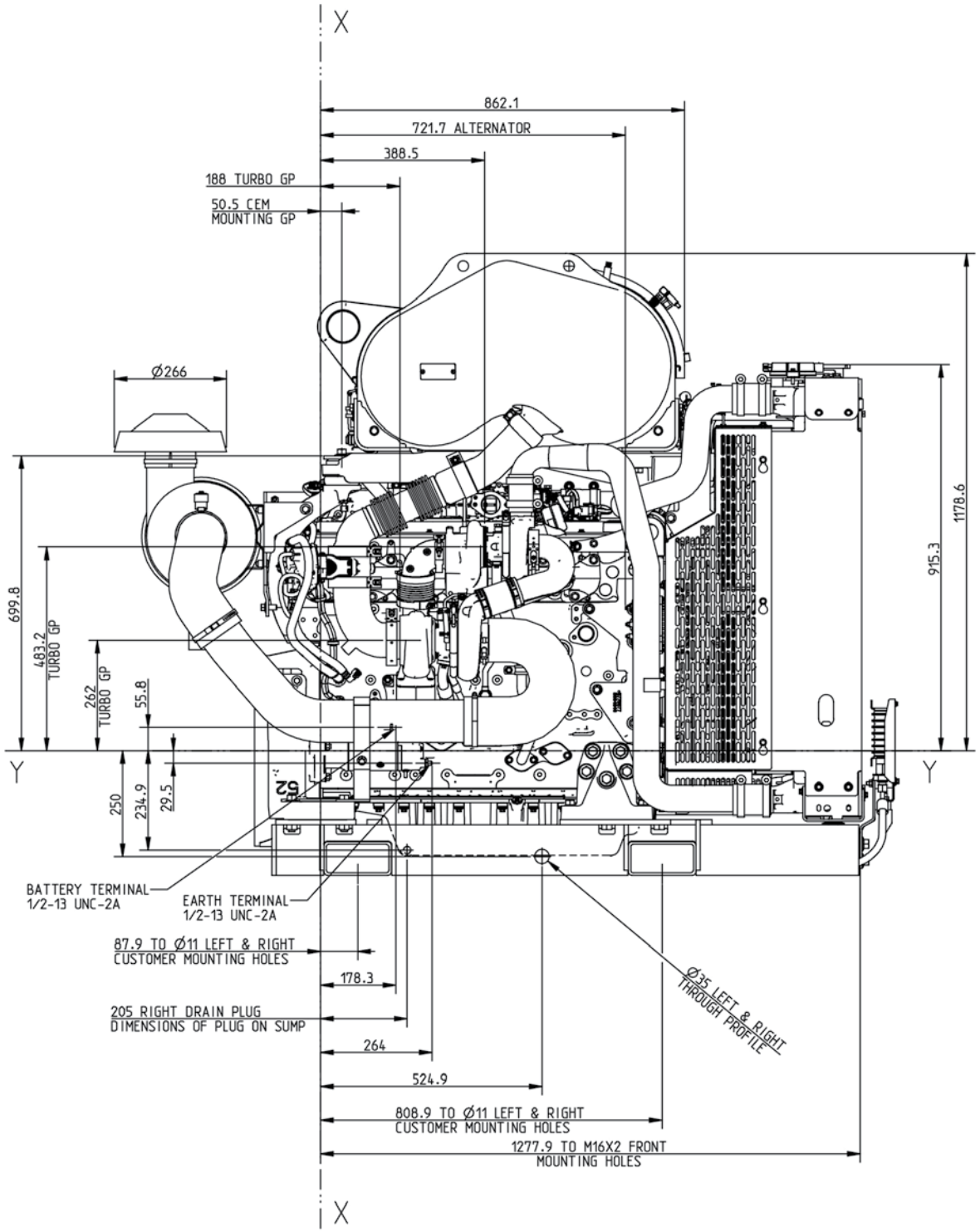
151 kW @ 2200 rpm – Left Side View with SAE 3 flywheel housing shown



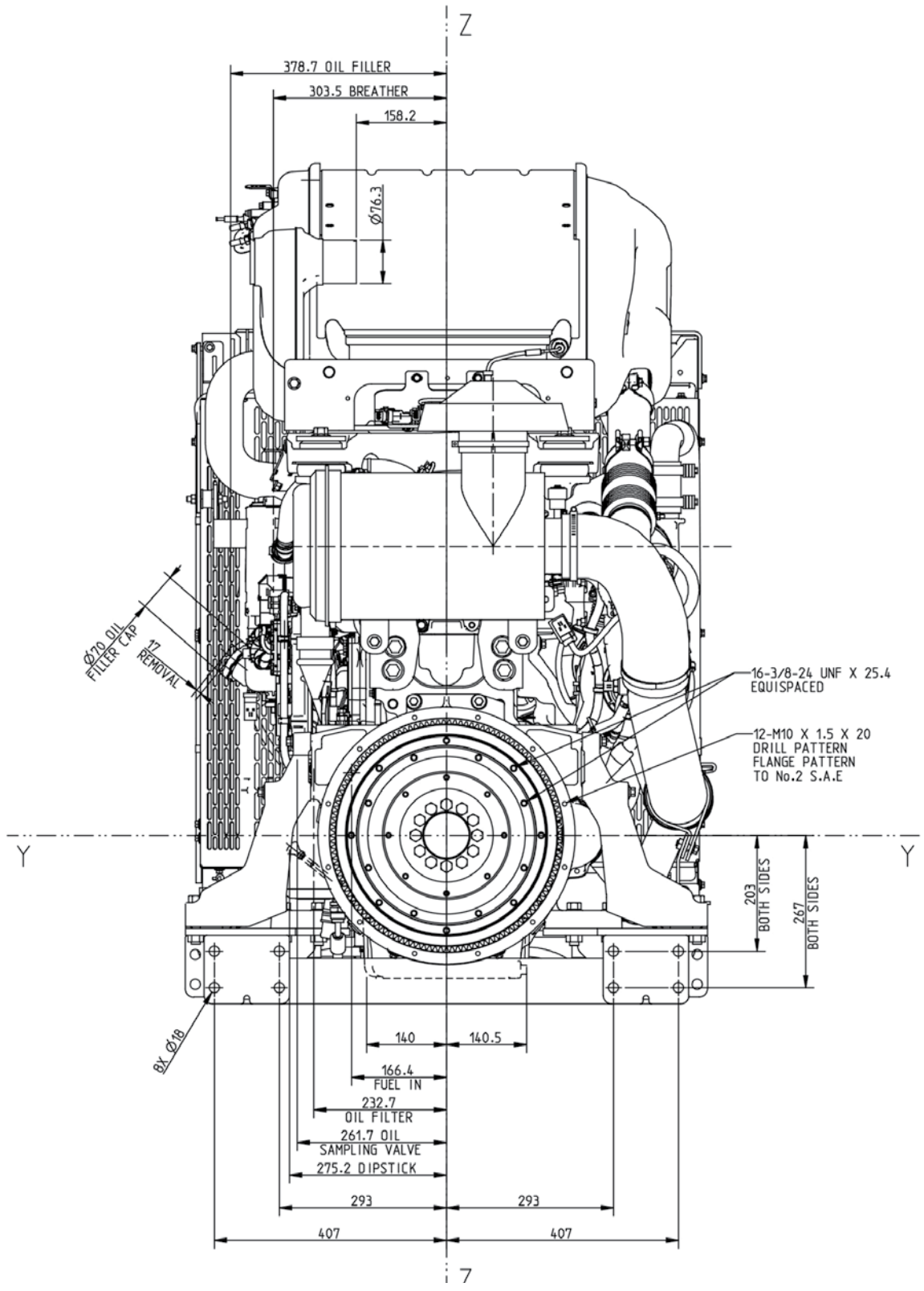
151 kW @ 2200 rpm – Front View with SAE 3 flywheel housing shown



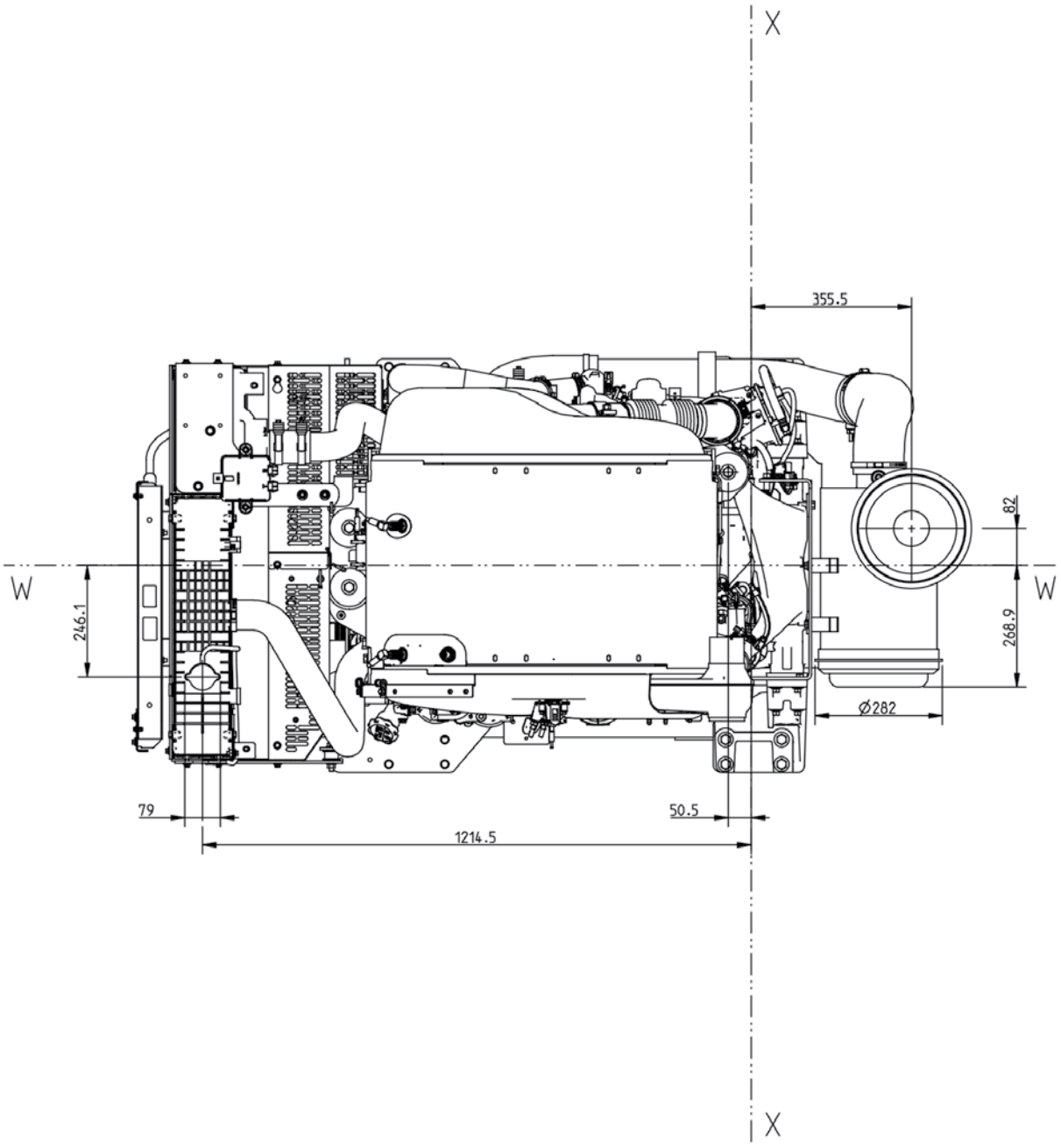
151 kW @ 2200 rpm – Right Side View with SAE 3 flywheel housing shown



151 kW @ 2200 rpm – Rear View with SAE 3 flywheel housing shown



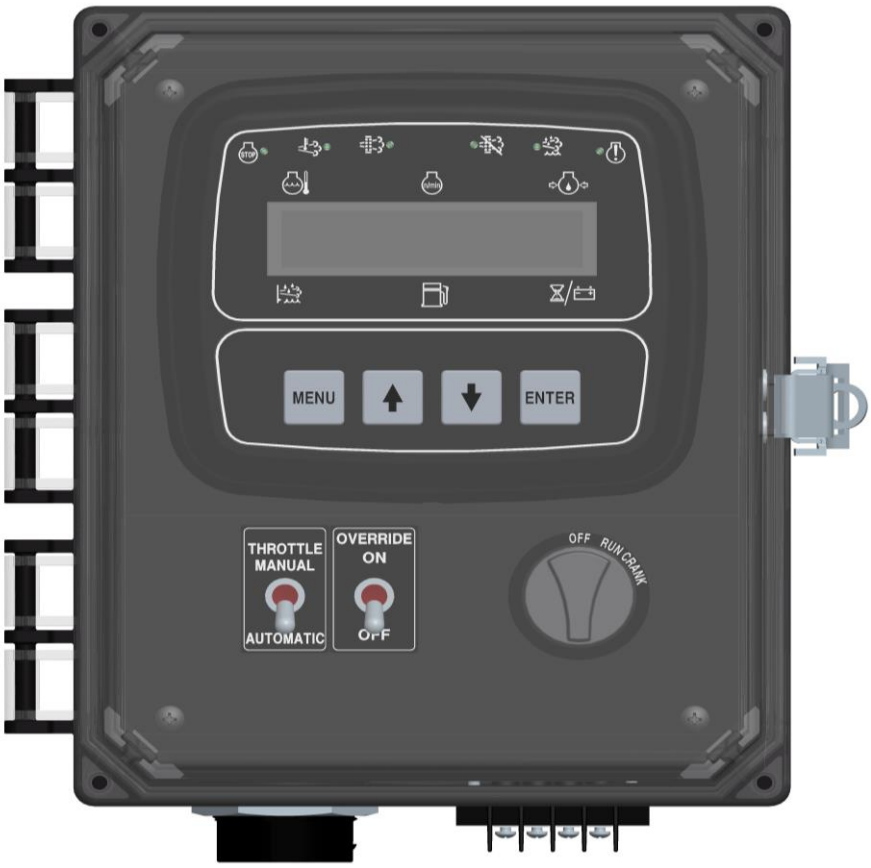
151 kW @ 2200 rpm – Plan View with SAE 3 flywheel housing shown



Product Manual

Engine Display & Control Panel

J1939 Final T4 Engines



Part Number: C4F-F10185
Revision: 1.0

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Phone 330.239.4345 • Fax 330.239.2845 • www.controlsinc.com

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PRIOR TO STARTING ENGINE

Prior to starting the engine, select the proper throttle control mode required for application. These settings are accessed in the Throttle Configuration menu.

Throttle Configuration	**Throttle Type - Throttle Type Selection (Default = Vernier)**
	TSC Mode Selection
	TSC Min Speed Selection (Default = 850 rpm)
	TSC Max Speed Selection (Default = 2400 rpm)
	TSC Ramp Rate Selection (Default = 100 rpm/sec)
	Throttle Curve Selection
	Multistate Speed 1 Selection
	Multistate Speed 2 Selection
	Multistate Speed 3 Selection
	Multistate Speed 4 Selection

MANUAL THROTTLE OPTIONS

1) **Vernier Throttle (Default)**
   Vernier throttle is standard up and down throttle between the minimum and maximum selections. The ramp rate is the rate of acceleration in rpm's per second. The control panel uses J1939 throttle, also called "torque speed control" or TSC1.

2) **Multistate Throttle**
   Multistate throttle provides for one, two, three or four specific operating speeds. Pressing the up and down buttons adjusts engine speed between the selected multistate speed selections.

Communication between the panel and the engine ECU occurs over the two wire CAN bus (CAN High wire and CAN Low wire). It is necessary that the panel and engine ECU settings be the same for the following parameters. The communication settings are available in the ***CAN Configuration menu*** shown below.

CAN Configuration Menu	Source Address (Default = 44) Available 3, 17, 228, 4, 43, 44
	TSC1 Address (Default = 3) Available 3, 17, 228, 4, 43, 44
	Engine Address (Default = 0)
	Oil/Fuel Transmit

PANEL OPERATION

1) **Engine Start - Turn key to run position**
2) **Engine Stop – Turn key to off position**
3) **Engine Throttle – Push up and down buttons**

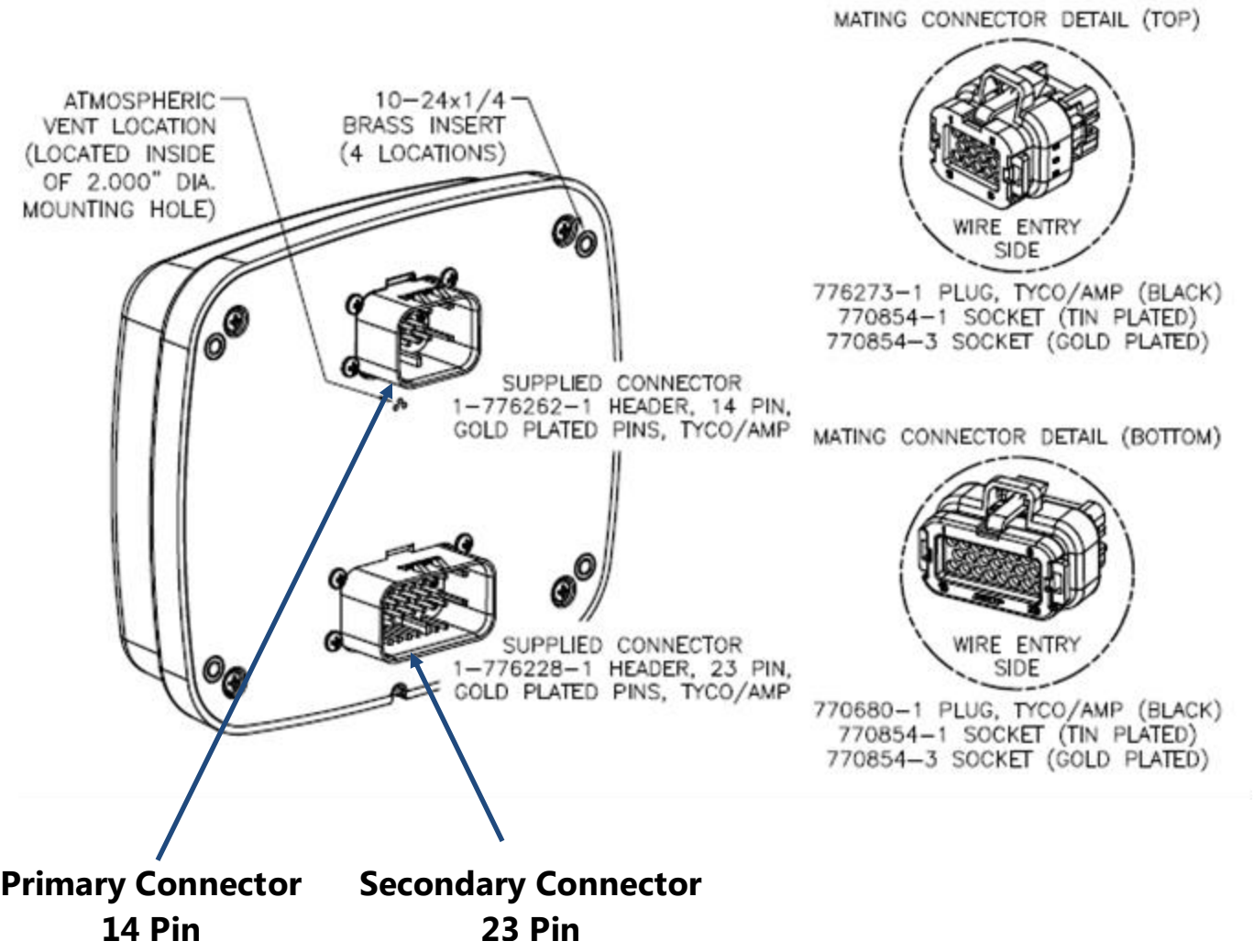
Manual Throttle Control

With the key in the RUN position, and the toggle switch placed in manual, the panel operates the throttle by pressing the up and down buttons. An arrow will indicate increasing or decreasing engine speed.

Hydro Throttle Control

Opening and closing the hydro Throttle Switch can change engine speed between the programmed Minimum Speed and the Last Operating Speed for each run. The last Operating Speed is the speed at which the engine was last when the Hydro Throttle switch was opened, ***or*** the Throttle switch was changed to "Automatic".

MODULE CONNECTORS



Primary Connector (14 Pin)

Pin	Function	Pin	Function
1	Relay #2 -ECU Signal	8	J1939 Low
2	Relay #1 NO	9	Relay #3 Common
3	Relay #3 NO	10	Not Used
4	Relay #2 & #4 Common	11	Battery Positive
5	Relay #4 NO	12	Battery Negative
6	Relay #1 Common	13	Fuel Level
7	J1939 High	14	DI #1 Hydro-Throttle

CAUTION:
Maximum current draw for signal circuits is 5 amps

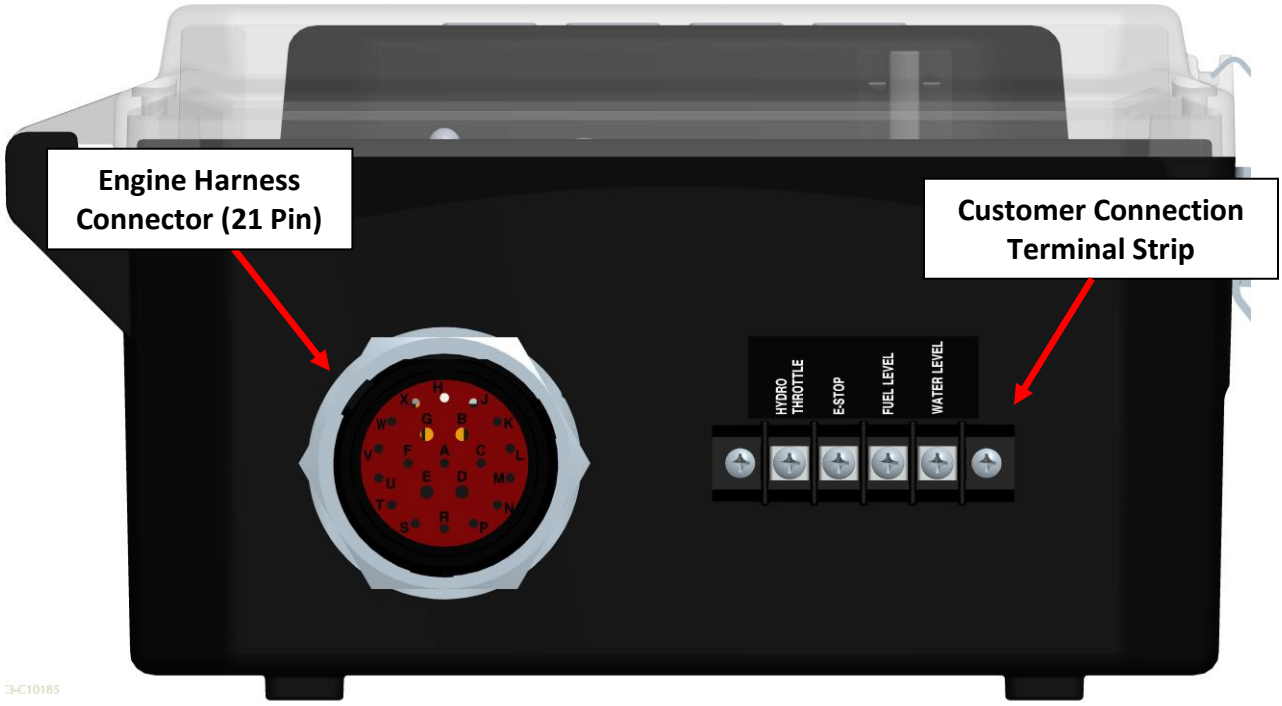
Secondary Connector (23 Pin)

Pin	Function	Pin	Function	Pin	Function
1	Relay #5	9	Relay 5/6 Common	16	Relay #6
2	Not Used	10	Not Used	17	DI #2 Override
3	Not Used	11	Not Used	18	DI #3 E-Stop
4	Not Used	12	Not Used	19	DI #4 Low Water
5	Not Used	13	DI #9	20	DI #5
6	Not Used	14	DI #8	21	DI #6
7	Not Used	15	Relay #7	22	DI #7
8	Relay 7/8 Common			23	Relay #8

Note: Modbus is available as an option in the C Series 200 Level product. Consult with a factory sales engineer for ordering.

PANEL CONNECTORS

Engine Harness Connector –Deutsch 21 pin (HDP24-24-21PE)



21 Pin Engine Harness Connector	
Pin	Function
B	Battery Positive
E	Battery Negative
G	Key On Power
D	Crank Signal
V	J1939 High
U	J1939 Low
J	Alternator Excite
P	Fuel Level
L	Analog Throttle Emulator
M	Analog Throttle Emulator
C	Analog Throttle Emulator
R	Digital Throttle Emulator
S	Digital Throttle Emulator

CAUTION:
Maximum current draw for relay output circuits is 5 amps

ENGINE ALARMS, CODES AND MESSAGES

ENGINE ECU ALARMS/DE-RATE/SHUT DOWNS

It is important to understand panel operation with respect to engine safety protections, alarms, and fault codes. The panel operates with J1939 engines. These engines have an ECU (engine control unit) which is essentially a computer that runs the engine. When engine parameters are out of normal operating ranges, the ECU takes specific actions which can include the following:

1) Broadcast a trouble code
2) Broadcast a red or yellow lamp
3) De-rate the engine
4) Shut down the engine
5) Turn on alarm horn

It is the engine ECU that de-rates or shuts down the engine when it is not operating within normal parameters. This includes more common shut downs like high engine temperature and low oil pressure but can encompass a large range of parameters depending on the ECU.

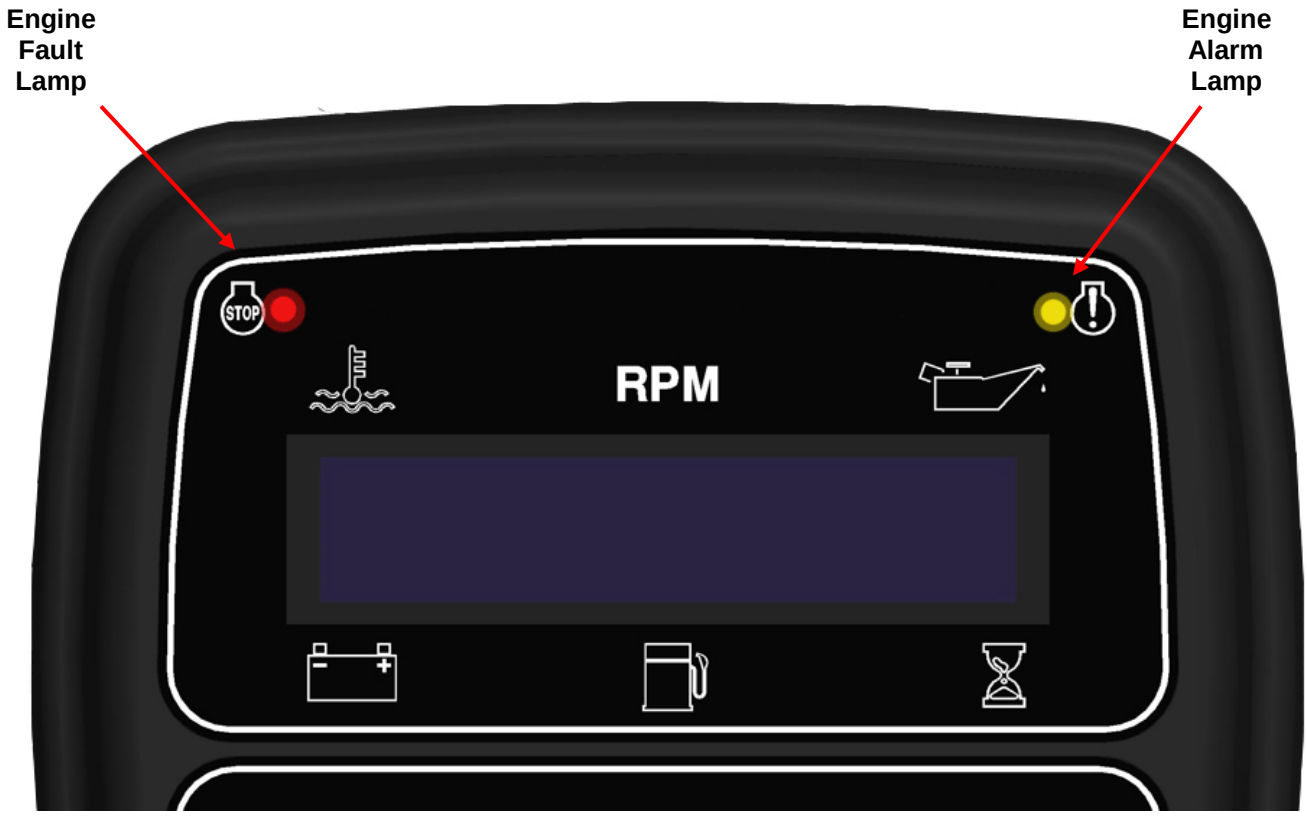
PANEL ALARM ANNUNCIATION AND CODE READER

This panel is configured to operate with standard J1939 engines where engine de-rate and shutdowns are managed by the engine ECU. The panel communicates with the engine ECU and serves as a trouble code reader. When the engine ECU broadcasts a trouble code (called an SPN.FMI code) the panel does the following:

1) Illuminates the appropriate LED indicator lamp
   a. Yellow Lamp = Alarm
   b. Red Lamp = Engine Shut Down
2) Displays the trouble code (standard SPN.FMI code)
3) Displays a code description on the LCD screen
4) Displays the occurrence count of the code

INDICATOR LAMPS

The panel red (alarm) and amber (pre alarm) lamp indicators.



ACTIVE AND STORED ENGINE ECU CODES

The panel also provides the ability to check the engine ECU for all ACTIVE and STORED engine ECU codes. These codes can be viewed via the Active Codes and Stored Codes menus. In addition, the control panel has its own Alarm Event Log menu that shows the last 16 engine ECU alarms as well as any control panel specific alarms.

CONTROL PANEL SPECIFIC ALARMS AND SHUT DOWNS

The panel has its own engine safety alarms and shut downs that can be enabled. These alarms and shut downs are managed by the control panel independent from the engine ECU. The available options are listed below and can be accessed via the Engine Safety Configuration menu.

Each alarm must be enabled in the Engine Safety Configuration menu to activate.

Heading	Default	Range	Units
Sender Check Bypass	0:10	0:05 – 1:00	Min:Sec
Fuel Level Check	Off	Off / Always / Run	
Low Fuel Pre Alarm	20	0 - 100	%
Low Fuel Alarm	1	0 - 100	%
Fuel Alarm Delay	0:05	0:01 – 1:40	Sec
Oil Pressure Check	Run	Off / Always / Run	
Low Oil Press Pre Alarm	15	0 - 100	PSI
Low Oil Press Alarm	10	0 - 100	PSI
Oil Press Alarm Delay	5	0:01 – 1:40	Sec
Temperature Check	Run	Off / Always / Run	
Low Temp Pre Alarm	0	0 - 300	Deg F
Low Temp Alarm	0	0 - 300	Deg F
High Temp Pre Alarm	220	150 - 300	Deg F
High Temp Alarm	230	150 - 300	Deg F
Temp Alarm Delay	0:05	0:01 – 1:40	Min:Sec
Battery Volts Check	Off	Off / Always / Run	
Low Battery Pre Alarm	12.0	0.0 – 40.0	Volts
Hi Battery Pre Alarm	15.0	0.0 – 40.0	Volts
Over Speed Check	Off	Off / Always / Run	
Over Speed Alarm	3000	650 - 5000	RPM
Over Speed Alarm Delay	0:05	0:01 – 1:40	Min:Sec

1) Off / Always / Run – Describes when the parameter will be monitored for alarm conditions. Run refers to when the engine is running. Off disables the alarm conditions. Always enables the alarm constantly regardless of engine state.

2) Alarm Delay – The time period, after Sender Check Bypass, that the parameter must be on the alarm condition before the alarm becomes latched.

CONTROL PANEL ANALOG AND DIGITAL INPUTS

*The panel is shipped from the factory with the **bold** print inputs pre-wired and enabled in the panel. Inputs not in bold print need to be wired and enabled to be used.*

Analog Inputs

Input	Heading	Default	Connector	Pin
Analog 1	**Function**	**Fuel Level**	**Terminal Strip**	**3**

Digital Inputs

Input	Heading	Default	Connector	Pin
Digital 1	**Normally**	**Open**	**Terminal Strip**	**1**
	Function	**Hydro Throttle**		
	Message	**None**		
	Check	**Always**		
Digital 2	**Normally**	**Open**		
	Function	**Pre Alarm**		
	Message	**Override Active**		
	Check	**Always**		
Digital 3	**Normally**	**Open**	**Terminal Strip**	**2**
	Function	**Alarm**		
	Message	**E-Stop**		
	Check	**Always**		
Digital 4	**Normally**	**Open**	**Terminal Strip**	**4**
	Function	**Alarm**		
	Message	**Low Water**		
	Check	**Run**		
Digital 5	Normally	Open	31 Pin	20
	Function	Available		
	Message	None		
	Check	Off		
Digital 6	Normally	Open	31 Pin	21
	Function	Available		
	Message	None		
	Check	Off		

Digital 7	Normally	Open	31 Pin	22
	Function	Available		
	Message	None		
	Check	Off		
Digital 8	Normally	Open	31 Pin	14
	Function	Available		
	Message	None		
	Check	Off		
Digital 9	Normally	Open	31 Pin	13
	Function	Available		
	Message	None		
	Check	Off		

Hydro Throttle (Digital) – A hydro throttle switch can be attached to the customer connection terminal strip position 1. With the Throttle toggle in the automatic position, closing this input to ground will allow the engine to run at the last operating speed. Opening the circuit will return the engine to idle. Additionally, the engine speed can be adjusted at the panel with the hare and turtle buttons while this circuit is closed. A single orange wire is provided with a single pin weather pack terminal attached

Emergency Stop (Digital) – An E-Stop switch can be attached to the customer connection terminal strip position 2. A shut down will occur when active. Wire as a normally open, close to ground circuit. ***Note: Shut Down Override will disable this function.*** For normally closed requirements, circuit board mounted jumper, JP11, must be moved to position B-C. A single grey wire is provided with a single pin weather pack terminal attached.

Fuel Level Sender (Analog) - A Fuel Level Sender can be attached to customer connection terminal strip position 3. Use a 240 to 33 ohm scale for a 0 to 100% display. Attaching a fuel sender will automatically change the LCD display from reading Fuel Rate to Fuel Level. A Pre Alarm is programmed at 20%. A shut down will occur below 5% if dipswitch 7 is in the ON position.

Low Water Level (Digital) – A level switch can be attached to the customer connection terminal strip position 4. Wire as a normally open, close to ground circuit. A shut down will occur when active.

ANALOG #1 INPUT FUNCTIONS

1) Fuel Level S-W – Fuel amount, in percentage, can be measured and displayed on the C3 module using a standard Stewart Warner scale sender of 240 ohms – 33 ohms. 240 = Empty and 33 = Full. Sender ground must be common with battery negative.
2) Fuel Level VDO – Fuel amount, in percentage, can be measured and displayed on the C3 module using a VDO scale sender of 10 ohms – 180 ohms. 10 = Empty and 180 = Full. Sender ground must be common with battery negative.
3) Oil Pressure PSI – Oil pressure, in PSI, can be measured and displayed on the C3 module using a standard Stewart Warner scale sender of 240 ohms – 33 ohms. 240 = 0 PSI and 33 = 100 PSI. Sender ground must be common with battery negative.
4) Oil Pressure bar – Oil pressure, in bar, can be measured and displayed on the C3 module using a standard Stewart Warner scale sender of 240 ohms – 33 ohms. 240 = 0 bar and 33 = 7 bar. Sender ground must be common with battery negative.
5) Oil Pressure VDO PSI – Oil pressure, in PSI, can be measured and displayed on the C3 module using a standard Stewart Warner scale sender of 10 ohms – 180 ohms. 10 = 0 PSI and 180 = 150 PSI. Sender ground must be common with battery negative.
6) Oil Pressure bar – Oil pressure, in bar, can be measured and displayed on the C3 module using a standard Stewart Warner scale sender of 10 ohms – 180 ohms. 240 = 0 bar and 33 = 10 bar. Sender ground must be common with battery negative.
7) Rheostat – Speed control can be accomplished by connecting a 5 K potentiometer in series with the flex analog input. Engine speed will vary with the change in resistance value.
8) 0 - 5 VDC – Reserved for OEM applications.
9) Ratiometric - Reserved for OEM applications.
10) 4-20mA - Reserved for OEM applications.
11) Switch – This setting allows for a switch to be connected rather than an analog sender. Set Analog 1 Message to assign a label to the switch device.
12) None – Set to None when no functionality is required.

DIGITAL FUNCTIONS

The digital inputs can be configured for different uses depending on the application. These include the following:

1) Alarm – Engine shutdown once active with display message as assigned. A red lamp will also be illuminated.
2) Pre Alarm – Warning message will be displayed along with a yellow lamp when active.
3) Soft Alarm – Recoverable Alarm. Engine will shut down as soon as this input is tripped, but will recover to running if the condition is cleared quickly enough.
4) Aux Throttle Up – Mimics the front panel key press for speed control.
5) Aux Throttle Down - Mimics the front panel key press for speed control.
6) Return to Idle – Engine will resume its pre-designated idle speed
7) Return to Operating Speed – Engine will return to its pre-designated operating speed

DIGITAL FUNCTION MONITORING

Off / Always / Run – Describes when the parameter will be monitored for alarm conditions. Run refers to when the engine is running. Off disables the alarm conditions. Always enables the alarm constantly regardless of engine state.

DIGITAL FUNCTION DELAYS

Alarm Delay – The time period, after Sender Check Bypass, that the parameter must be on the alarm condition before the alarm becomes latched.

CONTROL PANEL RELAY OUTPUTS

*The panel is shipped from the factory with the **highlighted** outputs enabled and pre-wired in the panel.*

Relay	Heading	Default	Connector	Pin
Relay 1	Function	None		-
	Polarity	Positive		
	Initial State	Off		
Relay 2	Function	**Fuel/Run**	21-Pin	G
	Polarity	**Positive**		
	Initial State	**On**		
Relay 3	Function	None	-	-
	Polarity	Positive		
	Initial State	Off		
Relay 4	Function	None	-	-
	Polarity	Positive		
	Initial State	Off		
Relay 5	Function	None		
	Polarity	Positive		
	Initial State	Off		
Relay 6	Function	None		
	Polarity	Positive		
	Initial State	Off		
Relay 7	Function	None		
	Polarity	Positive		
	Initial State	Off		
Relay 8	Function	None		
	Polarity	Positive		
	Initial State	Off		

The relays are rated at 5 amps.

RELAY FUNCTIONS

Available relays can be assigned for different uses.

a. None - Assign to "none" when not used.

b. Pre Alarm - Relay will be active when there is a pre alarm condition. Typically used to drive an alarm horn or lamp. Can be used to send a signal to a monitoring station.

c. Alarm - Relay will be active when there is an alarm condition. Typically used to drive an alarm horn or lamp. Also can be used to send a signal to a monitoring station.

d. Pre Alarm & Alarm - Energizes an external audible alarm when a pre alarm or alarm condition is present. Pressing the ENTER button will silence.

e. Alarm Horn - Energizes an external audible alarm when an alarm condition is present. Pressing the ENTER button will silence.

f. Engine Run - Relay will be active when engine RPM is greater than 600. Typically used to drive an auxiliary circuit such as louvers or send a signal to a monitoring station.

g. Low Oil Press Alarm - Relay closes if a low oil pressure shutdown is detected.

h. High Coolant Temp Alarm - Relay closes if a high engine temp shutdown is detected.

i. Over Speed Alarm - Relay closes if an over speed shutdown is detected.

j. Over Crank Alarm - Relay closes if an over crank alarm is detected.

k. Low Fuel Level Alarm - Relay closes if a low fuel level shutdown is detected.

l. Fuel / Run - Relay will be active during an engine start request and while the engine is running. Used to drive the engine's ECU circuit. Also active when requesting active and stored J1939 codes.

m. Custom 1 - Reserved for OEM applications.

n. Throttle B0 - Reserved for OEM applications.

o. Throttle B1 - Reserved for OEM applications.

RELAY POLARITY

a. Positive - Relay acts as a normally open contact.

b. Invert - Relay acts as a normally closed contact.

RELAY INITIAL STATE

a. On - Relay is activated upon power up.

b. Off - Relay is not activated upon power up.

EMISSIONS MONITORING

Emissions Information

The panel provides lamp indications, display messages and other emission related information. This information is broadcast from the engine ECU and is captured and displayed by the panel. The panel includes an Emissions Parameters viewing menu that allows the operator to view the following emissions related information.

Heading	Default	Range
DPF Soot Load	View Only	0 – 200%
DPF Ash Load	View Only	0 – 200%
Time Since Regeneration	View Only	# of Hours Since Last Regeneration
Regeneration Process	Current Status	Active or Not Active


STOP
RPM
DPF Ash Ld 64%

Regeneration

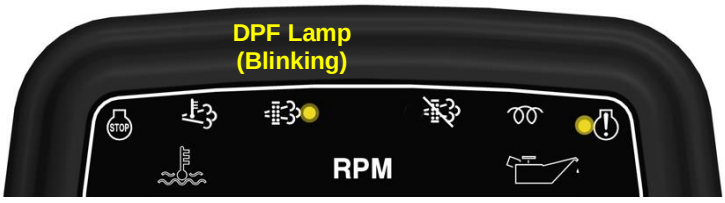
The regeneration process is controlled by the engine ECU. The engine ECU monitors emissions parameters such as soot level and ash level. When the engine ECU determines that a regeneration is necessary, it initiates the regeneration process which requires the engine to operate at a designated speed for a designated period of time as determined by the engine ECU. The engine ECU communicates the need for a regeneration via the regeneration lamp on the panel.

When the engine ECU initiates a regeneration, the yellow DPF (Diesel Particulate Filter) lamp will illuminate with the display message shown above. The operator can press the ENTER button (for Yes) to allow the regeneration to initiate or the MENU button (for No) to delay the regeneration process to a later time. Answering "No" only delays the regeneration process. The regeneration lamp stays illuminated and regen request prompts continue as long as the engine ECU determines a regeneration is required

Over time, the engine ECU increases the level of severity through both lamp indications and display messages.

Levels of severity:

1) Lowest Level
2) Moderate Level
3) High Level
4) Warning Level
5) Service Regen Level



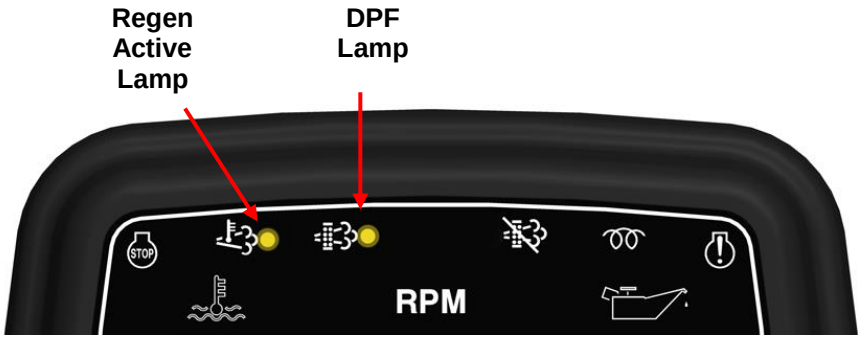
At the lowest level, the DFP lamp illuminates. As the levels increase, the DFP lamp begins to blink. As the levels continue to increase the yellow alarm lamp illuminates.

At the most severe level, the DPF lamp blinks and the red engine alarm lamp illuminates.

Standard Regeneration

If the operator selects ENTER for yes, the panel will show the “RPM May Increase” message and ask the operator to respond by pressing the MENU button for “no” or the ENTER button for “yes”.

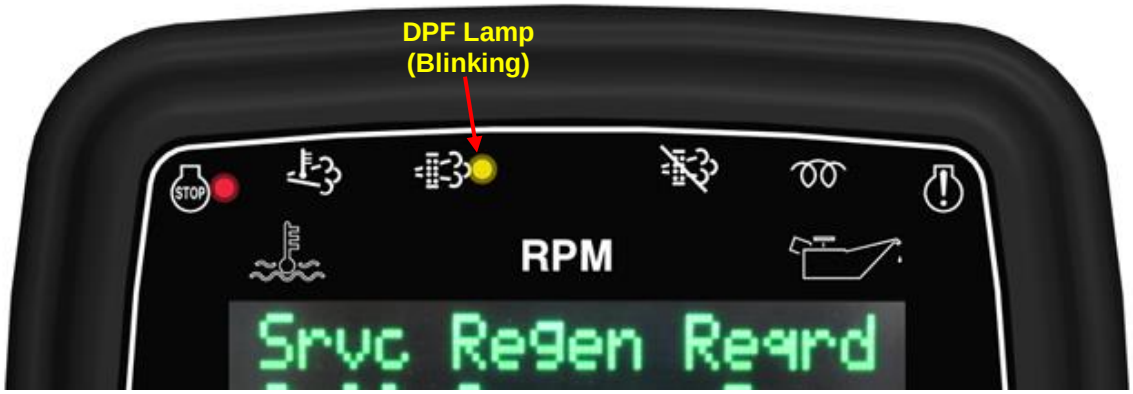
This interlock question is asked to make sure the operator is aware that the engine ECU may increase engine speed per the regeneration requirements.



The regeneration active lamp illuminates during the regeneration process. The DFP lamp stays illuminated until the engine ECU determines that a regeneration is no longer required.

Service Regen Level

The most severe level is the service regen level. At this level, the DFP lamp is blinking and the red alarm lamp illuminates. When the service level is reached, the engine ECU has determined that the situation is severe and a service regeneration is necessary. At the service regen level, the engine ECU may de-rate the engine or prevent it from starting and the message shown below appears on the display.



Regen Inhibit

The panel provides two methods for "inhibiting" a regeneration process. The first method is to answer "No" to the Regen Request message when it appears on the display. The second method is to select "Inhibit Regen" in the Emissions Configuration Menu (under Regen Options). The two available settings are "Auto" and "Inhibit Regen".

The "Auto" setting allows the engine ECU to initiate the regeneration process as it requires. The "Inhibit Regen" setting delays the regeneration process. The "Inhibit Regen" setting only delays the regeneration process until higher levels of severity are reached. At higher levels of severity, the engine ECU no longer accepts the "Inhibit Regen" message from the panel.

When the "Inhibit Regen" setting is selected, the inhibit lamp illuminates.

MENU SYSTEM

To Enter Menu System

Hold MENU button and press ENTER button.

Menu Navigation

Press MENU button to scroll menu options.

Press the UP arrow button to enter the menu.

Press the DOWN arrow button to reverse.

Exit Menu System

Hold MENU button and press ENTER button.

To Change a Setting

Press the ENTER button to bring up brackets, [ ].

Press UP arrow button and DOWN arrow button to change setting.

Press ENTER button to make selection, brackets disappear.

Recycle key to the OFF position after changing a setting.

MAIN MENUS

Emissions Parameters	Regen Options
	DEF Level
	DPF Soot Load
	DPF Ash Load
	Active Regen Status
	Regen Inhibit Status
	DPF Out Gas Temperature
	DPF Differential Pressure
Active Engine Fault Codes	View/Scroll Active Fault Codes
Stored Engine Fault Codes	View/Scroll Stored Fault Codes
Operation Event Log	View Last 32 Events (Start, Stop, Alarms)
Alarms Event Log	View Last 32 ECU and Controller Alarms)
Engine Parameters Menu	View ECU Engine Information (% Load, Torque, Oil Temp, etc.)
Engine Identification Menu	Engine Model # View
	Engine Serial # View
Module Information Menu	Control Unit Part# View
	Control Unit Software Version View

Viewing Menus

Controller Setup Menus	**Input Configuration**	**(1)**
(PASSWORD PROTECTED)	**Output Configuration**	**(2)**
	Throttle Configuration	**(3)**
	Engine Safety Configuration	**(4)**
	Module Configuration	**(5)**
	CAN Configuration	**(6)**
	Emissions Configuration	**(7)**

Configuration Menus

CONFIGURATION MENUS

(1) Input Configuration	Analog 1 Function (Fuel Level Settings)
	Digital Input 1 Setup (Pre-Set to Hydro-Throttle)
	Digital Input 2 Setup (Pre-Set to Override Active)
	Digital Input 3 Setup (Pre Set to E-Stop)
	Digital Input 4 Setup (Pre Set to Low Water)
	Digital Input 5 Setup (NO/NC, Action, Message, When Active, Delay)
	Digital Input 6 Setup (NO/NC, Action, Message, When Active, Delay)
	Digital Input 7 Setup (NO/NC, Action, Message, When Active, Delay)
	Digital Input 8 Setup (NO/NC, Action, Message, When Active, Delay)
	Digital Input 9 Setup (NO/NC, Action, Message, When Active, Delay)

(2) Output Configuration	Relay Output 1 Setup (Function, Polarity, Initial State)
	Relay Output 2 Setup Pre-Set to Fuel/Run
	Relay Output 3 Setup (Function, Polarity, Initial State)
	Relay Output 4 Setup (Function, Polarity, Initial State)
	Relay Output 5 Setup (Function, Polarity, Initial State)
	Relay Output 6 Setup (Function, Polarity, Initial State)
	Relay Output 6 Setup (Function, Polarity, Initial State)
	Relay Output 7 Setup (Function, Polarity, Initial State)
	Relay Output 8 Setup (Function, Polarity, Initial State)

(3) Throttle Configuration	Throttle Type - Throttle Type Selection (Default = TSC Vernier)
	TSC Mode Selection (Default = Primary)
	TSC Min Speed Selection (Default = 650 RPM)
	TSC Max Speed Selection (Default = 2400 RPM)
	TSC Bump Speed (Default = 20 rpm)
	TSC Ramp Rate Selection (Default = 100 rpm/sec)
	Throttle Curve Selection (Default = Linear)
	Multistate Speed 1 Selection
	Multistate Speed 2 Selection
	Multistate Speed 3 Selection
	Multistate Speed 4 Selection

(4) Engine Safety Configuration	Sender Check Bypass Time (Default = 0:10)
	Fuel Level Check Selection (Default = Off)
	Low Fuel Level Pre Alarm % Selection (Default = 20%)
	Low Fuel Level Alarm % Selection (Default = 1%)
	Fuel Level Alarm Delay Time (Default = 0:05)
	Oil Pressure Check (Default = Run)
	Low Oil Pressure Pre Alarm % (Default = 6 PSI)
	Low Oil Pressure Alarm % (Default = 5 PSI)
	Oil Pressure Alarm Time Delay (Default = 0:10)
	Engine Temperature Check (Default = Run)
	Engine Low Temperature Pre Alarm (Default = 0 Degrees F)
	Engine Low Temperature Alarm (Default = 0 Degrees F)
	Engine High Temperature Pre Alarm (Default = 244 Degrees F)
	Engine High Temperature Alarm (Default = 245 Degrees F)
	Engine Temperature Alarm Time Delay (Default = 0:10)
	Battery Volt Check (Default = Off)
	Low Battery Volt Pre Alarm (Default = 12.0 Volts)
	High Battery Volt Pre Alarm (Default = 15.0 Volts)
	Battery Volt Trim Setting 100mV (Default = 5)
	Over speed Alarm (Default = Off)
	Over speed Alarm RPM Setting (Default = 3000 RPM)
	Over speed Alarm Time Delay Selection

(5) Module Configuration	English/Metric Selection
	Hour Meter Source (Default Engine ECU)
	Hour Meter Setting (if not ECU)
	Battery Volt Source (Default = J1939)
	Pre Alarms Displayed (Default = 4)
	Clear Operation Log Yes/No
	Clear Alarm Log Yes/No

(6) CAN Configuration	Source Address (Default = 44)
	TSC1 Address (Default = 3)
	Engine Address (Default = 0)
	Oil/Fuel Transmit

(7) Emissions Configuration	DEF Level Check (Default = Off)
	Low DEF Pre Alarm (Default = 16%)
	TSC Regen Speed
	Allow Service Regen (Default = No)
	Regen Interlock (Default = Off)
	TSC Transmit (Default = On)