55K ELECTRIC HUSKY

ADVANCED PRESSURE SYSTEMS

OPERATION AND MAINTENANCE MANUAL

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ADVANCED PRESSURE SYSTEMS 2023



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About This Content

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Overview

The Husky pump is a powerful positive displacement, ultrahigh-pressure (UHP) triplex plunger pump system. These waterjet cleaning pumps are designed and manufactured to operate in continuous service at a designed flow and pressure. With pressures ranging from 2,758 bar (40,000 psi) to 3,793 bar (55,000 psi), the Husky is an extremely versatile pump. The Husky pump is designed for full-scale industrial use with minimal maintenance and reliable performance.

Features include:

- A triplex, direct-drive, high-pressure pump with easy access to seals and check valves.
- Multiple prime mover options:
 - o 150 hp TEFC electric motor
 - o 200 hp TEFC electric motor
 - o 250 hp TEFC electric motor
- Sensor lights and automatic shutdown for low inlet water pressure, high pump temperature, and low pump oil pressure.
- A closed-loop oil lubrication system.
- An inlet water booster pump with water filtration to 10 microns absolute.
- An over-pressure protection valve.

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

How It Works

Several items work together to operate the UHP fluid end. These items are the inlet water, the electric motor, the pump, and the cooling system. When all of these items work together high pressure water is created.

Inlet water is the first item. The inlet water flows through a water filter to ensure it is clean enough to flow through the rest of the system. From there, the water continues to the inlet check valve.

For the water to continue through the system, the motor must run. When the motor runs, it turns the crankshaft of the pump. In turn, the crankshaft moves the plungers.

The pump is connected to the motor and operates in a two-stroke cycle: the inlet stroke, and the pressure stroke.

The sequence of the inlet stroke has four steps:

- 1. The outlet check valve closes.
- 2. The plunger moves back.
- 3. The inlet check valve opens.
- 4. Water enters the pump.



After the inlet stroke is the pressure stroke which has five steps:

- 1. The inlet check valve closes.
- 2. The plunger moves forward.
- 3. The water is pressurized.
- 4. The outlet check valve opens.
- 5. High pressure water goes to the manifold.

At this point, the two-stroke cycle repeats.



The cooling system is the last item. It operates to make sure that the rest of the systems are at the correct temperature. The charge pump supplies low-pressure water to cool the UHP fluid end. The low-pressure water also lubricates the plungers and the plunger bearings.

A failed dynamic seal causes high-pressure water to leak into the low-pressure water that cools the bearing, cools the plunger, and lubricates the plunger. The symptoms of a failed dynamic seal are heat and pulsing water at the cooling water outlet line of the manifold. The temperature sensors on the cooling water outlet line heat in that circuit.



(image is used as reference only)

Safety

Advanced Pressure Systems designed this 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 the body—it will cause serious injury.
- Never point a waterjet cutting or cleaning tool at oneself or any person. Do not aim any waterjet tool at anything not intended to be cut.
- During equipment maintenance, take the system out of service. Lock and mark the controls with a warning sign. See section '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.

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 colorcoding, 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 APS manufactured or approved waterjet nozzles, cleaning tips, and drilling or cutting bits.

Mechanical

- Do not start the system unless the operator can properly shut it down.
- 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 indicates a 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

A DANGER	DANGER indicates a hazardous situation, which if not avoided, will result in death or serious injury.
A CAUTION	CAUTION emphasize operating or service procedures, or conditions that can result in equipment damage or impairment of system operation.
NOTICE	NOTICE indicates a non-hazardous situation, which if not avoided, can result in property damage.

Safety Labels

The section describes the safety labels and their locations.

High-Pressure Hose

This label indicates the minimum pressure rating of the hose to be used with the unit.

(Item 1 in the image below) This label is located on the high-pressure tubing assembly.



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 m.s. 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

The water supply and electrical systems can be locked out separately. Under most circumstances, both systems should be locked out.

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 using the 'Standard System Shutdown' procedure below.
- 2. Look at the gauges on the display to ensure that the fluid end pressure is bled down.
- 3. Turn off the water supply to the charge 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. 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 pump using the 'Standard System Shutdown' procedure below.
- 2. Disconnect from power source using main power disconnect.
- 3. Install a lockout/tagout device over the power source.

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. Note the warnings stamped on the unit. 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.

Before Starting the System

Prior to starting the system review the manufacturer's manuals included in the appendix covering the operation of the motor and motor starter.

- 1. Set unit on a level surface.
- 2. Check oil level and any water contamination in the hydraulic reservoir.
- 3. Check all electrical cables and connections.
- 4. Verify all bolts are torqued to the specified level.
- 5. Verify connections on the manifold are tight and do not leak.



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

- 6. Ensure the supply water and the filters and strainers are clean.
- 7. Verify the pressure relief valve has been calibrated. Procedures for this can be found in the 'Calibrating the Safety Valve' section later in this manual.

- 8. 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.
- 9. Check to ensure supply water is flowing to the system.
- 10. Inspect the pump for visible damage, debris, and cleanliness.

Startup

- 1. Ensure that supply line water is connected to the unit.
- 2. Turn on the pressurized supply line water.
- 3. Turn the inlet water valve to the ON position.

A CAUTION Failure to open the inlet water valve can severely damage the pump.

- 4. Open the top petcock on the water filter canister to purge the air from the filter canister. Close the petcock after water begins flowing from the valve.
- 5. Examine the pump for leaks. Fix any leaks before starting the pump.
- 6. Turn the key switch to ON.
- 7. After the screen turns on, press and hold the start button. Release the button after the motor starts.
- 8. Listen for unusual noises in the system.
- 9. 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 'Troubleshooting' later in this manual if the issue is not resolved.
- 10. Ensure the suction and discharge valves remain fully open during operation.

ACAUTION Never close the suction or discharge valves while the pump is running.

Shutdown

Standard System Shutdown

- 1. Use the rotary knob on the screen to dial back pressure as low as possible.
- 2. Push the idle button and let the motor slow down to idle speed.
- 3. Press the stop button to initialize shutdown.



If the pump is equipped with a VFD or a soft starter, the motor ramps down in speed over time depending on the starter settings.

4. Once motor has stopped turn the key off to shut down control system.

Emergency System Shutdown

1. Push the red E-Stop button on the control panel.

Operating the User Interface

Run Screen

1. On the run screen shown below there are 11 boxes, 6 on the left, 5 on the right. These indicate which physical button to push on the display screen to activate the labeled function.



- 2. Starting from top left is the "Metric" /"English" units changer button. The text displayed in the box will be the units shown AFTER the button is pressed.
- 3. Moving down, the next two buttons control the commanded motor RPM up and down. The current motor speed is displayed graphically in the horizontal bar graph and the setpoint is shown digitally below. These numbers may not match. Use the graph for reference when setting RPM.
- 4. The 4th button down on the left side is used to initiate the ECV calibration procedure.

- 5. The 5th button navigates to the configuration screen where a password will be required to modify some parameters of the pump.
- 6. The bottom most button on the left side of the display navigates to the monitor pages. The first page is the pump monitor. This displays pertinent information regarding the UHP pump and the hydraulic system digitally.
- 7. The buttons on the right side are used to start and stop the motor and run and idle the pump.
- 8. The bottom most button on the right side navigates to the alarm page where details of current alarms and past alarms are viewed.
- 9. On the home page, the output pressure in KPSI is shown. Depending on the pressure range the scale and setpoint will be limited appropriately.
- 10. The pressure setpoint is changed by rotating the dial on the right side of the display. If fine adjustment is needed simply push the knob until a click is felt and adjustments will be in 6.9 bar (100 psi) increments.
- 11. The motor speed and pump pressure setpoints can be changed at any time the pump will only try to meet the setpoints when the "Run" button is active and no faults are present.
- 12. **Note**: Caution must be taken when turning on a cold pump. The previous ECV calibration will likely not be saved for a cold pump. This could cause the pressure to rise over the limit of the fluid end. It is best to start low and come up to pressure gradually until the pump warms up.
- 13. Also shown on the home screen are basic motor and pump status, pump hours, and any active alarms.

Configuration Screen

1. The configuration screen is where different parameters of the pump can be changed.



- 2. A password is needed to access the configuration screen. Depending on the authorization level of the password entered options will vary and may not include all that are shown above. At any time entering an incorrect password will clear all options and reset permissions to none.
- 3. Use the top left and top right buttons to highlight the password boxes. Use the knob to change characters. A valid password must be entered to proceed.

- 4. If authorization level is high enough, the pressure setpoint will be able to be set higher than normal to allow the calibration of the safety valve. The box below the red text will display how many seconds before the permission is reset.
- 5. Other options such as enabling the remote stop are available. This option shuts down the motor like an e-stop. Enabling the remote run/idle option, which can change the pump state remotely with a digital input, are also present.
- 6. The VFD control and 40K/55K toggles must not be changed unless authorized by an APS service technician or engineer.
- 7. The "Cal Temps" button synchronizes the thermistors in the fluid end with the 4-20mA temperature transducer in the water filter. To do this the pump must be off, and cooled down, with water circulating through the fluid end.
- 8. F11 is a toggle to enable or disable the fluid end temperature monitoring if the thermistors are equipped.
- 9. The bottom most button on the left will navigate to the data log retrieval page where past logs can be downloaded to a USB device.

Log Screen

1. The log screen is where operating data for the pump can be retrieved.



- 2. In the two boxes, enter the year "YYYY" and month "MM" of the data to retrieve. For example, 2019 04 for April 2019.
- 3. Once the USB device is inserted press the button next to "Copy" and the status message will update appropriately indicating if the data file exists or if the USB device is not connected. If the file is found during the transfer it will display "Copying" once complete it will indicate that the operation is complete. It is recommended that data is pulled often as after a year it will be overwritten by the new data.

Pump Monitoring Screen

1. The pump monitoring screen is where detailed pump status can be viewed.



2. From this screen motor RPM can be controlled and whether the pump is in 'idle' or 'run' with the corresponding buttons.

Alarm Screen

1. The alarm screen is where current and previous alarm codes and shutdowns are displayed.

Time Stamp 👻	Alarm Message
%s	Scroll Main

2. To view previous alarms, select "All" and use the knob on the right of the display to scroll the screen up and down.

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.

- 1. Shutdown the pump according to the 'Standard System Shutdown' procedure above.
- 2. Remove all of the hydraulic oil from the hydraulic circuit.
- 3. Remove oil filters from the hydraulic circuit and control box and electronics.
- 4. Dispose of (or recycle) the oil, filters, and electronics in accordance with local regulations.

System Storage

If the system will be idle 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.
- 2. Coat all bearings and machined surfaces inside the crankshaft with a rust inhibiting oil.
- 3. Rotate the crankshaft once each month.

Cold Weather Storage

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

- 1. Open the top and bottom petcocks on the water filter canister to drain the canister. Close once all water is drained.
- 2. Drain all of the water from the high-pressure components: Disconnect the water supply hose at the connection point, and then attach a compressed air line. DO NOT TURN ON THE AIR SUPPLY AT THIS TIME.
- 3. Before the air is turned on, loosen the gland nut to the pressure transducer.
- 4. Loosen the gland nut to the safety valve.
- 5. Disconnect all high-pressure hoses and/or accessories connected to the high-pressure water outlets. These are to be stored independently.
- 6. Open the inlet water valve.
- 7. Slowly turn on compressed air to the pump. Allow the air to run until the system contains no more water—approximately 10 minutes.
- 8. Turn off the air supply and remove it from the connection point.
- 9. Connect the antifreeze supply line to the inlet water connection on the charge pump. Turn on the antifreeze pump.
- 10. Start the pump. Run at idle, watch for antifreeze to leak from the loose connections and outlet water ports to leak antifreeze—approximately 60 seconds.

- 11. Shut down the pump using the 'Standard System Shutdown' procedure above.
- 12. Plug the water inlet port.

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.

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

- 1. Open the covers on the power end and verify the bearings are clean and in good condition.
- 2. Replace all fluids previously removed for long term storage.
- 3. Verify the plungers, valves and seals 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. If antifreeze was added to the system, drain and flush this with water.
- 7. 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.

A 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



Never direct high-pressure fluid jets toward anyone or to any part of the 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.

A 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 pressure relief protection.



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 the spring load relief valve is set at 4,241 bar (61,500 psi).



A CAUTION Never adjust relief valves to open at more than directed above.

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.
- 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

Do not use a high-pressure hose with an operating pressure less than 3,793 bar (55,000 psi).

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.

A 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 the 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.



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 13.8 bar (200 psi) 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 is suspected to have malfunctioned without having it repaired and/or thoroughly checked for proper operation by a qualified high-pressure maintenance mechanic or a 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.
- 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 an operating pressure less than 3,793 bar (55,000 psi).

Do not use a rigid lance with an unknown burst rating 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.



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

Do not use a flex lance with an operating pressure less than 3,793 bar (55,000 psi).

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 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 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.



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.

A 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.



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 Precautions

Observe these precautions when maintaining 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 rated for 3,793 bar (55,000 psi) or greater 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 1,379 bar (20,000 psi) per minute].
- High-pressure water may remain in the system for a prolonged period after closing the highpressure 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 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 servicing and before starting the pump.
- Use only approved work platforms. Never climb on or around the equipment on makeshift devices.

Protective Clothing

- Do not wear loose clothing while working around rotating parts of machinery.
- Pressurized air can drive particles into eyes and skin if handled incorrectly. To prevent injury, use appropriate protective equipment and clothing, and exercise extreme caution.
- See Personal Protective Equipment (PPE) for more information.

Gland Nut 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"	35 - 45 (47 - 60)
9/16"	60 - 75 (80 - 100)

Daily Inspection

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

• Prior to startup, check power end 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 motor and motor starter 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.

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 specific application 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 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 pressure rating for high pressure fittings must be a minimum of 3,793 bar (55,000 psi).

- 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.

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

Preventative Maintenance Schedule

Install minor maintenance kit	Every 150 hours of operation
Install major maintenance kit	Every 600 hours of operation ¹
Replace water filters	Every major kit installation or ΔP > 25 psi
Replace hydraulic oil filters	Every 1000 hours or annually
Examine accumulators for charge	Every 6 months

1) Major kit includes minor kit parts

2) If water quality does not meet the specifications outlined, then water filters may require more frequent replacement

ECV Rebuild



- 1. Disconnect the hydraulic hose attached to the oil connector.
- 2. To remove the ECV housing from the ECV body, hold the body nut with a wrench and then turn the ECV housing with a spanner wrench.
- 3. Loosen the ECV body from the high-pressure manifold with a wrench and remove the body, adapter, poppet, seat, and static cap seal.
- 4. Examine the bearing assembly, the plunger seal, the O-ring, the poppet, the seat, and the static cap seal for obvious unusual wear, and then discard them. If unusual wear is found, determine the cause and make appropriate repairs as required or call APS technical support.

- 5. Remove the retainer ring from the ECV body.
- 6. Remove the ECV housing cap together with the springs from the ECV housing body.
- 7. Pull the shaft and the attached separator plate out of the ECV housing.
- 8. Remove the piston by pressing it out from the ECV body housing.
- 9. Remove the seven breather vents.
- 10. Remove the retainer ring and bearing sleeve from the cap.
- 11. Remove the nut that holds the plunger to the piston, and then separate the plunger and piston by tapping from the plunger nut side with a soft mallet.
- 12. Clean the separator plate, the piston, and the ECV housing cap and body with a water-soluble cleaning compound.
- 13. Thoroughly dry the components.
- 14. Install new U-packing seals on the separator plate and the piston.
- 15. Lubricate the inside of the ECV housing and the piston and separator plate seals with food grade grease.
- 16. Install the new plunger through the piston. Install new nut. Torque nut to 34-40 N-m (25-30 ft-lb).
 NOTICE When correctly installed, the open areas of the U-packing seals face each other.
- 17. Install the piston/plunger assembly into the ECV housing.
- 18. Install the separator plate into the ECV housing.
- 19. Set the ECV housing cap with the spring pockets facing up and then place the springs into the pockets of the cap.
- 20. Lower the ECV housing body onto the cap.
- 21. Turn the assembly over and install the retainer ring. If the retainer ring is not easily installed, then the separator plate or the piston is not installed correctly. Disassemble the ECV and reassemble it.
- 22. Install new breather vents.
- 23. Lubricate the plunger seal and accompanying O-ring with FOOD GRADE GREASE and install them into the ECV body.
- 24. Install the bearing sleeve into the ECV housing cap. Install the retainer ring to hold it in position.
- 25. Lubricate the bearing assembly with FOOD GRADE GREASE and install it into the ECV body.
- 26. Install new O-rings onto the ECV body. Set the ECV body aside, in a clean area.
- 27. The ECV body, the poppet, the seat, and the static cap will be installed directly to the manifold during reassembly.

ECV Installation

$ \begin{array}{c c} $	ITEM	DESCRIPTION	PART NUMBER
	1	ECV BODY	013412-1
Cong I MATTER	2	ADAPTER	013425-1
	3	POPPET	013411-1
C C C C C C C C C C C C C C C C C C C	4	SEAT	011901-1
	5	STATIC CAP SEAL	006738-1

- 1. Install the new ECV static cap seal onto the seat.
- 2. Lubricate all visible ECV O-rings with FOOD GRADE GREASE.
- 3. Apply BLUE LUBRICANT on the ECV body-to-manifold threads.
- 4. Install the ECV body, the poppet, the seat, and the static cap seal into the manifold hand tight.
- 5. While ensuring that the fitting on the adapter points down, tighten the ECV body to the manifold.
- 6. Apply BLUE LUBRICANT on threads of the ECV body.
- 7. Support the ECV housing from the bottom and install the ECV housing onto the ECV body. Turn the ECV housing onto the ECV body as far as possible by hand.

NOTICE During installation, support and rotate the ECV housing from the bottom. Use this method to get correct thread alignment and to prevent cross threading.

- 8. Use a spanner wrench in the holes in the rear of the ECV housing to tighten the ECV housing to the ECV body.
- 9. Connect the high-pressure water and ECV connections.
- 10. Connect the high-pressure water line to the manifold.
- 11. Connect the low-pressure water hoses to the manifold.
- 12. Connect the drain lines.
- 13. Remove tools, parts, and rags from around the pump.
- 14. Open the inlet water valve and check for leaks.



Failure to open the inlet water valve before starting the pump may cause severe damage to the pump.

- 15. Do the 'Calibrate the External Control Valve' procedure found later in this manual.
- 16. Run the pump at 690 bar (10,000 psi) for three minutes, then three minutes each at 1379 bar (20,000 psi), 2069 bar (30,000 psi), 2758 bar (40,000 psi), 3,793 bar (55,000 psi) examining for leaks and heat.

Safety Valve Service

The safety valve protects the operator and pump from high pressure during a catastrophic failure. If an over-pressure condition occurs, the safety valve opens and unloads the circuit. The safety valve is set to discharge above 4241 bar (61,500 psi).

Signs of a Problem:

If the safety valve opens, reset it by returning the motor to idle. Operate the pump at low pressure and idle for one minute, then increase to full speed. If the safety valve opens again, the restriction must be located. Turn the motor switch to OFF and examine the nozzle and hoses for restrictions. Do not restart the motor before solving the problem.



<u>Disassembly:</u>

1. Do the 'Lockout/Tagout' procedure found in the 'Safety' section above.



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

- 2. Remove the hose from the safety valve.
- 3. Loosen the locknut with a spanner wrench.
- 4. Release the spring tension by turning the spring cage counterclockwise with the spanner wrench until it is loose enough to remove by hand.
- 5. Be careful of the spring washers located in the spring cage; remove the spring cage from the safety valve body. If the spring washers fall out of the spring cage, put them in a safe place. They are required for reassembly. There are 20 spring washers.
- 6. Remove and discard the O-ring and back-up ring.
- 7. Remove the seat and poppet and discard them.

Assembly:

- 1. Examine all parts of the safety valve assembly for damage to the threads and sealing surfaces. Repair or replace as necessary.
- 2. Install the back-up ring and O-ring. Lubricate them with FOOD GRADE GREASE.
- 3. Stack the spring washers in the spring cage in the order shown below.



- 4. Place the poppet into the plunger insert guide and install a new seat.
- 5. Apply BLUE LUBRICANT to the safety valve body threads.
- 6. Install the spring cage onto the valve body until there is 38.1 mm (1.5 in.) of the stem extending from the spring cage.



7. Do the 'Calibrate the Safety Valve' procedure found later in this manual.

Water Filter Element Replacement

Dirty or incorrect filters can shorten pump life.

1. Do the 'Lockout/Tagout' procedure found in the 'Safety' section above.

\Lambda DANGER

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. Orientate the bleed valve as shown.
- 13. Apply a thin layer of BLUE LUBRICANT to the threads and face of the clamp T-bolt, and then tighten the clamp.



The clamp may need to be struck 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.

Hydraulic Filter Element Replacement



1. Do the 'Lockout/Tagout' procedure found in the 'Safety' section above.



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.

Dynamic Seal Temperature Sensor Replacement

This portion of the manual is for fluid ends equipped with Dynamic seal temperature sensors.

1. Do the 'Lockout/Tagout' procedure found in the 'Safety' section above.

A DANGER

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

2. Disconnect the cable from the appropriate sensor.



- 3. Remove the sensor.
- 4. Install the new sensor.
- 5. Do the 'Calibrate the Dynamic Seal Sensors' procedure found later in this manual.

Calibrations

Calibration Overview

The following calibrations are required to keep the pump operating correctly.

Calibrating the Dynamic Seal Temperature Sensor

The dynamic seal temperature sensors require periodic calibration. Such instances include after replacing a sensor or after maintenance that requires disconnecting the sensor.

The system recognizes if the sensors need calibrating and automatically adjusts them. The calibration process terminates after 5 minutes, if the motor is started, or if inlet water pressure is lost. The Pump data screen 2 can be viewed while the motor is off and with cooling water flowing past the sensors to make sure that the calibration has been effective. When correctly calibrated, the sensors should have no more than a 1.5-degree Fahrenheit difference in temperature.

- 1. Turn the key switch to RUN, but do not start the motor.
- 2. Open the inlet water valve to apply water pressure to the pump to let cooling water flow past the inlet water temperature sensor and the three cylinder sensors.
- 3. Let the pump temperatures stabilize. Temperature stabilization takes approximately 5 minutes.
- 4. Enter the configuration screen by clicking the 'Config' button on the home screen.
- 5. Use the top left and top right buttons to highlight the password boxes. Use the knob to change characters. A valid password must be entered to proceed.
- 6. Select the 'Cal Temps' button to complete the calibration.



Calibrating the External Control Valve

Calibrate the ECV every time the poppet or poppet seat is replaced, the pump is rebuilt, or whenever the ECV starts to affect output water pressure.

If operating the pump in a cold environment, the oil may take an excessive amount of time to warm up enough to calibrate the ECV correctly. Contact APS technical service if assistance is required.

- 1. Make sure that the following conditions are met, or the calibration will not be accurate:
 - Deadhead the UHP system by closing all output water valves so that all water goes over the ECV.
 - Pump oil is at operating temperature [>24°C (75°F)].
- 2. On the programmed display, navigate to the Calibration screen and then press begin to start the calibration.
 - For the duration of the test (2 minute or less), this process can be stopped by pressing abort, pressing the E-stop, pushing the SYSTEM IDLE button, or a shutdown occurs.
 - During the test, the pump sets to 2100 RPM and the PLC adjusts the control signal to the ECV up in steps to calibrate signal from 0-3,793 bar (55,000 psi).
 - When finished, the pump returns to idle and zero pressure The calibration curve generated can then be stored. If not stored when power is cycled calibration will revert to previous calibration setting.
 - Run the pump at 690 bar (10,000 psi) for three minutes, then three minutes each at 1,379 bar (20,000 psi), 2,069 bar (30,000 psi), 2,758 bar (40,000 psi), 3,793 bar (55,000 psi) examining for leaks and heat.



Calibrating the Safety Valve

Although the maximum system output under normal operating conditions is 3,793 bar (55,000 psi), the safety valve is set to discharge above 4,241 bar (61,500 psi). This accommodates expected pressure spikes. The safety valve protects the operator and pump from high pressure during a catastrophic failure. Calibrating the safety valve at pressures below 4,241 bar (61,500 psi) can cause excessive actuation of the safety valve, resulting in premature wear to the safety valve poppet and seat.

The pump must be able to deliver 4,241 bar (61,500 psi) minimum water pressure.



- 1. Install the ECV spacer onto the ECV poppet.
 - Remove the ECV housing and ECV body from the manifold.
 - Install the ECV spacer between the poppet and the seat.
 - Reinstall the ECV housing and ECV body to the manifold.
- 2. Disconnect the hose from the safety valve.
- 3. Adjust the safety valve spring cage so that 38.1 mm (1.5 in.) of the stem extends from the spring cage.



- 4. Deadhead the pump.
- 5. Activate the extended pressure range on the control display by navigating to the config screen and entering the correct password. Extended pressure range will be available for 12 minutes.



6. The pump can now be set up to 4,275 bar (62,000 psi). Run the pump and increase the water pressure to 4,103 bar (59,500 psi). Make sure that the valve does not dribble or discharge. If the valve dribbles or discharges, push the SYSTEM IDLE button, tighten the spring cage approximately 1/4 turn, and then go back to Step 5.

NOTICE One turn is equivalent to 82.7–103.4 bar (1,200–1,500 psi).

- 7. Increase the pump pressure to 4,241 bar (61,500 psi) see if the valve dribbles at this pressure.
 - If the safety valve discharges completely, return to Step 3.
 - If the valve does not dribble:
 - Push the SYSTEM IDLE button on the control.
 - Loosen the spring cap 1/4 turn.
 - Continue to step 8.
- 8. Enter the Run screen and run the pump at 4,103 bar (59,500 psi). Make sure that leakage does not occur. Continue to step 9 if no leakage is observed.



If leakage is noted, install a safety valve service kit, and then restart this calibration procedure.

- 9. After the valve is correctly calibrated, shut off the pump.
- 10. Tighten the locknut against the spring cage.
- 11. Reconnect the hose to the safety valve.
- 12. Remove the spacer from the ECV.
- 13. Lubricate all visible ECV O-rings with FOOD GRADE GREASE.

- 14. While supporting the ECV assembly from the bottom of the housing, install the ECV into the manifold. Turn the ECV into the manifold most of the way by hand.
- 15. During installation, support and rotate the ECV assembly from the bottom of the ECV housing. Use this method to get correct thread alignment and to prevent cross threading. Additionally, if a wrench is used on the ECV body, do not over torque the ECV nut, as this damages the threads in the manifold body.
- 16. Tighten the ECV body to the manifold.
- 17. Use a spanner wrench in the holes in the rear of the ECV housing and then tighten the ECV housing to the ECV body.

55K Fluid End Assembly

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 Precautions

Observe these precautions when maintaining 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 rated for 3,793 bar (55,000 psi) or greater 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 highpressure 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 any fault or malfunction is detected, 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 service and before starting the pump.
- Use only approved work platforms. Never climb on or around the equipment on makeshift devices.

Protective Clothing

- Do not wear loose clothing while working around rotating parts of machinery.
- Pressurized air can drive particles into eyes and skin if handled incorrectly. To prevent injury, use appropriate protective equipment and clothing, and exercise extreme caution.
- See Personal Protective Equipment (PPE) for more information.

Gland Nut 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"	35 - 45 (47 - 60)
9/16"	60 - 75 (80 - 100)



ITEM	PART NUMBER	DESCRIPTION	ITEM	PART NUMBER	DESCRIPTION
1	013533-1	SUBPLATE	21	A-12749	DAMPER, PULSATION, BLDR, 8 SAE
2	013539-1	TIE ROD	22	A-21080-1	NUT, HEX, GR 8, PLATED, 7/8-14
3	A-0265-118	SNAP RING, INT, 3/16 HSNG	23	A-9926	WASHER, HARD, 1.5 OD X 7/8 ID
4	013540-1	SPACER, SEAL, LOW PRESS, 55K	24	A-0290-014	O-RING, HIGH RISILIENCY
5	A-9566	SEAL, HP. 9/16 SHAFT	25	006112-1	MANIFOLD, BACKUP RING, S-200
6	A-0265-086	SNAP RING, INT	26	006113-1	NUT, ADAPTER, MANIFOLD, S-200
7	009217-1	BEARING ASSY, S-200	27	006114-1	INSERT, MANIFOLD, S-200
8	A-0275-030	0-RING, BUNA, 70 DURO, 2-030	28	006738-1	STATIC CAP SEAL, END CAP
9	013525-1	ADAPTER	29	A-00315-9	WASHER, HARD, 9/16, CAD PLATED
10	013517-1	SEAL CARRIER	30	A-00299-44	SCREW, HEX HD, 2-3/4 LG X 9/16-18
11	A-0274-1	O-RING, STR THD, BUNA, 1/8 OD	31	016856-1	MANIFOLD
12	A-13262	THERMISTOR, 10K OHM, BRASS	32	013537-1	PILOT, PONY ROD
13	016170-1	SEAL, DYNAMIC	33	A-11216	SEAL, OIL
14	A-10654	SEAL, LIP	34	A-0275-153	O-RING, BUNA-N, 70 DURO, 2-153
15	017793-1	FILLER TUBE	35	006068-1	NUT, PLUNGER ADAPTER
16	013387-1	CYLINDER, HP	36	A-9412	SPRING, COMPRESSION
17	014252-1	GUIDE RING, CYLINDER	37	018020-1	PLUNGER ASSY
18	A-0275-040	0-RING, BUNA, 70 DURO, 2-040	38	014676-1	ROD, PONY
19	016863-1	CHECK VALVE ASSY	39	A-0275-313	O-RING, BUNA-N, 70 DURO, 2-313
20	016862-1	END CAP	40	006069-1	ADAPTER, PONY ROD, S-200

Using the Loading Tool

Unloading the Tie Rods

1. Do the 'Lockout/Tagout' procedure found in the 'Safety' section above.

DANGER

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

- 2. Close the inlet water valve.
- 3. Disconnect the ECV drain line connection.

NOTICE If the ECV can be set aside so that there is no interference with maintenance, then the ECV drain line can remain connected.

- 4. Disconnect the hydraulic hose from the ECV.
- 5. Use a 2 in. wrench to remove the ECV from the manifold. Set the ECV aside.
- 6. Disconnect the inlet and the low-pressure cooling water hoses from the manifold.
- 7. Disconnect the high-pressure tube assembly from the manifold.
- 8. Remove the six manifold screws that hold the manifold to the end caps. Remove the manifold.



ITEM	DESCRIPTION	PART NUMBER
1	MANIFOLD	016856-1
2	END CAP	016862-1

9. Open the hand pump relief valve, and then attach the pressure-loading tool body to the hand pump quick-disconnect.



The hand pump hydraulic hose must be installed to the tool with the hand pump relief valve open.



ITEM	DESCRIPTION
1	HAND PUMP QUICK DISCONNECT
2	LOADING TOOL BODY

10. Install the pressure-loading tool onto the tie rods. Turn the tool studs onto the exposed tie rod threads by hand.



11. Tighten the tool studs firmly with a wrench or ratchet to seat the tool piston fully into the pressure-loading tool body and against the end cap. While tightening the studs, alternate between opposite studs. Use a crisscross pattern to avoid binding.

NOTICE A correctly installed piston has no visible shoulder, as shown in this illustration.



- 12. Index-mark the pressure-loading tool studs and the pressure-loading tool body with a permanent marker. The marks help to monitor rotation of the tool studs.
- 13. Loosen each of the four tool studs exactly one turn. Use the previously made index-marks to monitor rotation.
- 14. Close the hand pump relief valve.
- 15. Pump the hand pump until the gauge pin reaches the Husky icon.
- 16. Loosen each of the primary tie rod nuts of the pump two full turns. (The wrench supplied with the pressure-loading tool may need to be used).
- 17. Turn the hand pump relief valve.
- 18. While the pressure-loading tool is still attached to the pump, tighten two pressure-loading tool studs (opposite corners) to compress the piston back into the pressure-loading tool body.
- 19. Remove the pressure-loading tool from the tie rods.
- 20. Do Steps 10-19 for the remaining positions of the pump.

Loading the Tie Rods

1. Push the check valves into the end caps by hand.



- 2. Assemble the UHP components into position on the tie rods as shown below.
 - Point the filler tube and high-pressure cylinder in the direction shown in the image below.
 - Make sure that the port for the thermistor located in the subplate adapter points straight down.



- 3. Lubricate the threads of the tie rods and both sides of the washers with SILVER ANTI-SEIZE.
- 4. Install the washers and primary tie rod nuts by hand, and then firmly seat all components using a 1/2 in. drive ratchet with a 1-5/16 in. socket.

5. Open the hand pump relief valve and attach the pressure-loading tool to the hand pump quickdisconnect fitting.



6. Install the pressure-loading tool onto the tie rods by turning the tool studs onto the exposed threads of the tie rods by hand.



- 7. Tighten the pressure-loading tool onto the tie rods and end cap following the tightening sequence below:
 - When tightening, alternate in a crisscross pattern to avoid binding.
 - Tighten the tool studs firmly to seat the tool piston fully into the tool body and against the end cap. See the figure below for examples of incorrect and correct piston installation.



Once tightened, do not back off the tool studs during this step.



To insert the piston fully into the cylinder, the hydraulic hose of the hand pump must be installed to the tool with the pump pressure released. A correctly installed piston has no visible shoulder, as shown in the following illustration.



- 8. Close the hand pump relief valve.
- 9. Pump the hand pump until the gauge pin reaches the Husky icon. Watch the pressure gauge for several seconds to make sure that there are no leaks in the hydraulic lines.
- 10. Tighten the primary tie rod nuts of the pump, by hand, until they are firmly against the washers and end caps.

NOTICE tie rod nuts—tighten the nuts by hand.

- 11. Release the pump pressure.
- 12. Remove the pressure-loading tool from the tie rods.
- 13. Do Steps 2 through 12 for the remaining positions of the pump.
- 14. Install the manifold onto the end caps:



Tighten nuts by hand

TOOL STUDS

ITEM	DESCRIPTION	PART NUMBER	NOTES
1	MANIFOLD BOLTS		
2	O-RING	A-0290-014	REPLACED DURING MAJOR AND MINOR MAINTENANCE
3	BACKUP RING	006112-1	REPLACED DURING MAJOR MAINTENANCE
4	O-RING	A-0290-014	REPLACED DURING MAJOR AND MINOR MAINTENANCE

- Install the O-rings and backup rings onto the top face of the UHP end caps.
- Lubricate the six manifold screw threads and washers with SILVER ANTI-SEIZE.
- Torque the manifold screws in three steps using the following pattern:
 - 81.3 N-m (60 ft-lb)
 - 122 N-m (90 ft-lb)
 - 176.3 N-m (130 ft-lb)



- 15. While supporting the ECV assembly from the bottom of the housing, install the ECV into the manifold. Turn the ECV into the manifold most of the way by hand.
- 16. Tighten the ECV body to the manifold.
- 17. Use a spanner wrench in the holes in the rear of the ECV housing and then tighten the ECV housing to the ECV body.
- 18. Connect the high-pressure water and ECV connections.
- 19. Connect the high-pressure water line to the manifold.
- 20. Connect the low-pressure water hoses to the manifold.
- 21. Connect the drain lines.
- 22. Open the inlet water valve at a slow rate and do a check for leaks.

NOTICE Failure to open the inlet water valve before starting the pump may cause severe damage to the pump.

23. Remove the tools, parts, and rags from around the pump.



WARNING! High-pressure leaks can severely injure or kill someone. When pressurizing any new, rebuilt, or serviced high-pressure component, 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.

- 24. Do the 'Calibrate the External Control Valve' procedure.
- 25. Run the pump at 690 bar (10,000 psi) for three minutes, then three minutes each at 1,379 bar (20,000 psi), 2,069 bar (30,000 psi), 2,758 bar (40,000 psi), and 3,793 bar (55,000 psi), examine for leaks and heat while pressure is increased.
- 26. The pump is ready for operation.

Installing the Minor Maintenance Kit

Install the minor maintenance kit every 150-service hours.

- Install all of the parts at the same time—do not replace components individually when doing scheduled maintenance.
- Clean all of the components before assembly. It is important to keep the work area clean while working on the equipment.
- Read the entire procedure before starting service, pay particular attention to safety instructions.

Prepare to Install the Kit

1. Do the 'Lockout/Tagout' procedure found in the 'Safety' section above.



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

- 2. Do the 'Unloading the Tie Rods' procedure.
- 3. Remove the UHP end cap from the UHP tie rods. Slowly pull the end cap back about 51 mm (2 in.). Use two small pry bars in the groove between the high-pressure cylinder and the end cap to separate them. Be careful not to damage the plastic guide ring.
- 4. Remove the UHP cylinder, filler tube, seal carrier, and subplate adapter.

Check Valve Maintenance

- 1. Pry the check valve body from the end cap using two screwdrivers as shown.
- 2. Disassemble the check valve body assembly by removing the outlet poppet cage and the inlet screw.
 - The check valve body can be held in the rebuild clamp to remove the inlet screw.
 - The outlet poppet cage will be reused.





ITEM	DESCRIPTION	PART NUMBER
1	OUTLET POPPET CAGE	006101-1
2		013515-1

- 3. Assemble the inlet check valve as shown in the following figure. Position the components as follows:
 - Position of the conical spring: the large spring diameter must point towards the inlet poppet.
 - Position of the inlet seat: make sure that the chamfered holes point away from the poppet.



ITEM	DESCRIPTION	PART NUMBER
1	INLET SCREW	013515-1
2	CHAMFERED HOLES	
3	INLET SEAT	016896-1
4	INLET POPPET	002078-1
5	CONICAL SPRING	A-19088

4. Apply a small drop of LOCTITE 242 to the inlet screw threads. Be careful not to get any LOCTITE on any other component. Clean all excess LOCTITE from the threads. Set this assembly aside for the LOCTITE to dry while continuing with this procedure.



Apply LOCTITE 242 on threads only

- 5. Apply BLUE LUBRICANT to the threads of the outlet poppet cage.
- 6. Assemble the components of the outlet cage assembly as shown below.



ITEM	DESCRIPTION	PART NUMBER
1	OUTLET POPPET CAGE	006101-1
2	COMPRESSION SPRING	A-9636
3	OUTLET POPPET ASSY	014643-1
4	OUTLET SEAT	014641-1

7. Install the outlet cage assembly into the check valve body until it is hand tight.



8. Install the check valve body in the rebuild clamp as shown and then torque the outlet poppet cage to 81 N-m (60 ft-lb).





The rebuild clamp included with the toolkit is the preferred method to hold the check valve while torquing the outlet cage. If the clamp is unavailable, use a soft-jawed vise as a substitute.

9. Install the end cap seal, the new check valve seal, the new O-ring, and the retainer ring as shown. Lubricate the check valve seal and O-ring with FOOD GRADE GREASE. Install the components in the following order to prevent damage to the O-ring:



ITEM	DESCRIPTION	PART NUMBER
1	RETAINER RING	008014-1
2	O-RING	A-0290-028
3	CHECK VALVE SEAL	008015-1
4	END CAP SEAL	008016-1
5	FOOD GRADE GREASE	

10. Adjust the valve in the rebuild clamp so that the ASSEMBLY PINS have enough room to travel down below the surface of the inlet face hole.



ITEM	DESCRIPTION	PART NUMBER
1	ASSEMBLY PIN	A-21146-1

- 11. Install the rubber band (included in the check valve service kit) around the perimeter of the check valve body so that it covers the check valve body inlet holes.
- 12. Insert the assembly pins (included with the check valve service kit) down, through two opposing inlet face holes, as shown in the preceding figure. The pins stop against the rubber band and extend above the inlet face of the body.



The assembly pins orientate the inlet seat during the next steps.

13. Install the inlet components to the check valve body. Turn the inlet screw into the check valve body face approximately halfway.



14. Orientate the inlet seat by slowly turning the inlet seat counterclockwise until a click is heard to show that the assembly pins are indexing against the holes in the seat. At this point, the seat should not be able to rotate clockwise.

15. Finish hand tightening the inlet screw the rest of the way.



Be sure there is enough room for the assembly pins to drop below the inlet face hole surface after removing the rubber band.

- 16. Torque the inlet screw to 13.6 N-m (120 in-lb.).
- 17. Remove the clamp and the rubber band and then let the assembly pins drop out of the inlet holes. If the pins do not drop out, the inlet seat is misaligned or installed incorrectly, which binds the assembly pins. If the assembly pins bind, remove the inlet components, and do this procedure from Step 10.



18. Lubricate the O-ring (A-0275-032) with FOOD GRADE GREASE and then install it into the groove of the check valve body.



19. Set the check valve aside on a clean surface and repeat this process for the remaining check valves.

Seal Carrier Maintenance



ITEM	DESCRIPTION	PART NUMBER
1	SEAL CARRIER	013517-1
2	DYNAMIC SEAL	016170-1
3	U-CUP SEAL	A-10654
4	U-CUP INSTALL TOOL	009588-1

- 1. Remove the dynamic seal and U-cup seal.
- 2. Examine and clean the seal carrier. Make sure that the cooling ports are free of debris.
- 3. Manually install the dynamic seal fully against the shoulder of the seal carrier.
- 4. Use the U-cup seal installation tool and manually install the U-cup seal against the shoulder of the seal carrier. Make sure that the U-cup lip seal groove faces towards the tool.
- 5. Set the seal carrier aside on a clean surface and repeat this process for the remaining seal carriers.

Subplate Adapter Maintenance



1.	In the following order, remove the o-ring, snap ring and spacer, high pressure seal, bearing snap
	ring and the bearing assembly.

- 2. Examine and clean the subplate adapter. Make sure that the cooling ports are free of debris.
- 3. Install the bearing assembly. Make sure that the side of the bearing with the metal lip points away from the subplate adapter.
- 4. Install the bearing snap ring.
- 5. Use the HP seal installation tool (007725-2) to install the HP seal and press down until the tool bottoms out against the subplate adapter. Make sure that the metal side of the HP seal points away from the subplate adapter. Remove the tool.



- 6. Install the spacer and then snap ring.
- 7. Lubricate the O-ring with FOOD GRADE GREASE and install it into the groove of the subplate adapter.

PART NUMBER 013525-1

A-0275-030

009217-1

A-0265-086

A-9566

013540-1

A-0265-118

Install the Kit

	ITEM	DESCRIPTION	PART NUMBER
	1	ECV BODY	013412-1
Con g The The Top	2	ADAPTER	013425-1
	3	POPPET	013411-1
O D	4	SEAT	011901-1
	5	STATIC CAP SEAL	006738-1

- 1. Do the 'Load the Tie Rods' procedure.
- 2. Install the new ECV static cap seal onto the seat.
- 3. Lubricate all visible ECV O-rings with FOOD GRADE GREASE.
- 4. Apply BLUE LUBRICANT on the ECV body-to-manifold threads.
- 5. Install the ECV body, poppet, adapter, seat, and the static cap seal into the manifold hand tight.
- 6. While ensuring that the fitting on the adapter points down, tighten the ECV body to the manifold.
- 7. Apply BLUE LUBRICANT on threads of the ECV body.
- 8. Support the ECV housing from the bottom and install the ECV housing onto the ECV body. Turn the ECV housing onto the ECV body as far as possible by hand.

NOTICE During installation, support and rotate the ECV housing from the bottom. Use this method to get correct thread alignment and to prevent cross threading.

- 9. Use a spanner wrench in the holes in the rear of the ECV housing to tighten the ECV housing to the ECV body.
- 10. Connect the high-pressure water and ECV connections.
- 11. Connect the high-pressure water line to the manifold.
- 12. Connect the low-pressure water hoses to the manifold.
- 13. Connect the drain lines.
- 14. Remove tools, parts, and rags from around the pump.
- 15. Open the inlet water valve and do a check for leaks.



Failure to open the inlet water valve before starting the pump may cause severe damage to the pump.

- 16. Do the 'Calibrate the External Control Valve' procedure found later in this manual.
- 17. Run the pump at 690 bar (10,000 psi) for three minutes, then three minutes each at 1,379 bar (20,000 psi), 2,069 bar (30,000 psi), 2,758 bar (40,000 psi), 3,793 bar (55,000 psi) examining for leaks and heat.

Installing the Major Maintenance Kit

Install the minor maintenance kit every 150-service hours.

- Install all of the parts at the same time—do not replace components individually when doing scheduled maintenance.
- Clean all of the components before assembly. It is important to keep the work area clean while working on the equipment.
- Read the entire procedure before starting service, pay particular attention to safety instructions.

Prepare to Install the Kit

1. Do the 'Lockout/Tagout' procedure found in the 'Safety' section above.



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

2. Remove the three breather vents located on the top of the crankcase and replace them with the new ones (A-0857-2) included in the major maintenance kit.



- 3. Do the 'Unloading the Tie Rods' procedure.
- 4. Remove the UHP end cap from the UHP tie rods. Slowly pull the end cap back about 51 mm (2 in.). Use two small pry bars in the groove between the high-pressure cylinder and the end cap to separate them. Be careful not to damage the plastic guide ring.
- 5. Pry the check valve body from the end cap using two screwdrivers as shown.



- 6. Discard the check valves. The major maintenance kit includes new check valves.
- 7. Remove the HP cylinder, filler tube, seal carrier, and subplate adapter.

Pony Rod Replacement

1. Do Use the plunger installation tool to remove the three plungers.



- 2. Remove the subplate from the crankcase (eight hex screws).
- 3. Remove the pony rod pilots.

NOTICE If needed, 5/16-18 screws can be installed into the pony rod pilots to assist with removing them.

- 4. Remove the plunger adapter nuts from the pony rod adapters.
- 5. Remove the pony rod adapters. Use the pony rod adapter tools and steel nut. Assemble the tools into the pony rod adapter as shown.



ITEM	DESCRIPTION	PART NUMBER
1	PONY ROD ADAPTER	006069-1
2	PONY ROD TOOL	007738-1
3	PONY ROD TOOL	007737-1
4	3/8-16 STEEL NUT	A-0301-6

- Install the pony rod adapter tool B into the pony rod adapter.
- Slide the pony rod adapter tool A over the pony rod adapter tool B.
- Align the tongue of the pony rod adapter tool A with the groove in the pony rod adapter.
- Install the steel nut finger tight.
- Turn the pony rod adapter tool A to remove the pony rod adapters.

- 6. Remove the three pony rods from the pony rod adapters.
- 7. Install the three new pony rods into the wrist pins with the tapered end orientated into the crankcase and the machined flat end facing away from the crankcase.



ITEM	DESCRIPTION	
1	TAPERED END	
2	MACHINED FLAT END	

8. Install the new pony rod adapter O-rings. Make sure that the O-rings are fully in the grooves located inside of the pony rod adapters.



ITEM	DESCRIPTION	PART NUMBER
1	O-RING	A-0275-313
2	PONY ROD ADAPTER	006069-1
3	O-RING GROOVE	

9. Install the pony rod adapters. Apply LOCTITE 242 to the threads. Use the pony rod adapter tools and steel nut. Torque the pony rod adapters to 102 N-m (75 ft-lb).

NOTICE Only apply a very small drop of LOCTITE 242 to the threads.

10. Install the oil seals and O-rings on the pony rod pilots. Lubricate the O-rings with FOOD GRADE GREASE.



ITEM	DESCRIPTION	PART NUMBER
1	PONY ROD PILOT	013537-1
2	SEAL	A-11216
3	O-RING	A-0275-153

- 11. Install the pony rod pilots. Orientate the pony rod pilots so that the O-ring and oil seal points towards the crankcase and the side with the screw holes points away from the crankcase.
- 12. Apply SILVER ANTI-SEIZE to the subplate hex screws.
- 13. Install the subplate. Torque the hex screws to 169 N-m (125 ft-lb) in the sequence shown in the following figure.



- 14. Apply BLUE LUBRICANT to the adapter nut threads.
- 15. Install the plungers, springs, and adapter nuts to the pony rod adapters. Torque the adapter nuts to 95 N-m (70 ft-lb).



ITEM	DESCRIPTION	PART NUMBER
1	ADAPTER NUT	006068-1
2	SPRING	A-9412
3	PLUNGER	018020-1
Seal Carrier Maintenance



ITEM	DESCRIPTION	PART NUMBER
1	SEAL CARRIER	013517-1
2 DYNAMIC SEAL		016170-1
3 U-CUP SEAL		A-10654
4	U-CUP INSTALL TOOL	009588-1

- 1. Remove the dynamic seal and U-cup seal.
- 2. Examine and clean the seal carrier. Make sure that the cooling ports are free of debris.
- 3. Manually install the dynamic seal fully against the shoulder of the seal carrier.
- 4. Use the U-cup seal installation tool and manually install the U-cup seal against the shoulder of the seal carrier. Make sure that the U-cup lip seal groove faces towards the tool.
- 5. Set the seal carrier aside on a clean surface and repeat this process for the remaining seal carriers.

Subplate Adapter Maintenance



1.	In the following order, remove the o-ring, snap ring and spacer, high pressure seal, bearing snap
	ring and the bearing assembly.

- 2. Examine and clean the subplate adapter. Make sure that the cooling ports are free of debris.
- 3. Install the bearing assembly. Make sure that the side of the bearing with the metal lip points away from the subplate adapter.
- 4. Install the bearing snap ring.
- 5. Use the HP seal installation tool (007725-2) to install the HP seal and press down until the tool bottoms out against the subplate adapter. Make sure that the metal side of the HP seal points away from the subplate adapter. Remove the tool.



- 6. Install the spacer and then snap ring.
- 7. Lubricate the O-ring with FOOD GRADE GREASE and install it into the groove of the subplate adapter.

PART NUMBER 013525-1

A-0275-030

009217-1

A-0265-086

A-9566

013540-1

A-0265-118

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, the manufacturer's manuals may be needed. They are provided with the pump. The following symptoms are discussed in this section:

- High pressure line pulsation
- Knock in power end
- Water hammer
- Valve wear
- Packing failure

Before starting any procedure:

- Look for obvious problems.
- Read and understand each procedure.
- Make sure that the appropriate tools are available.
- Make sure that the appropriate parts are 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 Service Department for assistance.

	Malfunction	Indication	Check
1.	1. High pressure line	Suction supply line has been affected	Debris or scale back
	pulsation		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

- Plunger failure
- Oil wiper seal leakage
- Packing seal leakage
- Crankshaft oil seal leak

	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	Cavitation effects	Low supply line water pressure	
	hammer/wheezing		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		

High Dynamic Seal Temperature

If inlet water temperature is higher than the specification, dynamic seals fail prematurely.



The "Monitor" screen shows the data from the dynamic seal temperature sensors if equipped. There is a bar graph for each of the cylinder sensors The bar graph plots the temperature difference between given cylinder and the coldest cylinder.

When one dynamic seal is hot as compared to the others, it displays as the highest temperature. The cylinders normally run hotter than the inlet water temperature. An excessively hot seal temperature generates a dynamic seal temperature warning.

APS recommends that all three dynamic seals are changed when the pump displays an alarm because of a seal failure. A single new seal runs "cold" when compared to the two older seals and may show an error code when there is no reason to. The alarm is designed to help prevent a plunger failure, which is a far more expensive component than the dynamic seals.

Low Inlet Water Pressure



High Oil Temperature

Compare the oil temperature on the display to the temperature gauge on the oil reservoir site gauge.



Low Oil Pressure



Low or High Output Pressure



Water filter pressure cartridges dirty2 VES Replace cartridges Retest



Specifications

General

DIMENSIONS	65" H x 104" W x 47" D
DRY WEIGHT 5,350 LBS. (EST.)	
REQUIRED CLEARANCE	1 FT. ON ALL SIDES
SITE GRADE	LEVEL; SLOPE LESS THAN 8° FROM HORIZONTAL
MOUNTING TYPE	SKID FRAME

Standard Operating Parameters

OUTPUT PRESSURE	3,793 bar (55,000 PSI)
OUTPUT FLOW RATE	6.5 GPM @ 70 Hz
OUTPUT FLOW RATE	5.5 gpm @ 60 Hz

High Pressure Pump

TYPE	TRIPLEX, DIRECT DRIVE
HYDRAULIC LUBRICATION	FORCED
STROKE	1.4 IN.
PLUNGER DIAMETER	0.562 IN.
OIL	SHELL MORLINA S3 BA 100
LUBRICANT CAPACITY	40 GALLONS

Electric Motor

	WEG – W22 NEMA PREMIUM EFFICIENCY, 3 PH						
HORSEPOWER (HP)	125	1:	50	20	00	25	50
VOLTAGE (VAC)	380	230	460	380	460	380	460
FREQUENCY (HZ)	50	6	0	50	60	50	60
SPEED (RPM)	1480	17	'80	1475	1785	1480	1780
RATED CURRENT (A)	170	205	170	279	230	273	281
LOCKED ROTOR CURRENT (A)	1190	1190	1122	1423	1564	1665	1827
FRAME SIZE	444/5TS		445,	/7TS	447,	/9TS	
SERVICE FACTOR		1	1.25	1	1.15	1.15	1.15

Service Connections

FLUID END	40K	55K
INLET (CHARGE PUMP)	1" NPT	1" NPT
INLET (FLUID END)	-12 JIC	-12 JIC
OUTLET	3/8" HP (F)	5 MM TYPE-M (2X)
OUTLET	-	8 MM TYPE-M (1X)
COOLING LOOP	-06 JIC	-06 JIC

Component Identification

ELECTRIC UNIT



ITEM	DESCRIPTION	FUNCTION
1	VISUAL DISPLAY	PRIMARY USER INTERFACE WITH THE PUMP
2	WATER CHARGE PUMP	BOOSTS SUPPLY WATER PRESSURE TO THE UHP ASSEMBLY
3	HYDRAULIC FILTER BANK	FILTERS HYDRAULIC OIL (WATER REMOVAL / PARTICULATE)
4	HEAT EXCHANGER	REMOVES HEAT FROM HYDRAULIC OIL
5	INLET WATER FILTER	FILTERS WATER FROM THE INLET SOURCE
б	EXTERNAL CONTROL VALVE (ECV)	CONTROLS UHP OUTLET PRESSURE
7	HYDRAULIC OIL RESERVOIR	STORES OIL FOR THE CRANKCASE AND OTHER COMPONENTS
8	ACCUMULATORS	REDUCES CAVITATION ON CHECK VALVES
9	HIGH PRESSURE FLUID END	CREATES THE UHP OUTPUT
10	HIGH PRESSURE OUTLET	CONNECTION POINT FOR TOOLING
11	I/O PANEL	LOCATION FOR SENSOR WIRING POINTS
12	SAFETY VALVE	RELEASES PRESSURE OVER SET POINT
13	SIGHT GAUGE / THERMOMETER	VISUAL INDICATOR OF HYDRAULIC OIL LEVEL & TEMPERATURE
14	HYDARULIC CONTROL BLOCK	SETS LUBRICATION PRESSURE AND CONTAINS ECV CONTROL VALVE
15	ELECTRIC MOTOR	DRIVES THE PUMP
16	MOTOR STARTER (AS EQUIPPED)	CONTROLS THE ELECTRIC MOTOR START/STOP FUNCTIONS

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		
pН	-	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	6.9 BAR (100 PSI) MAX.
WATER SUPPLY FLOW RATE	10 GPM (HP & UHP FLUID ENDS) 25 GPM (LP FLUID ENDS)

Inlet Water Filtration

10 micron absolute

References

Engineering Drawings

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

Spare Parts

Fluid End Parts

DESCRIPTION	PART NUMBER	MAJOR KIT	MINOR KIT
SUBPLATE 55K HUSKY	013533-1		
SUBPLATE ADAPTER	013525-1		
SEAL CARRIER	013517-1	ЗX	
HP CYLINDER	013387-1	ЗХ	
CHECK VALVE ASSY, 55K	016863-1	3X	
END CAP ASSY, 55K	016862-1		
ACCUMULATOR	A-12749		
THERMISTOR	A-13262		
O-RING, BUNA-N. 90 DURO, -902	A-0274-1		
U-CUP SEAL, PUR, 3/4 ID	A-10654	ЗX	ЗX
DYNAMIC SEAL	016170-1	ЗX	ЗX
FILLER TUBE	017793-1		
PLUNGER BEARING	009217-1	ЗX	
BACKUP RING	006112-1	ЗX	ЗX
O-RING, HIGH RESILIENCY, -014	A-0290-014	6X	6X
GUIDE RING, HP CYLINDER	014252-1		
O-RING, BUNA-N. 70 DURO, -040	A-0275-040	3X	3X
RETAINING RING, INT, .866 IN.	A-0265-086	3X	
SHAFT SEAL, 9/16	A-9566	3X	
SPACER RING, LP SEAL	013540-1	3X	
RETAINING RING, INT, 13/16 IN.	A-0265-118	3X	
0-RING, BUNA-N. 70 DURO, -030	A-0275-030	ЗX	ЗX
PONY ROD SEAL CARRIER	013537-1		
SHAFT SEAL, 1-5/8	A-11216	ЗX	
PLUNGER ASSY	018020-1		
COMPRESSION SPRING, .90 OD	A-9412		
PLUNGER RETAINER NUT	006068-1		
PONY ROD ADAPTER	006069-1		
PONY ROD	014676-1	ЗX	
O-RING, BUNA-N. 70 DURO, -313	A-0275-313	ЗX	
O-RING, BUNA-N. 70 DURO, -153	A-0275-153	ЗX	
TIE ROD, 55K	013539-1		
WASHER, 7/8	A-9926		
MANIFOLD	016856-1		
STATIC SEAL	006738-1		
MANIFOLD INSERT	006114-1		
ADAPTER NUT, MANIFOLD	006113-1		
BOLT, HEX, 9/16"-18 X 2-3/4"	90-019-275		
BOLT, SHCS, 5/8"-11 X 3"	90-120-300		
NUT, HEX, 7/8"-14	90-625-000		
FLAT WASHER, 9/16"	90-818-000		

Maintenance Kits

MINOR MAINTENANCE KIT	014756-1	EVERY 150 HOURS
MAJOR MAINTENANCE KIT	018306-1	EVERY 600 HOURS
MAJOR MAINTENANCE PACKAGE	059563-1	1 MAJOR, 1 MINOR, 1 SPARES KIT
CHECK VALVE MAINTENANCE KIT	018624-1	INCLUDED IN MINOR KIT
ECV MAINTENANCE KIT	014490-1	INCLUDED IN MAJOR AND MINOR KIT
SAFETY VALVE REBUILD KIT	017086-3	INCLUDED IN MAJOR KIT
WATER FILTER ELEMENT	A-9935	
OIL PARTICULATE FILTER	A-18850	
WATER REMOVAL FILTER	A-18851	
SPARES KIT	015104-1	
STARTUP KIT	018625-1	
CRANKCASE BREATHER	A-7461	

Lubricants

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

Water Quality Test Kit

Water Test Kit	007851-1

Electronic Components

PRESSURE TRANSDUCER	11-001-001
TEMPERATURE TRANSDUCER	11-001-002
LEVEL/TEMP SENSOR	11-001-024
CONTROL SCREEN	11-001-017

Tools and Tool Kits

55K TOOLKIT	014757-1
LOADING TOOL	042512-2
LOADING TOOL OIL	A-24498-1
LOADING TOOL HOSE	A-245022
LOADING TOOL QD (MALE)	A-24496-2
LOADING TOOL QD (FEMALE)	A-24497-2
LOADING TOOL GAUGE	A-24500-2
LOADING TOOL ADAPTER	A-26017-1
LOADING TOOL O-RING	A-0275-039
LOADING TOOL BACKUP RING	A-0276-039
LOADING TOOL SEAL KIT	A-24501-1



	8			7			
	ITEM NO.	QTY.	PART NO.	DESCRIPTION			
	1	1	32-700-600	TRPLX UNIT-HUSKY, ELECTRIC, BASE			
	2	1	013503-1	HIGH PRESSURE ASSEMBLY, 55KSI, HUSKY			
G	3	1	33-001-045	ASSEMBLY, HIGH PRESSURE TUBING, E-HUSKY, 55K			
	4	1	33-995-017	DECAL, VINYL, 55K MAWP, MANIFOLD, HUSKY			
	5	3	33-995-018	DECAL, VINYL, 55K MAWP, END CAP, HUSKY			

FLOW ELECTRIC HUSKY

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В

PART NUMBER: 32-755-600 55,000 PSI MAXIMUM OPERATING PRESSURE ASSEMBLED BY ADVANCED PRESSURE SYSTEMS, TOMBALL, TX. PRIME MOVER: 200 HP ELECTRIC MOTOR

• 480VAC/60HZ/3PH, 1750 RPM

• 380VAC/50HZ/3PH, 1475 RPM FULL LOAD AMPS: 230 A @ 460 VAC, 273 A @ 380 VAC ESTIMATED WEIGHT: 5,000 LBS. (DRY) OIL CAPACITY: 20 GALLONS / USE SHELL MORLINA S3 BA 100



									C	JUT S. PERSIMMON	ESS OTHER	WISE SPECIFIED:	-
								AP	J	ALL DIMENSIONS ARE DIMS IN N	IN INCHES	S, INTERPRET PER ANSI Y14.5-200 OR REFERENCE ONLY	' THIRD ANG
	-		REVISIONS					SHAPE IEL	HNOLOGIES GROUP	BREAK SH TOLERA	harp edge NCES (EX	es and deburr .015 XCEPT AS NOTED)	_DWG BY
ZONE	REV.		DESCRIPTION		DATE	APPROVED		IE APS LOGO A		MACHINE S.F.	63/ D. 00	DIM TOLERANCES: (in) $X = \pm .063$	APRVD BY
	0		INITIAL RELEASE		11/16/2020	K. SMITH	INC. IN THE UN	ITED STATES ANI	D/OR OTHER COUNTRIES	ANGLE	±1°	$.XX = \pm .015$ $.XXX = \pm .005$ $.XXXX = \pm .0005$	REF. DWG.
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ZONE	REV.		DESCRIPTION		DATE	APPROVED		HE APS LOGO A			DIM TOLERANCES: (in) $X = \pm .063$	APRVD BY
	0		INITIAL RELEASE		11/16/2020	K. SMITH	INC. IN THE U	NITED STATES AN	D/OR OTHER COUNTRIES	ANGLE ±1°	$XX = \pm .015$ $XXX = \pm .005$ $XXXX = \pm .0005$	REF. DWG.
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Γ	ITEM NO.		PART NO.	DESCRIPTION	ITEM NO.		PART NO.	DESCRIPTION
Ī	1	1	31-700-016	WELDMENT, SKID, E-HUSKY	51	8	90-812-000	FLAT WASHER, 3/8"
Ī	2	1	200680-02	GAUGE, LIQUID LEVEL, ALUMINUM, 5 INCH	52	27	90-816-000	FLAT WASHER, 1/2"
G	3	1	202281-01	COVER, ACCESS, TOP FRONT, TANK, HISKY, 1.625 INCH	53	24	90-820-000	FLAT WASHER, 5/8"
Ī	4	1	A-7564	BREATHER, PRESSURIZED, 40 MICRON	54	8	90-822-000	FLAT WASHER, 3/4"
Ī	5	1	31-700-018	WLDMNT, BRKT, E-HUSKY, E-BOX/IO PANEL	55	2	10-950-201	HOSE CLAMP, T-BOLT, STAINLESS, 2-1/8" OD
Ī	6	1	31-700-019	WLDMNT, BRKT, E-HUSKY, HYD FLTR	56	2	99-050-009	SWIVEL, VIBR DAMP, LEVEL MOUNT, 3/4-10
Ī	7	1	33-995-041	LABEL, STICKER, ARROW, ROTATION	57	1	99-050-024	CLAMP, LOOP, 1" ID, VIBR DAMP
_	8	1	31-700-021	WLDMNT, BRKT, E-HUSKY, UHP SENSOR	58	4	99-050-025	STUD, VIBRATION DAMPING, 50 DUR, 5/16"-18 X 5/8"
	9	1	33-955-012	MTR-ELEC, 200 HP, 480/60, 448/9TS, F0, C-FACE	59	2	A-9768	FINGER GUARD, CHROME PLATED, 6 IN DIA
Ī	10	1	009688-1	ADAPTER, WELDMENT, ENG	60	1	33-995-001	LABEL, PLATE, WARNING, OIL ONLY
	11	1	009691	COUPLING;SHAFT;3 1/2 ID	61	1	33-995-003	LABEL, PLATE, SERVICE/SUPPORT
ľ	12	1	A-9695	SHAFT COUPLING, SPLIT, LOCKING	62	1	33-995-004	LABEL, PLATE, MODEL/SERIAL
F	13	1	A-10741	SHAFT COUPLING, FLEXIBLE, 4 INCH, 13 INCH	63	2	33-995-005	LABEL, STICKER, FLOW LOGO, TANK
	14	1	12-005-0204	FITTING, STRT, MNPT-MJIC, 02-04	64	1	33-995-010	DECAL, VINYL, WATER FILTER TAG
	15	1	12-005-0806.B	FITTING, STRT, MNPT-MJIC, 08-06.B	65	1	33-995-013	DECAL, VINYL, FILTER, WATER SEPERATOR
	16	1	12-005-0808	FITTING, STRT, MNPT-MJIC, 08-08	66	1	33-995-014	DECAL, VINYL, FILTER, PARTICULATE REMOVAL
	17	2	12-005-0808.B	FITTING, STRT, MNPT-MJIC, 08-08.B	67	1	33-995-036	LABEL, PLATE, E-HUSKY, BULKHEAD
_	18	1	12-061-1616.B	FITTING, 45, MNPT-MJIC, 16-16.B	68	1	33-001-003	ASSEMBLY, HYDRAULIC FILTER, HUSKY
	19	1	12-015-2424	FITTING, STRT, MSAE-FSAE, 24-24	69	1	33-001-020	ASSEMBLY, IO PANEL ENCLOSURE, HUSKY
Ī	20	1	12-016-0806	FITTING, STRT, MSAE-MJIC, 08-06	70	1	33-001-021	PUMP, EXT GEAR, 33CC, SAE-A, 11 TH 16/32 PTCH
	21	1	12-016-1616	FITTING, STRT, MSAE-MJIC, 16-16	71	1	33-001-042	ASSEMBLY, HEAT EXCHANGER, E-HUSKY
	22	4	12-027-0606.B	FITTING, STRT, FJIC-HOSE, 06-06.B	72	1	33-001-043	ASSEMBLY, WATER FILTER, E-HUSKY
E	23	4	12-027-0808.B	FITTING, STRT, FJIC-HOSE, 08-08.B	73	1	33-001-044	ASSEMBLY, CONTROL/RELIEF VALVE MANIFOLD, E-HUSKY
	24	2	12-027-1212.B	FITTING, STRT, FJIC-HOSE, 12-12.B	74	1	33-001-053	ASSEMBLY, CHARGE PUMP, E-HUSKY
	25	6	12-027-1616.B	FITTING, STRT, FJIC-HOSE, 16-16.B	75	1	A-19090-1	SENSOR, XDCR, 60 KSI, 0-10V
	26	1	12-033-0804	FITTING, 90, MNPT-MJIC, 08-04	76	1	52-500-001	TUBE, HIGH PRESSURE, 1/4 INCH, 60KSI, 27 IN LONG
	27	1	12-033-0808	FITTING, 90, MNPT-MJIC, 08-08	77	27 IN.	A-2883	TUBING, FLEX, 9/32"
_	28	1	12-044-1212	FITTING, 90, MSAE-MJIC, 12-12	78	1	22-008-001	COLLET ASSY, 1/4 HP ANTI-VIBE
	29	1	12-046-2424	FITTING, 90, MSAE-HOSE, 24-24	79	1	006122-6	CRANK CASE ASSY, E-HUSKY
	30	1	12-052-0404	FITTING, 90, MJIC-FJIC, 04-04	80	3	002839-1	SPACER, CYLINDER, MOUNTING PLATE, HUSKY, SS, 1.5"
	31	1	12-052-0606.SS	FITTING, 90, MJIC-FJIC, 06-06.SS	81	1	013410-1	VALVE ASSEMBLY, EXTERNAL CONTROL, HUSKY, 55KSI
	32	1	12-061-1616	FITTING, 45, MNPT-MJIC, 16-16	82	12	10-412-030	BOLT, HEX HEAD, M12X1.75MM X 30MM, CLASS 8.8
D	33	1	12-063-2424	FITTING, 45, MNPT-HOSE, 24-24	83	1	25-700-001	CPLG, LBE, PMP, HUSKY
	34	1	12-250-1205	PLUG, MNPT, HOLLOW HEX, 12	84	1	11-700-002	ASSEMBLY, CONTROL PANEL, E-HUSKY
	35	8	90-008-075	BOLT, HEX, 1/4"-20 X 3/4"	85	1	11-001-007	CORD GRIP, ALUM, 3/4"NPT, LIQ TIGHT
	36	1	90-012-075	BOLT, HEX, 3/8"-16 X 3/4"	86	48 IN.	13-006-2000.BLU	HOSE, PUSH-LOK, -6, BLUE, 250 PSI, PRK 801
	37	6	90-012-100	BOLT, HEX, 3/8"-16 X 1"	87	22 IN.	13-008-2000.BLK	HOSE, PUSH-LOK, -8, BLACK, 250 PSI, PRK 801
_	38	2	90-012-125	BOLT, HEX, 3/8"-16 X 1-1/4"	88	40 IN.	13-008-2000.BLU	HOSE, PUSH-LOK, -8, BLUE, 250 PSI, PRK 801
	39	4	90-016-100	BOLT, HEX, 1/2"-13 X 1"	89	26 IN.	13-012-2000.BLU	HOSE, PUSH-LOK, -12, BLUE, 250 PSI, PRK 801
	40	3	90-016-450	BOLT, HEX, 1/2"-13 X 4-1/2"	90	84 IN.	13-016-2000.BLU	HOSE, PUSH-LOK, -16, BLUE, 250 PSI, PRK 801
	41	8	90-017-125	BOLT, HEX, 1/2"-20 X 1-1/4"	91	1	13-700-003	HOSE KIT, HYD, E-HUSKY
ļ	42	8	90-020-150	BOLT, HEX, 5/8"-11 X 1-1/2"	92	1	A-10248	OIL, HYD, MORLINA 100, 55 GAL
С	43	16	90-020-175	BOLT, HEX, 5/8"-11 X 1-3/4"				
ļ	44	4	90-022-150	BOLT, HEX, 3/4"-10 X 1-1/2"				
	45	6	90-506-050.SS	BUTTON PHILIPS, #10-24 X 1/2" SS				



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90-622-000

90-708-000

90-710-000

90-712-000

90-808-000

NUT, HEX, 3/4"-10

NUT, NY-LOCK, 1/4"-20

NUT, NY-LOCK, 5/16"-18

NUT, NY-LOCK, 3/8"-16

FLAT WASHER, 1/4"

									701 S. PERSIMMON DR. TOM	MBALL, TX 77375	
									ALL DIMENSIONS ARE IN INCHE DIMS IN MM ARE F	ES, INTERPRET PER ANSI Y14.5-2009 OR REFERENCE ONLY	THIRD ANG
A				REVISIONS				SHAPE TECHNOLOGIES GROUP	BREAK SHARP EDG TOLERANCES (E	GES AND DEBURR .015 EXCEPT AS NOTED)	DWG BY
	ZONE	REV.		DESCRIPTION	DATE	APPROVED		THE APS LOGO ARE EITHER REGISTERED		DIM TOLERANCES: (in) $X = \pm .063$	APRVD BY
		0		INITIAL RELEASE	10/30/2020	K. SMITH	INC. IN THE U	NITED STATES AND/OR OTHER COUNTRIES	ANGLE ±1°	$.XX = \pm .015$ $.XXX = \pm .005$ $.XXXX = \pm .0005$	MATERIAL
			8	7	6		5		4	3	5



 NOTES: APPLY LOCTITE THREADLOCKER BLUE 242 TO THREADS TORQUE BOLTS TO 185 FT. LBS. APPLY THREAD SEALANT TO TAPERED PIPE THREADS ACCESS COVERS SHOULD BE INSTALLED PRIOR TO ASSEMBLY TO PREVENT CONTAMINANTION OF HYDRAULIC TANK, GREASE O-RINGS PRIOR TO INSTALLATION INCLUDED WITH CONTROLS PACKAGE 	G
	F
TAIL B LE 1 : 3 EN FOR CLARITY)	E
3 12-033-0808 3 12-005-0806.B 005-0808.B 5.B	D
	С
DETAIL C SCALE 1 : 3	В
TRPLX UNIT-HUSKY, ELECTRIC, BASE THIS DOCUMENT CONTAINS CONFIDENTIAL INFORMATION WHICH MAY BE CONTROLLED AND IS NOT TO BE DISCLOSED TO OTHERS FOR ANY PURPOSE NOT USED FOR MANUFACTURING PURPOSES WITHOUT WRITTEN PERMISSION FROM ADVANCED PRESSURE SYSTEMS. B. PARKER DWG. NO. 32-700-600 REV. 00 HEAT TREAT. SHT 2 OF 7	A





INC. IN THE UNITED STATES AND/OR OTHER COUNTRIES ANGLE

±1°

2	1

- 2. APPLY BLUE GOOP THREAD LUBRICANT TO THREADS PRIOR TO INSTALLATION

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	TRPLX UNIT-HUSKY, ELECTRIC, BASE									
	FORMATION T TO BE NOR LISED	JMENT CONTAINS CONFIDENTIAL INF CH MAY BE CONTROLLED AND IS NO SED TO OTHERS FOR ANY PURPOSE N	THIS DOCI WHIC	PROJECTION 🔶 🖵						
A	WRITTEN SYSTEMS.	ANUFACTURING PURPOSES WITHOUT SSION FROM ADVANCED PRESSURE S	FOR M/ PERMIS	K. SMITH						
) REV. 00	32-700-600	DWG. NO.	B. PARKER						
	SHT 4 OF 7	_								
		1		2						





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с	E E E E E E E E E E E E E E E E E E E	
В	REF. NO.HOSE SIZEFITTING 1LOCATION FROMFITTING 2LOCATION TOEST. OALCOLOR[1]-1612-027-1616.BBULKHEAD12-027-1616.BCHARGE PUMP INLET22 IN.BLUE[2]-1612-027-1616.BCHARGE PUMP OUTLET12-027-1616.BHEAT EXCHANGER INLET40 IN.BLUE[2]-1612-027-1616.BCHARGE PUMP OUTLET12-027-1616.BHEAT EXCHANGER INLET40 IN.BLUE	
_	IOI I	
A -	REVISIONS AUXANCED PRESSURE STREEM AUXANCES INTERPRET PER ANSI/14.5-200 DIMS IN MAR EFOR REFORMED ONLY BE REVISION APPROVED APS AND THE APS LOGO ARE EITHER REGISTERED MACHINE S.F. & DIM TOLERANCES (IN) APRVD BY B. PARKER DWG. NO. 32-700-600 F	REV.
F	NEW Description Date AT NOVED TRADEMARKS OF SHAPE TECHNOLOGIES MACHINE FILLETS R.02 X = ± .03 0 INITIAL RELEASE 10/30/2020 K. SMITH Inc. IN THE UNITED STATES AND/OR OTHER COUNTRIES MACHINE FILLETS R.02 X = ± .03 MATERIAL HEAT TREAT. SHT 7 OF 8 7 6 5 4 3 2 1	<u>00</u> F 7

			8	7						
	ITEM NO.	QTY.	PART NO.	DESCRIPTION						
	1	1	013533-1	SUBPL-55KSI HUSKY						
	2	3	013525-1	ADPTR-SUBPLATE, 55KSI						
G	3	3	013517-1	SEAL CARR-55KSI HUSKY						
	4	3	013387-1	CYL-HP, HUSKY, 55KSI						
	5	3	016863-1	VLV ASSY-CHK, 55KSI						
	6	3	016862-1	END CAP ASSY-55KSI						
	7	3	A-12749	ACCUMULATOR, BLADDER, 2600 PSI, 10 CU IN						
	8	3	A-13262	SENSOR, THERMISTOR, 10K OHM						
	9	3	A-0274-1	O-RING, BUNA-N, 90 (SHORE A)						
	10	3	A-10654	SEAL, U-CUP, PUR, 3/4 ID, 1 OD, 1/8 IN						
	11	3	016170-1	SEAL, DYN, 3/4 OD, HDS WHITE						
	12	3	017793-1	FLR TBE-55KSI						
F	13	3	009217-1	BRG-SLVE, PLGR, GRAPHITE						
	14	3	006112-1	RNG-B/U, MANF, LSP BLUE						
	15	6	A-0290-014	O-RING, DISOGRIN, HIGH RESILIENCY, -014						
	16	3	014252-1	GDE-RNG, HP CYL, 55KSI, HUSKY						
	17	3	A-0275-040	O-RING, BUNA-N, 70 (SHORE A), -040						
	18	3	A-0265-086	RETAINING RING, INT, SST, .866 IN						
	19	3	A-9566	SEAL, SHAFT, PTFE, 9/16 ID, 1-1/8 OD, .281 IN						
	20 3		013540-1	SPCR-RNG, LP SEAL, HUSKY, SST						
	21 3		A-0265-118	RETAINING RING, INT, SST, 13/16 IN						
	22 3		A-0275-030	O-RING, BUNA-N, 70 (SHORE A), -030						
Е	23	3	013537-1	ROD-PONY, 55KSI HUSKY, 3.24 IN LG						
	24 3 A		A-11216	SEAL, SHAFT, CRWA6, 1-5/8 ID, 2-3/8 OD, .395						
	25	3	018020-1	PLGR ASSY-CERAMIC, HUSKY						
	26	3	A-9412	SPRING, COMPR, SST, .576 ID, .900 OD						
	27	3	006068-1	NUT, RTNR, PLUNGER, HUSKY, SST						
	28	3	006069-1	ADAPTER, PONY ROD, HUSKY						
	29	3	014676-1	ROD, PONY, 55 KSI HUSKY, 4 IN LONG						
	30	3	A-0275-313	O-RING, BUNA-N, 70 (SHORE A), -313						
	31	3	A-0275-153	O-RING, BUNA-N, 70 (SHORE A), -153						
	32	12	013539-1	TIE ROD-END CAP, HUSKY, 55 KSI, 15-5 SST						
Ð	33	12	A-9926	WASHER, FLAT, HDND, STL, ZINC, 7/8						
	34	1	016856-1	MANF-WTR, END CAP, HUSKY, 55KSI						
	35	1	006738-1	SEAL, STATIC, 0.8405 ID, ALUM BRZ						
	36	1	006114-1	INSR-MANF,1.130 IN						
	37	1	006113-1	NUT, ADAPTER, MANIF, HUSKY, SST						
	38	6	90-019-275	BOLT, HEX, 9/16"-18 X 2-3/4"						
	39	8	90-120-300	BOLT, SHCS, 5/8"-11 x 3"						
	40	12	90-625-000	NUT, HEX, 7/8"-14						
	41	6	90-818-000	FLAT WASHER, 9/16"						
	42	2	12-200-0600.SS	PLUG, MSAE, 06.SS						
С	43	2	12-044-0606.SS	FITTING, 90, MSAE-MJIC, 06-06.SS						
-	44	1	12-044-0812.SS	FITTING, 90, MSAE-MJIC, 08-12.SS						
	45	1	12-016-0806.SS	FITTING, STRT, MSAE-MJIC, 08-06.SS						



								ADVANCED PRESSURE SYSTE 701 S. PERSIMMON DR. TOM	:MS IBALL, TX 77375	TITLE:
			REVISIONS					UNLESS OTHER	WISE SPECIFIED:	-
	ZONE	REV.	DESCRIPTION	DATE	APPROVED			ALL DIMENSIONS ARE IN INCHES DIMS IN MM ARE FO	S, INTERPRET PER ANSI Y14.5-2009 DR REFERENCE ONLY	THIRD ANG
A		F LEGACY FLOW REVISION		4/15/2015			TAPE TEGHNOLOGIES GROUP	BREAK SHARP EDGE TOLERANCES (EX	ES AND DEBURR .015 (CEPT AS NOTED)	DWG BY
		27	INITIAL RELEASE, APS VERSION	4/20/2020	K. SMITH		S LOGO ARE EITHER REGISTERED		DIM TOLERANCES: (in) .X = ± .030	APRVD BY
		28 UPDATED MANIFOLD BOLTS, SUBPLATE FITTINGS, TORQUE SPEC		4/26/2021	K. SMITH	INC. IN THE UNITED S	STATES AND/OR OTHER COUNTRIES	ANGLE ±1°	$.XX = \pm .010$ $.XXX = \pm .005$ $.XXXX = \pm .0005$	MATERIAL
		ŝ	7	6		5		4	3	



										ADVANCED PRESSURE SYST 701 S. PERSIMMON DR. TO	T EMS MBALL, TX 77375	TITLE:
				REVISIONS					UNLESS OTHE	RWISE SPECIFIED:	-	
	ZONE	ONE REV. DESCRIPTION				DATE	APPROVED	SHAPE TECHNOLOGIES GRC	ALL DIMENSIONS ARE IN INCHES, INTERPRET PER ANSI 114.5- DIMS IN MM ARE FOR REFERENCE ONLY			THIRD ANG
1		F	LEGAC	LEGACY FLOW REVISION		4/15/2015			BREAK SHARP EDO TOLERANCES (E	GES AND DEBURR .015 EXCEPT AS NOTED)	DWG BY	
		27	INITIAL REL	EASE, APS VERSION		4/20/2020	K. SMITH	APS AND TH	HE APS LOGO ARE EITHER REGISTERED		DIM TOLERANCES: (in) $X = \pm .030$	APRVD BY
		28	UPDATED MANIFOLD BOLTS, SUBPLATE FITTINGS, TORQUE S		ORQUE SPEC	4/26/2021	K. SMITH	INC. IN THE UN	ik trademarks of shape technologies NITED STATES AND/OR OTHER COUNTRIES	ANGLE ±1°	$.XX = \pm .010$ $.XXX = \pm .005$ $.XXXX = \pm .0005$	MATERIAL
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								-	ADVANCED PRESSURE SYST	EMS /BALL, TX 77375	TITLE:
			REVISIONS					iς –	UNLESS OTHER	WISE SPECIFIED:	
	ZONE	REV.	DESCRIPTION DATE		APPROVED		ALL DIMENSIONS ARE IN INCHES, INTERPRET PER ANSI YI DIMS IN MM ARE FOR REFERENCE ONLY			³⁰⁹ THIRD ANG	
٩		F	LEGACY FLOW REVISION	LEGACY FLOW REVISION 4/1					BREAK SHARP EDG TOLERANCES (E	es and deburr .015 XCEPT AS NOTED)	DWG BY
ľ		27	INITIAL RELEASE, APS VERSION		4/20/2020	K. SMITH	APS AND THE APS LOGO ARE EITHER REGISTERED			DIM TOLERANCES: (in) $X = \pm .030$	APRVD BY
		28	UPDATED MANIFOLD BOLTS, SUBPLATE FITTINGS, TORQUE SPEC		4/26/2021	K. SMITH	INC. IN THE UNITED STATES AN	ID/OR OTHER COUNTRIES	ANGLE ±1°	.XX = ± .010 .XXX = ± .005 .XXXX = ± .0005	MATERIAL
		8 7		6			- 5		4		}



		REVISIONS				2	ADVANCED PRESSURE SYSTEMS 701 S. PERSIMMON DR. TOMBA UNLESS OTHERWISE	LL, TX 77375 E SPECIFIED:	TITLE:	HIGH PRE	SSURE	ASSEMBLY,	55KSI, HUSKY	
ZC	NE REV.	DESCRIPTION	DATE	APPROVED		CHNOLOGIES GROUPA	ALL DIMENSIONS ARE IN INCHES, IN DIMS IN MM ARE FOR R	ITERPRET PER ANSI Y14.5-2009 REFERENCE ONLY	THIRD ANGLE PR		\rightarrow	THIS DOCUMENT WHICH MAY DISCLOSED TO	CONTAINS CONFIDENTIAL INFOR BE CONTROLLED AND IS NOT TO OTHERS FOR ANY PURPOSE NO	RMATION O BE R USED
^	F LEGACY FLOW REVISION 4/15/2015			BREAK SHARP EDGES A TOLERANCES (EXCE	IND DEBURR .015 EPT AS NOTED)	DWG BY	K. SMITH		FOR MANUFAU PERMISSION F	CTURING PURPOSES WITHOUT WE ROM ADVANCED PRESSURE SYS	RITTEN STEMS.			
	27	INITIAL RELEASE, APS VERSION	4/20/2020	K. SMITH	APS AND THE APS LOGO A	RE EITHER REGISTERED		DIM TOLERANCES: (in) $X = \pm .030$	APRVD BY	B. PARKER		DWG. NO.	013503-1	28 REV.
	27 INTIGE RELEASE, AT 3 VERSION 4/20/2020 28 UPDATED MANIFOLD BOLTS, SUBPLATE FITTINGS, TORQUE SPEC 4/26/2021		K. SMITH	INC. IN THE UNITED STATES AN	D/OR OTHER COUNTRIES	ANGLE ±1°	$.xx = \pm .010$ $.XXX = \pm .005$ $.XXXX = \pm .0005$	MATERIAL			HEAT TREAT.	S	SHT 4 OF 6	
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										ADVANCED PRESSURE SYSTI 701 S. PERSIMMON DR. TON	EMS //BALL, TX 77375	TITLE:
				REVISIONS					5		RWISE SPECIFIED:	
Ţ	ZONE	REV.		DESCRIPTION		DATE	APPROVED			DIMS IN MM ARE FO	OR REFERENCE ONLY	THIRD AND
А		F LEGACY FLOW REVISION		4/15/2015			Convocoales and P	BREAK SHARP EDG TOLERANCES (E	es and deburr .015 XCEPT AS NOTED)	DWG BY		
		27		INITIAL RELEASE, APS VERSION		4/20/2020	K. SMITH				DIM TOLERANCES: (in) $X = \pm .030$	APRVD BY
		28 UPDATED MANIFOLD BOLTS, SUBPLATE FITTINGS, TORQUE SPEC		4/26/2021	K. SMITH	INC. IN THE UNITED STATES A	ND/OR OTHER COUNTRIES	ANGLE ±1°	$.XX = \pm .010$ $.XXX = \pm .005$ $.XXXX = \pm .0005$	MATERIAL		
		8	3	7	6			5		4	3	

	HIGH PRESSURE ASSEMBLY, 55KSI, HUSKY								
E PR	OJECTION		THIS DOCI WHIC	THIS DOCUMENT CONTAINS CONFIDENTIAL INFORMATION WHICH MAY BE CONTROLLED AND IS NOT TO BE DISCLOSED TO OTHERE FOR ANY PURPOSE HOR LISED					
	K. SMIT	Н	FOR M/ PERMIS	FOR MANUFACTURING PURPOSES WITHOUT WRITTEN PERMISSION FROM ADVANCED PRESSURE SYSTEMS.					
	B. PARK	ER	DWG. NO.	013503-1		REV. 28			
			HEAT TREAT.	_	SHT 5	OF 6			
		2		1					



						ADVANCED PRESSURE SYSTEMS 101 S. PERSIMMON DR. TOMBALL, TX 77375		ASSEMBLY, 55KSI, HUSKY
		REVISIONS				UNLESS OTHERWISE SPECIFIED:		
Z	ONE REV.	DESCRIPTION	APPROVED		ALL DIMENSIONS ARE IN INCHES, INTERPRET PER ANSI Y 14.5-2009 DIMS IN MM ARE FOR REFERENCE ONLY	THIRD ANGLE PROJECTION \bigcirc	WHICH MAY BE CONTROLLED AND IS NOT TO BE DISCLOSED TO OTHERS FOR ANY PURPOSE NOR USED	
<u>م</u>	F	LEGACY FLOW REVISION	4/15/2015			BREAK SHARP EDGES AND DEBURR .015 TOLERANCES (EXCEPT AS NOTED)	DWG BY K. SMITH	FOR MANUFACTURING PURPOSES WITHOUT WRITTEN PERMISSION FROM ADVANCED PRESSURE SYSTEMS.
	27	INITIAL RELEASE, APS VERSION	K. SMITH	APS AND THE APS LOGO ARE EITHER REGISTERED M	ACHINE S.F. $63/$ DIM TOLERANCES: (in) XX = \pm 0.030	APRVD BY B. PARKER	DWG. NO. 013503-1 REV. 28	
	28	UPDATED MANIFOLD BOLTS, SUBPLATE FITTINGS, TORQUE SPEC	K. SMITH	INC. IN THE UNITED STATES AND/OR OTHER COUNTRIES	$\begin{array}{cccc} XX &= \pm & .010\\ \hline NGLE &\pm 1^{\circ} & $	MATERIAL	HEAT TREAT. SHT 6 OF 6	
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	ITEM NO.	QTY.	PART NO.	DESCRIPTION	
	1	1	006080-1	CRANK CASE, YELLOW, HUSKY	
	2	1	009689-1	PLATE, ADAPTER, CRANK CASE	
G	3	1	A-9308	BEARING, RADIAL, SPHERICAL, DBL ROW	
	4	1	A-9309	BEARING, RADIAL, SPHERICAL, DBL ROW	
	5	1	006078-1	Shaft, Crank Shaft, 6.2 Inch, steel	
	6	1	006088-1	SPACER, BEARING, HUSKY, STEEL	
	7	1	A-9310	BUSHING, TAPER, 3-3/16 IN ID, 4-5/8 IN OD	
	8	1	A-9391	BUSHING, TAPER, 2.5 IN ID, 3.75 IN OD	
	9	1	006086-1	CAP, BEARING, HUSKY	
	10	1	006089-1	COVER, CRANK CASE, HUSKY, YELLOW	
	11	1	006090-1	GASKET, CRANK CASE, HUSKY	
	12	3	007422-1	CONNECTING ROD ASSEMBLY, CRANK CASE, HUSKY	
F	13	6	008691-1	BUSHING, CON ROD, MODIF. S-200	
	14	3	006074-1	PIN, WRIST, HUSKY, 1-1/2 OD	
	15	3	006072-1	CROSS HEAD, WRIST PIN, HUSKY	
	16	1	A-9311	SEAL, OIL, CRWA1, VITON, 3-5/8 ID, 4-5/8 OD	
	17	1	25-700-001	CPLG, LBE, PMP, HUSKY	
	18	1	30-002-043	O-RING, 2-043 BUNA-N 70 DURO	
	19	1	30-002-168	O-RING, 2-168 BUNA-N 70 DURO	
	20	1	30-002-270	O-RING, 2-270 BUNA-N 70 DURO	
	21	1	A-10742	ADAPTER, CPLG, SAE 11.5	
	22	1	009690-1	FLYWHEEL, CRANK CASE, E-HUSKY	
Е	23	1	008661-1	GUIDE, FLYWHEEL, CRANK CASE, E-HUSKY	
	24	2	201706-12	CLAMP, SUPPORT, STEEL, 3/4 INCH	
	25	3	A-0857-2	BREATHER VENT, 1/4 NPT, SINTERED BRZ, 40 MIC	
	26	1	A-3438	GAUGE, LIQUID LEVEL, ALUM	
	27	1	A-7461	FILTER, AIR, BREATHER, 3-3/4 IN DIA	
	28	1	12-002-1208	FITTING, STRT, MNPT-FNPT, 12-08	
	29	1	12-009-1212	FITTING, STRT, FNPT-MSAE, 12-12	
	30	1	12-015-1208	FITTING, STRT, MSAE-FSAE, 12-08	
	31	1	12-016-1004	FITTING, STRT, MSAE-MJIC, 10-04	
	32	1	12-030-1212	FITTING, 90, MNPT-FNPT, 12-12	
D	33	1	12-033-0808	FITTING, 90, MNPT-MJIC, 08-08	
	34	1	12-044-0604	FITTING, 90, MSAE-MJIC, 06-04	
	35	1	12-100-0804	RUN TEE, MJIC-MSAE-MJIC, 08-08-04	
	36	1	12-104-1212	BRCH TEE, FNPT-FNPT-MNPT, 12-12-12	
	37	1	12-200-0600	PLUG, MSAE, HOLLOW HEX, 06	
-	38	2	12-250-0800	PLUG, MNPT, 08	
	39	1	12-250-1205	PLUG, MNPT, HOLLOW HEX, 12	
	40	12	90-012-075	BOLT, HEX, 3/8"-16 X 3/4"	
	41	3	90-016-275	BOLT, HEX, 1/2"-13 X 2-3/4"	
	42	6	90-020-225	BOLT, HEX, 5/8"-11 X 2-1/4"	
С	43	3	90-108-200	BOLT, SHCS, 1/4"-20 X 2"	
	44	12	90-812-000	FLAT WASHER, 3/8"	
	45	3	90-816-000	FLAT WASHER, 1/2"	
	46	6	90-820-000	FLAT WASHER, 5/8"	
	47	1	12-015-2424	FITTING, STRT, MSAE-FSAE, 24-24	
_	48	1	12-046-2424	FITTING, 90, MSAE-HOSE, 24-24	
	49	1	12-250-0205	PLUG, MNPT, HOLLOW HEX, 02	

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									<u> </u>	701 S. PERSIMMON DR. TON	MBALL, TX 77375	
							AP	5	UNLESS OTHER ALL DIMENSIONS ARE IN INCHE	THIRD ANG		
A	ZONE	REV.	DESCRIPTION		SHAPE TEC	CHNOLOGIES GROUP ^A	DIMS IN MM ARE FO BREAK SHARP EDG TOLERANCES (E)	DR REFERENCE ONLY ES AND DEBURR .015 XCEPT AS NOTED)	DWG BY			
		0	INITIAL RELEASE		5/14/2021	K. SMITH	APS AND TH	HE APS LOGO AI			DIM TOLERANCES: (in) $X = \pm .063$	APRVD BY
		1	ADDED 12-250-0205 TO SHEET 4		9/15/2021	K. SMITH	INC. IN THE UN	ITED STATES AND	D/OR OTHER COUNTRIES	ANGLE ±1°	$.XX = \pm .005$ $.XXX = \pm .005$ $.XXXX = \pm .0005$	MATERIAL
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[2	<u>2,5 X A-9308</u>)/	10-									
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	0			0	-(0060)	78-1)					
_							-(007422-1)3X [1,3) (008691-1)6X				-
		0									
					Ø			-(006088-1)			-
_							20		310)		-
								\sim	-(<u>A-9309</u>)	2	
				3 6		(006074-1) 7	> ((A-9310) 6	
	NOTES				006072	-1) 7 >					
	TORQUE BOLTS TO 70 FT. LBS. DF CHECK BEARING CLEARANCE / CHECK BEARING CLEARANCE / STEEL STAMP BOTH CONNECTIN APPLY LOCTITE THREADLOCKER PREHEAT TO TEMPERATURE OF 2 REMOVE LOCKING RING (IT IS S AND VERIFY BEARING CLEARAN PRE-LUBE BEARINGS, WRIST PINS	RY AT ASSEMBLY, MIN: 0.003", MAX: 0.006" IG ROD HALVES ON BEARING LOCK SIDE; NUMBER 1,2,3 FROM LEF 8 BLUE 242 TO THREADS, TORQUE TO 15 FT. LBS. 240°F ± 10°F FOR INSTALLATION OF PART A-9308 TO PART 006078-1 OFT AND EASILY DAMAGED), ADJUST BEARING, REINSTALL LOCKIN NCE PER MANUFACTURERS INSTRUCTION; SET LOCK TABS 5 AND CROSSHEADS AT ASSEMBLY	FT TO RIGHT 1 ING RING					- Ala			-(90-108-200)3X 4
							ADVANCED PRESSURE SYSTEMS 701 S. PERSIMMON DR. TOMBALL, TX 77375 UNLESS OTHERWISE SPECIFIED:	TITLE:	ASSEMBLY,	CRANK CASE, E-H	IUSKY
		REVISIONS					ALL DIMENSIONS ARE IN INCHES, INTERPRET PER ANSI Y14 DIMS IN MM ARE FOR REFERENCE ONLY	THIRD ANGLE PI		THIS DOCUMENT CONTAIN WHICH MAY BE CONT DISCLOSED TO OTHERS F	IS CONFIDENTIAL INFORMATION IROLLED AND IS NOT TO BE FOR ANY PURPOSE NOR USED
ZONE	REV.	DESCRIPTION	DATE	APPROVED		Shore rearingeodies and P	BREAK SHARP EDGES AND DEBURR .015 TOLERANCES (EXCEPT AS NOTED)	DWG BY	K. SMITH	FOR MANUFACTURING PERMISSION FROM AD	PURPOSES WITHOUT WRITTEN VANCED PRESSURE SYSTEMS.
	0	INITIAL RELEASE	5/14/2021	K. SMITH	APS AND T TRADEMARKS C	HE APS LOGO ARE EITHER REGISTERED DR TRADEMARKS OF SHAPE TECHNOLOGIES	MACHINE S.F. 63/ DIM TOLERANCES: (ii) MACHINE FILLETS R.02 .X = ± .030 .XX = ± .010		B. PARKER		06122-6 00
		ADDED 12-250-0205 TO SHEET 4	9/15/2021	K. SMITH	INC. IN THE UI	NITED STATES AND/OR OTHER COUNTRIES	ANGLE ±1° .XXX = ± .000 .XXXX = ± .000		2		SHT 3 OF 4

							ADVANCED PRESSUR 701 S. PERSIMMON D UNLESS	e Systems R. Tomball, TX 77375 Totherwise specified:	TITLE:
		REVISIONS			ALL DIMENSIONS ARE IN DIMS IN MM	INCHES, INTERPRET PER ANSI Y14.5-2009 ARE FOR REFERENCE ONLY			
ZONE	REV.	DESCRIPTION	DATE	APPROVED			TOLERAN	DWGBY	
	0	INITIAL RELEASE	5/14/2021	K. SMITH	APS AND TH	HE APS LOGO ARE EITHER REGISTERED	MACHINE S.F.	DIM TOLERANCES: (in)	APRVD BY
	1	ADDED 12-250-0205 TO SHEET 4	9/15/2021	K. SMITH	INC. IN THE UN	ITED STATES AND/OR OTHER COUNTRIES	ANGLE ±	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	MATERIAL



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	ITEM NO.	QTY.	PART NO.		DESCRIPTION						
	1	2	A-26688-1	FILTER H	ER HOUSING, HYDRAULIC, 18.4" LONG						
	2	1	12-014-2424	FIT	TING, STRT, MSAE-MSAE, 24-24						
	3	2	12-015-2412	FII	FITTING, STRT, MSAE-FSAE, 24-12						
	4	2	12-044-1212	FI	tting, 90, msae-mjic, 12-12						
F	5	1	A-18850	FILTER ELE	MENT, 5 MICRON, PARTICLE, 13 IN LG						
'	6	1	A-18851	FILTER ELEMEN	I, 40 MICRON, WATER REMOVAL, 13 IN LG						

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						APS AND THE APS LOG REGISTERED TRADEMARKS	O ARE EITHER OR TRADEMARKS		UNLESS OTHER ALL DIMENSION INTERPRET PER	RWISE SPECIFIED IS ARE IN INCHES ANSI Y 14,5-2009	TITLE:
A			REVISIONS			UNITED STATES AND/OR O	THER COUNTRIES				
ZC	ONE RI	REV.	DESCRIPTION	DATE	APPROVED						THIRD AND
		0	INITIAL RELEASE	5/29/2019	K. SMITH	THIS DOCUMENT CONTAINS CONFI WHICH MAY BE CONTROLLED	IDENTIAL INFORMATION AND IS NOT TO BE	FINISH	63	DIM IOLERANCES: (in) .X = \pm .063	DWG BY
		1	ADDED FILTER ELEMENTS, DETAIL	8/9/2019	K. SMITH	DISCLOSED TO OTHERS FOR ANY FOR MANUFACTURING PURPOSE	PURPOSE NOR USED	FILLETS	R.02	$.XX = \pm .015$	
		2	UPDATED SHEET FORMAT	4/16/2020	K. SMITH	PERMISSION FROM ADVANCED	PRESSURE SYSTEMS.	ANGLE	±1°	$.XXX = \pm .005$ $.XXXX = \pm .0005$	
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	ITEM NO.	QTY.	PART NO.	DESCRIPTION
	1	1	A-3478	HEAT EXCHANGER, SHELL/TUBE, 500 PSI
	2	2	12-002-2412	FITTING, STRAIGHT, MNPT-FNPT, 24-12
G	3	1	12-005-1616.B	FITTING, STRT, MNPT-MJIC, 16-16.B
	4	2	12-033-1212	FITTING, 90, MNPT-MJIC, 12-12
	5	1	12-316-0350.B	NIPPLE, 1" NPT, 3.5" LG, BRASS
	6	1	99-013-003	BALL VALVE, ON/OFF, MNPT-FNPT, 1/4", T-HANDLE
	7	1	99-013-010	BALL VALVE, ON/OFF, FNPT-FNPT, 1" NPT, T-HANDLE
	8	1	12-033-1616.B	FITTING, 90, MNPT-MJIC, 16-16.B

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NOTES: 1. APPLY THREAD SEALANT TO ALL TAPERED PIPE THREADS

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							ADVANCED PRESSURE SYSTEMS 701 S. PERSIMMON DR. TOMBALL, TX 77375 UNLESS OTHERWISE SPECIFIED:					ASSEMBLY, HEAT EXCHANGER, E-HUSKY			
			REVISIONS				ALL DIMENSIONS ARE IN INCHES, INTERPRET DIMS IN MM ARE FOR REFERENCE	PER ANSI Y14.5-2009 CE ONLY	THIRD ANGLE PR	OJECTION -		THIS DOCUME WHICH M DISCLOSED	IT CONTAINS CONFIDENTIAL INFORMATION AY BE CONTROLLED AND IS NOT TO BE O OTHERS FOR ANY PURPOSE NOR USED		
ZC	DNE I	NE REV. DESCRIPTION DATE APPROVED							TOLERANCES (EXCEPT AS NOTED)		DWG BY	K. SMITH		FOR MANUF PERMISSIO	
		0 INITIAL RELEASE 6/12/2020 K. SMITH				K. SMITH	SMITH APS AND THE APS LOGO ARE EITHER REGISTERED MACHINE S.F. 43 DIM TOLERANCES: (in)				APRVD BY	B. PARKER		DWG. NO.	33-001-042 REV. 01
(C6 1 CHANGED FITTING FROM 45 TO 90 8/12/2021 JFLORES				JFLORES	IRADEMARKS OR IRADEMARKS OF SHAPE IECHNOLOGIES MACHINE HILLEIS R.UZ XXX = ± .015 INC. IN THE UNITED STATES AND/OR OTHER COUNTRIES ANGLE ±1° XXXX = ± .005 XXXX = ± .005		MATERIAL			HEAT TREAT.	SHT 1 OF 1			
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	ITEM NO.	QTY.	PART NO.	DESCRIPTION	
	1	1	63-000-008	FILTER HOUSING, SS, 1.5" NPT, 1/4" GP, 30" CRTGE	NOTES:
	2	1	99-013-004	BALL VALVE, ON/OFF, MNPT-FNPT, 1/2" NPT	1. APPLY THREAD SEALANT TO ALL TAPERED PIPE THREADS
G	3	1	12-002-0804.B	FITTING, STRT, MNPT-FNPT, 08-04.B	2. ITEM SHIPPED LOOSE WITH CONTROLS PACKAGE (PART 11-001-001)
	4	1	12-002-2416.B	FITTING, STRT, MNPT-FNPT, 24-16.B	3. TIEM SHIPPED LOOSE WITH CONTROLS PACKAGE (PART 11-001-002)
	5	1	12-002-2412.B	FITTING, STRT, MNPT-FNPT, 24-12.B	
	6	1	12-030-0404.B	FITTING, 90, MNPT-FNPT, 04-04.B	
	7	1	12-033-1212.B	FITTING, 90, MNPT-MJIC, 12-12.B	
	8	1	12-033-1616.B	HITING, 90, MNPI-MJIC, 16-16.B	
	9		A-4309	VALVE, DRAIN COCK, ISU PSI, BRASS, I/4" NPI	
	10	4	A-9935	FILTER ELEMENT, TO MICRON, 20 IN LONG	
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					<u>(A-9935)</u> 4X
					$1 \times 12-002-2416 B$
D_					$1 \times 12 - 033 - 1616 B \longrightarrow$
С					$\square \square $
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В					(1) (12-002-0804.B) - (99-013-004)

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								5	ADVANCED PRESSURE SYSTE 701 S. PERSIMMON DR. TOM UNLESS OTHER	MS IBALL, TX 77375 WISE SPECIFIED:	TITLE:
									ALL DIMENSIONS ARE IN INCHE	S, INTERPRET PER ANSI Y14.5-2009 DR REFERENCE ONLY	THIRD AN
		REVISIONS			anare rea	INVEDGIES GROUP	BREAK SHARP EDG TOLERANCES (E)	es and deburr .015 (CEPT AS NOTED)	DWG BY		
ZONE	REV.		DATE	APPROVED	APS AND THE APS LOGO ARE EITHER REGISTERED				DIM TOLERANCES: (in) $X = \pm .063$	APRVD BY	
	0	INITIAL RELEASE		6/12/2020	K. SMITH	INC. IN THE UNITED STATES AND/OR OTHER COUNTRIES			ANGLE ±1°	$.XX = \pm .015$ $.XXX = \pm .005$ $.XXXX = \pm .0005$	MATERIAL
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						ADVANCED PRESSURE SYST 701 S. PERSIMMON DR. TO/ UNLESS OTHE	i ems MBALL, TX 77375 RWISE SPECIFIED:	TITLE:
						ALL DIMENSIONS ARE IN INCHI DIMS IN MM ARE F	ES, INTERPRET PER ANSI Y14.5-2009 FOR REFERENCE ONLY	THIRD ANC
^		REVISIONS			Shape reconditions	BREAK SHARP EDC TOLERANCES (E	GES AND DEBURR .015 EXCEPT AS NOTED)	DWG BY
	ZONE REV.	DESCRIPTION	DATE	APPROVED	APS AND THE APS LOGO ARE EITHER REGIS		DIM TOLERANCES: (in) $X = \pm .063$	APRVD BY
	0	INITIAL RELEASE	6/12/2020	K. SMITH	INC. IN THE UNITED STATES AND/OR OTHER C	OUNTRIES ANGLE ±1°	$.xx = \pm .015$ $.XXX = \pm .005$ $.XXXX = \pm .0005$	MATERIAL
-	8	7	6		5	4	3	



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SSEMBLY, CONTROL/RELIEF VALVE MANIFOLD, E-HUSKY						
GLE PROJECTION	THIS DOCUMENT CONTAINS CONFIDENTIAL INFORMATION WHICH MAY BE CONTROLLED AND IS NOT TO BE DISCLOSED TO OTHERS FOR ANY PURPOSE NOR USED					
K. SMITH	FOR MANUFACTURING PURPOSES WITHOUT WRITTEN PERMISSION FROM ADVANCED PRESSURE SYSTEMS.					
B. PARKER	DWG. NO.	33-001-044	3-001-044 REV			
	HEAT TREAT.		SHT 1	OF 1		
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					APS AND THE APS LOG	o are either Or trademarks		UNLESS OTHER ALL DIMENSION	INISE SPECIFIED IS ARE IN INCHES	TITLE:
					OF SHAPE TECHNOLOG	IES INC. IN THE	C	DIM'S IN [mm] ARI BREAK SHARP EDO	E REFERENCE ONLY GES & DEBURR .015	
		REVISIONS					TOLE	RANCES (E)	(CEPT AS NOTED)	
ZONE	REV.	DESCRIPTION	DATE	APPROVED	THIS DOCUMENT CONTAINS CONFIDENTIAL INFORMATION WHICH MAY BE CONTROLLED AND IS NOT TO BE DISCLOSED TO OTHERS FOR ANY PURPOSE NOR USED FOR MANUFACTURING PURPOSES WITHOUT WRITTEN	FINISH	03/	$X = \pm .063$	DWG BY	
	0	INITIAL RELEASE	6/12/2020	K. SMITH		FILLETS	R.02	$.XX = \pm .015$	APRVD BY	
A2	1	ADDED WASHERS FOR SPACING	2/23/2021	B. PARKER	PERMISSION FROM ADVANCED	PRESSURE SYSTEMS.	ANGLE	±1°	$.XXX = \pm .005$ $.XXXX = \pm .0005$	
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QTY	U/M	PART NUMBER	DESCRIPTION
1	EA	006738-1	STATIC CAP SEAL;END CAP
1	EA	011901-1	SEAT;ECV;DIESEL EAGLE
1	EA	013411-1	POPPET;55K ECV
1	ΕA	013412-1	BODY;55K ECV
1	ΕA	013413-1	BEARING ASSY;55K ECV
1	EA	013414-1	SEAL;PLUNGER;55K ECV
1	ΕA	013425-1	ADAPTER;55K ECV
1	ΕA	013427-1	HOUSING;55K ECV
1	ΕA	013428-1	PLUNGER;55K ECV
1	ΕA	013429-1	PISTON;55K ECV
1	ΕA	013430-1	CAP;HOUSING;55K ECV
1	ΕA	A-0275-128	O-RING;BUNA-N;70 DUR;N0.2-128
1	ΕA	A-0275-129	O-RING;BUNA-N;70 DUR;NO.2-129
1	ΕA	A-0275-208	O-RING;BUNA-N;70 DUR;NO.2-208
1	ΕA	010245-1	PLATE;SEPARATOR;MCV
1	ΕA	010246-1	CONNECTER;OIL;MCV
1	ΕA	A-00619-137	RING;RETAINER;INT;MEDIUM;1.375
7	ΕA	A-0857-1	VENT;BREATHER;BRONZE;1/8 NPT
1	ΕA	A-11264	BEARING;SLEEVE;1-1/8" BORE
6	ΕA	A-11319	SPRING;DIE;1";MEDIUM-HEAVY;RED
2	ΕA	A-00167-49	SEAL;U-PCKNG;5/32X5X5 9/16
1	ΕA	A-00619-600	RING;RETAINER;INT;MEDIUM;6.0"
1	ΕA	A-11322	CAPLUG;TAPERED;W-8
1	ΕA	A-32252-1	CAP;PET;RED;1 1/2 IN;1 IN LG
1	ΕA	200860-10	PLUG;TAPERED PLASTIC;.683
0	ΕA	A-2185	LUBRICANT;BLUE
1	EA	A-0308-10	NUT;HEX;S/L;STL;3/8-24