



STREAMLINE S30 WATERJET INTENSIFIER

OPERATION AND MAINTENANCE MANUAL



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KMT WATERJET SYSTEMS 2004



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SECTION 1

INTRODUCTION

1.1 Overview

The Streamline S30, specifically designed for integration into a waterjet cutting system, combines all the unique capabilities and advantages of waterjet cutting with the reliability, ease of operation and service support that have made KMT Waterjet Systems a leader in waterjet technology.

The S30 does not include a control panel or enclosure and will not run as a stand-alone unit. An electrical interface allows the system builder to supply all power, control and logic interface to the intensifier from the motion control panel. The entire cutting system can be operated and controlled from one location.

Table 1-1
Streamline S 30

Motor Horsepower Rating		Maximum Operating Pressure	Maximum Flow Rate (at full pressure)	Maximum Single Orifice Diameter (at full pressure)
HP	Kw			
30	22	60,000 psi (4,137 bar)	0.52 gpm (2.0 L/min)	0.010 inch (0.254 mm)

The S30 is available with a single or redundant intensifier. The redundant unit allows operation to continue if a problem is detected on the active intensifier. Operation can be switched to the secondary intensifier until the next convenient shutdown, when service can be performed on the primary intensifier.

1.2 Performance Features and Options

The S30 is designed with the same convenience and ease of access for maintenance and service you have come to expect from KMT Waterjet. The hydraulic cylinder head simply bolts to the hydraulic cylinder; each high pressure assembly can be removed and serviced independently, and the hydraulic seal cartridge can be quickly replaced as a single unit.

The robust performance and standard features are the result of aggressive development and decades of experience.

- Continuous operation at 60,000 psi (4,137 bar).
- The innovative hard seal end cap provides a metal-to-metal seal against the sealing head, totally, eliminating the potential for leaks.
- While dramatically increasing seal life, the unique design of the patented HyperLife™ seal conforms to the cylinder bore as it expands under pressure, creating an absolute seal.

- Each long, slow stroke of the plunger moves more water, while reducing seal and component wear.

The following options are available at the time of purchase, or as upgrades for existing equipment.

- A booster pump and low pressure water filter ensure water quality and supply to the high pressure system.
- A safety dump valve instantly releases high pressure from the system.
- The individual cables in the electrical wiring harness are attached to terminal blocks inside the optional junction box.
- Proportional pressure control provides remote control of hydraulic operating pressure.

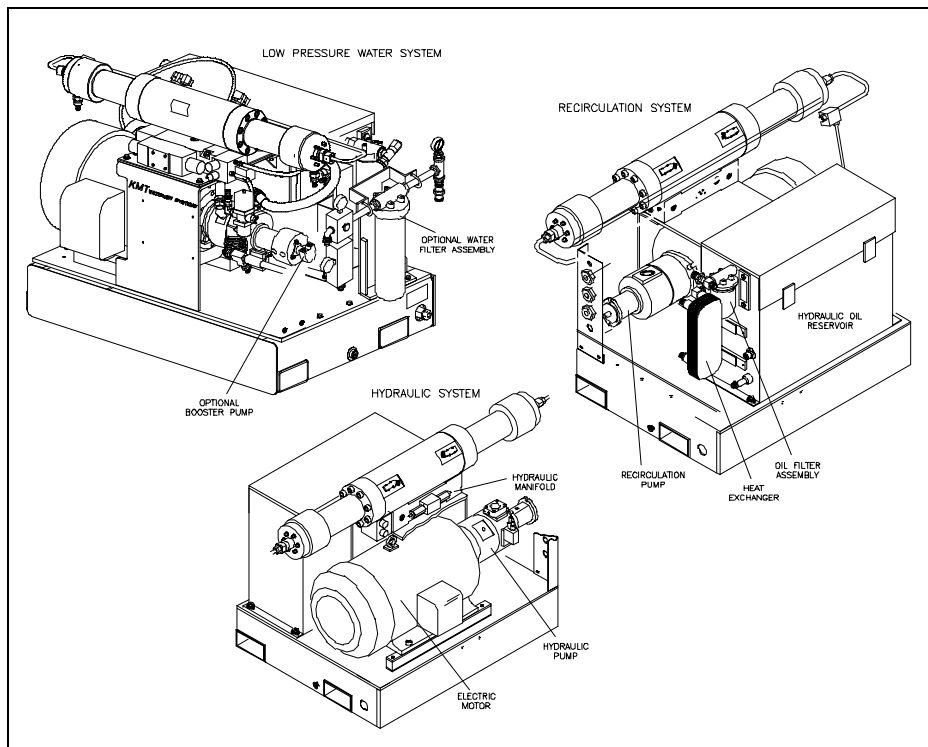
1.3 Operational Overview

The following provides a brief overview of the function and primary components associated with the individual systems. A detailed discussion of each system is provided in Sections 4 through 8. Equipment specifications are provided in Section 10, Specifications.

Low Pressure Water System

The low pressure water system supplies the cutting water flow to the intensifier. The optional booster pump and low pressure water filter assembly enhance performance and allow the pressure of the cutting water supply to be monitored.

Figure 1-1: System Components



Recirculation System

The recirculation system is a cooling and filtration system that provides properly conditioned oil to the main hydraulic system. Major system components include the recirculation pump, heat exchanger, oil filter assembly and the hydraulic oil reservoir.

Hydraulic System

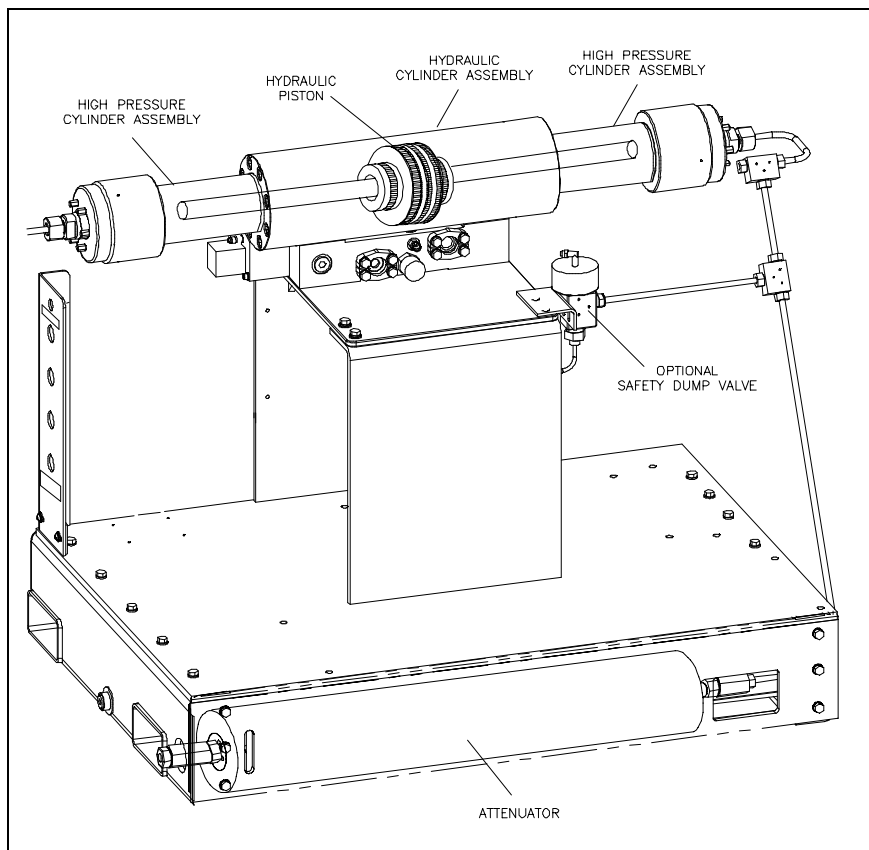
The hydraulic system supplies the intensifier with the hydraulic oil required to produce high pressure water. Major system components include the electric motor, hydraulic pump, and the 4-way directional control valve mounted on the hydraulic manifold.

High Pressure Water System

The high pressure water system is the heart of the waterjet system. Water is pressurized and continuously delivered to the cutting head. As water passes through a tiny hole in the orifice, water pressure is converted to water velocity capable of cutting most any material.

The major components include the high pressure cylinder assemblies, hydraulic cylinder assembly, hydraulic piston, attenuator and the optional safety dump valve.

Figure 1-2: High Pressure System Components




1.4 Safety

The high pressure waterjet cutting system is a high energy cutting tool capable of cutting many dense or strong materials. Do not touch or be exposed to high pressure water. 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.

All personnel operating, servicing or working near the waterjet cutting equipment shall adhere to the following safety precautions, as well as the applicable plant safety precautions.

- Only KMT factory trained, qualified personnel shall service and maintain the equipment.
- The operator shall practice and promote safety at all times to avoid potential injury and unnecessary downtime.
- The operator shall ensure that the work area around the equipment is clean and free of debris and oil spills.
- All protective guards, shields or covers shall be in place on the equipment at all times.

-  Safety glasses and ear protection shall be worn when operating or working near the equipment.

Lockout/Tagout Procedure

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.

The lockout/tagout procedure applies to any employee who operates and/or performs service or maintenance on the machine. Before any maintenance or repairs are performed, the machine shall be isolated, and rendered inoperative as follows.

1. Shut down the machine and open the high pressure cutting water valve to bleed the water and hydraulic pressure from the system.
2. Disconnect, lockout and tag the main, customer supplied, power source.

3. Close, lockout and tag the manual shutoff valves for all service connections: cutting water in, cooling water in and out, and air.

Warning Labels

Warning labels are posted on the machine to indicate potential hazards. The operator and service personnel shall pay particular attention to these warning labels. Table 1-2 describes the necessary precautions and provides the part number required to order replacement labels.

Table 1-2
Warning Label Precautions




1		The electric motor and optional junction box can present an electrical shock hazard. Always disconnect and lockout the main power before performing any type of maintenance.
2		The surface of high pressure water and hydraulic components becomes hot during normal operation. Failed, or failing components, can become extremely hot during operation.
3		High pressure water and/or hydraulic pressure can remain in the system even when the pump has been shut off. All pressure can be safely bled from the system by opening the high pressure cutting water valve for a few seconds after shutting off the pump.

Table 1-2
Warning Label Precautions

4



All personnel involved in the installation, operation and/or service of the intensifier must carefully read, understand and follow the procedures in this manual to avoid creating unsafe conditions, risking damage to the equipment, or personal injury.

P/N 20415794

Safety precautions and warnings for specific procedures are emphasized throughout this manual as illustrated in the following examples. These precautions must be reviewed and understood by operating and maintenance personnel prior to installing, operating or servicing the machine. Adherence to all Warnings, Cautions and Notes is essential to safe and efficient service and operation.



Warnings emphasize operating or service procedures, or conditions that can result in serious personal injury or death.



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

NOTE

Notes provide additional information that can expedite or improve operating or service procedures.



Emergency Medical Treatment

An emergency medical card is included in the binder of this manual. This information should be used to aid in the treatment of a waterjet injury. Additional cards may be obtained by contacting KMT Waterjet Systems using the address or telephone number shown on the card.

Medical Alert

This card is to be carried by personnel working with high pressure waterjet equipment. Obtain medical treatment immediately for ANY high pressure waterjet injuries.

KMT Waterjet Systems
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This person has been working with water jetting at pressures to 60,000 psi (414 MPa, 4137 bar, 4,218 Kg/cm²) with a jet velocity of 3,000 fps (914 mps). Foreign material (sand) may have been injected with water. Unusual infections with microaerophilic organisms occurring at lower temperatures have been reported, such as gram negative pathogens as are found in sewage. Bacterial swabs and blood cultures may therefore be helpful. This injury must be treated as an acute surgical emergency and be evaluated by a qualified surgeon. Circulation may be compromised, therefore, **DO NOT APPLY HEAT TO INJURED PART**. For first aid: (1) Elevate injured part (2) Antibiotics (3) Keep injured person NPO.

1.5 Worldwide Product Support

The KMT Waterjet Customer Service Department is available to answer your questions regarding equipment installation and service. Technical assistance is available by phone and on-site support is available on request.

On-site technical assistance is available during equipment installation and startup. Additionally, technical support for service and maintenance issues and training of operators and maintenance personnel is available. Periodic training sessions are also conducted at KMT Waterjet and customer facilities.

Contact the KMT Waterjet Customer Service Department for additional information.

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1.6 Spare Parts

KMT Waterjet maintains a well-stocked Spare Parts Department, staffed by trained, knowledgeable personnel. If required, emergency shipment is available. Contact the Customer Service Department to order spare parts, or for additional information.

1.7 Manual Organization

This manual contains operating and maintenance procedures for the Streamline S30. Information is organized as follows:

NOTE

The procedures, guidelines and parts list included in this document pertain only to the factory installed components from KMT Waterjet Systems. Modifications or additions made by the system builder are not addressed.

- Section 1, Introduction, provides an overview of equipment features and options, a brief operational overview, details regarding safety issues and contact information for product support.
- Section 2, Installation, details installation requirements and procedures. Guidelines for commissioning the intensifier are also provided.
- Section 3, Maintenance, highlights routine and preventive maintenance requirements. Precautions associated with high pressure cutting equipment are also reviewed.
- Sections 4 through 8 are specific to each individual system. Each section contains a detailed description of the principles of operation and the function of each system. Routine maintenance procedures associated with the system are also detailed.
- Section 9, Troubleshooting, is a comprehensive guide containing the information required to diagnose problems and repair the machine.
- Section 10, Specifications, contains a comprehensive list of equipment specifications; a detailed discussion of water quality standards and treatment guidelines; as well as horsepower requirements for various orifice sizes.
- Section 11, Parts List, contains part numbers, descriptions and drawings to facilitate the ordering of replacement parts.

1.8 Equipment and Service Manual Questionnaire

We are interested in your impression of the KMT Waterjet System recently installed at your location. Your comments and recommendations will aid us in our continuing goal to improve our products, and make our technical information more useful to our customers.

At your convenience, please take a few minutes to complete the following questionnaire, and return it to the applicable Customer Service Department listed above.



Equipment and Service Manual Questionnaire

1. General Appearance

Was the unit received in good condition?

☐ Yes ☐ No

Comments: _____

Is the unit a convenient size?

☐ Yes ☐ No

2. Controls

Are the controls user friendly?

☐ Yes ☐ No

Is the unit easy to operate?

☐ Yes ☐ No

Comments: _____

3. Performance

Does the unit perform smoothly and meet your expectations?

☐ Yes ☐ No

Does the unit run quietly?

☐ Yes ☐ No

Comments: _____

4. Did the installation and startup go smoothly?

☐ Yes ☐ No

Comments: _____

5. What features do you consider the most significant?

Quiet operation _____

Appearance _____

Performance/Operation _____

Repair/Maintenance _____

Other _____

6. What areas could be improved?

Appearance _____

Performance _____

Serviceability _____

Other _____



7. Manual Organization

Does the Table of Contents help you find topics easily? ☐ Yes ☐ No

Comments: _____

Is the information well organized? ☐ Yes ☐ No

Comments: _____

Is the page layout suitable for the material being presented? ☐ Yes ☐ No

Comments: _____

8. Graphics

Are the illustrations suitable for the material being presented? ☐ Yes ☐ No

Comments: _____

9. Text

Does the information adequately explain how to operate and service the equipment? ☐ Yes ☐ No

Comments: _____

Are there paragraphs or procedures you feel need clarification? Please identify them by page number and add your comments. ☐ Yes ☐ No

Comments: _____

Is there anything you would add or delete to make the manual more useful? ☐ Yes ☐ No

Comments: _____

Is there any information that should receive more emphasis? ☐ Yes ☐ No

Comments: _____

Name	_____	Title	_____
Company	_____	Date	_____
Address	_____		



SECTION 2

INSTALLATION

2.1 Overview

Installation and commissioning requirements and procedures are detailed in this section. These procedures require a thorough understanding of the individual components and systems, safety issues, and the overall operation of the intensifier.

All personnel involved in the installation, operation and/or service of the intensifier must carefully review this manual prior to installing and commissioning the machine.

The Technical Service Department at KMT Waterjet Systems is available to assist in the installation and commissioning process. Service and repair training for maintenance personnel is also available.

2.2 Installation Summary

The following summary lists the procedures required for the installation and commissioning of the intensifier system. Details and requirements for each item are discussed in this section.

- Properly sized power drops with fused disconnects or circuit breakers, and properly sized starting components must be installed.
- Plumbing and manual shutoff valves for the inlet and outlet cooling water, and the inlet and outlet cutting water must be installed.

Incoming source water must meet specific water quality standards, flow rates and pressure requirements. It may be necessary to install water conditioning and/or pressure boosting equipment to meet these water purity and pressure requirements.

- High pressure tubing runs from the intensifier to the cutting station must be installed with the appropriate mountings, support brackets and hardware.
- Wiring must be installed and connected between the intensifier and the cutting station control system.
- If the unit is equipped with an optional booster pump or dump valve, drain water plumbing must be suitably located and installed for the proper disposal of wastewater.
- If the unit is equipped with an optional dump valve, a pneumatic drop with a manual shutoff valve and regulator for the air connection must be installed.
- The machine must be commissioned and tested.

2.3 Site Requirements

The intensifier must be installed indoors where air borne dust and contaminants are minimal. The ambient temperature should be between 40° F (5° C) and 104° F (40° C), with a maximum relative humidity of 95 percent.

Refer to Table 2-1, Equipment Dimensions and Weight, to establish a suitable installation site. A minimum clearance of 36 inches (914 mm) should be provided on all sides of the machine to facilitate service.

Figure 2-1: Equipment Dimensions

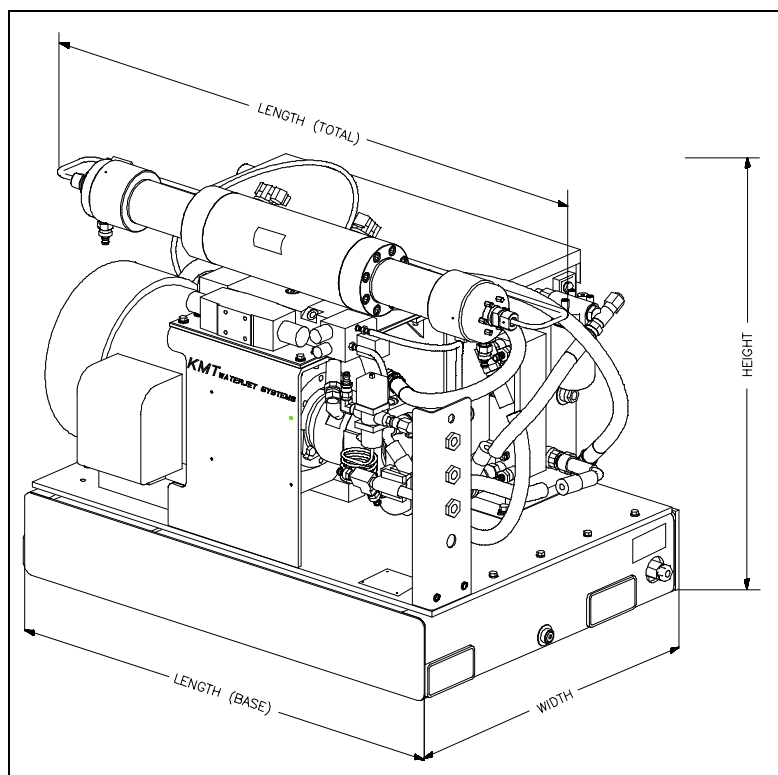


Table 2-1
Equipment Dimensions and Weight

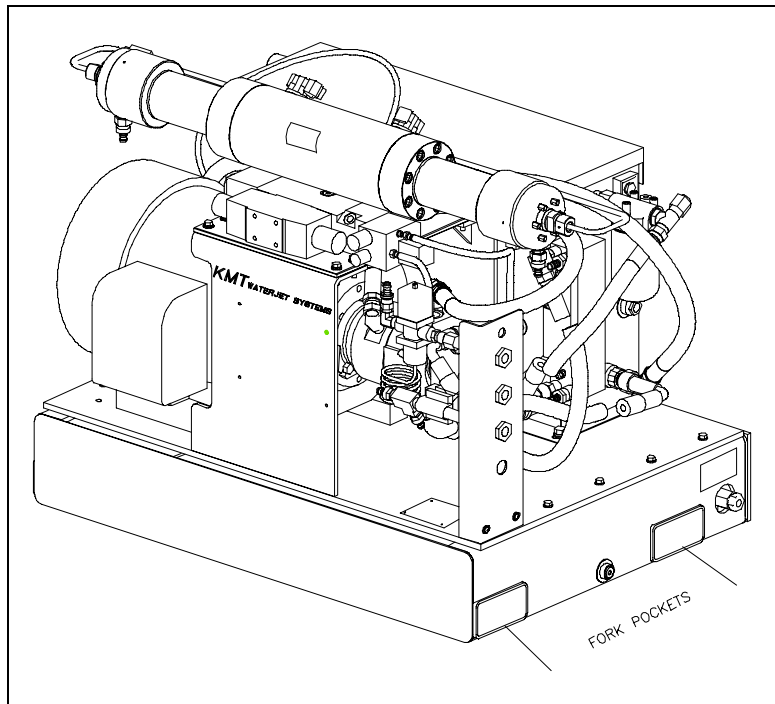
Total Length	Base Length	Width	Height	Weight
53.50" (1,359 mm)	44.00" (1,117 mm)	32.39" (823 mm)	37.00" (940 mm)	1,750 lbs (794 kg)
<i>Redundant Model</i>				
	39.07" (992 mm)	28.25" (718 mm)		2,030 lbs (921 kg)

Transporting

The weight of the machine is not evenly distributed from one end to the other. Note the warnings stamped on the crate. The center of gravity is clearly identified on the sides of the crate. 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. The pockets are positioned in relationship to the center of gravity to balance the weight on the forklift.

Figure 2-2: Fork Pockets



The machine **must** be lifted from the bottom. **Do not** attempt to lift the machine from the intensifier.

2.4 Power Requirements

Power supplied to the pump and wiring for remote control must comply with local, regional and national electrical codes. Service voltage and ampacity must meet the requirements detailed in Table 2-2. Voltage fluctuations in excess of +/- 10 percent of nominal voltage may damage the machine and void the warranty.

Table 2-2
Ampacity and Power Voltage Requirements

Power Voltage	Motor Horsepower	Full Load Amps	Recommended Circuit Breaker Amps
208/3/50-60	30	86	125
230/3/60	30	76	100
400/3/50	30	43	60
415/3/50	30	43	60
460/3/60	30	38	50
575/3/60	30	32	40

2.5 Service Connections

The intensifier requires two incoming water sources, cooling water and cutting water; a drain line for cooling water and a high pressure discharge line. A drain line for wastewater is required for units equipped with an optional dump valve or booster pump. The optional dump valve also requires an air supply line. All piping must comply with local, regional and national codes.

With the exception of the wastewater drain line, manual shutoff valves should be installed for all connections. To facilitate service, the valves should be located as close as practical to the interface connection.



Thoroughly purge all supply plumbing prior to connection to remove any residue that could contaminate the system.

Figure 2-3: Service Connections

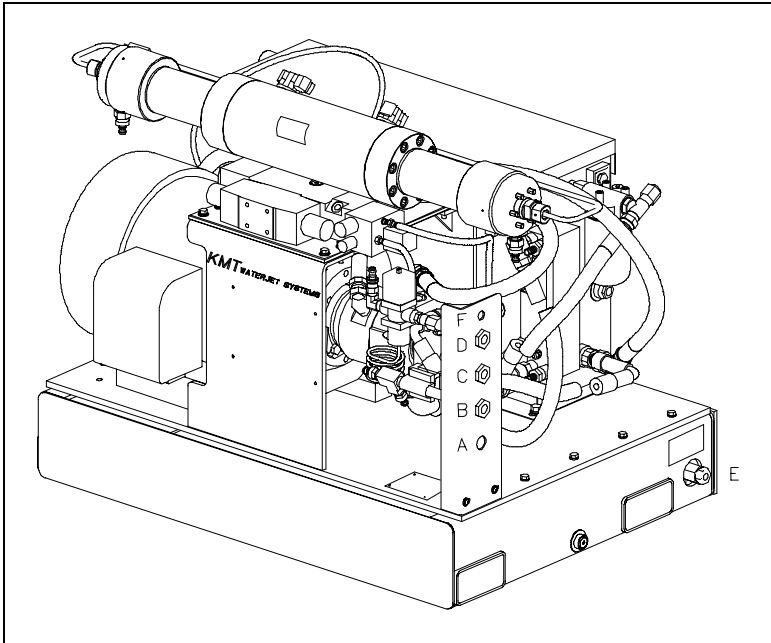


Table 2-3
Service Connections

A	Drain, optional*	1/2" NPT Connection
B	Cutting Water In	1/2" NPT Connection
C	Cooling Water Out	1/2" NPT Connection
D	Cooling Water In	1/2" NPT Connection
E	Cutting Water Out	9/16" HP Connection
F	Plant Air, optional**	1/4" NPT Connection

* Supplied with optional booster pump or dump valve

** Supplied with optional dump valve

Cooling Water

Inlet cooling water flows through the oil-to-water heat exchanger in the hydraulic system to control heat buildup in the hydraulic oil. The cooling water is then discharged through the cooling water out port to either the drain or routed to a customer supplied water chiller.

Cooling water supply piping must be sized to meet the flow and pressure requirements of the equipment. If municipal or well water is used for cooling, ensure the supply flow and pressure meet the requirements in Section 10, Specifications.

If a facility-wide chilled water system is used for cooling, ensure there is a minimum of 35 psi (2.4 bar) pressure differential between the facility supply and discharge plumbing. Installation of an in-line pressure boosting pump may be necessary to provide adequate cooling flow.

Cutting Water

Inlet cutting water is routed to the intensifier where it is pressurized and delivered to the cutting head. The cutting water supply must meet the minimum water quality standards outlined in Section 10, Specifications. Poor water quality will drastically shorten component life and void the warranty.

Cutting water supply piping must be sized to meet the flow and pressure requirements listed in Section 10. Only PVC, copper or rubber hose should be used between the cutting water source and the machine.

The inlet cutting water on base units must be maintained at a minimum pressure of 60 psi (4 bar) at all times. If the facility water pressure is below, or can fall below 60 psi (4 bar), a water pressure booster pump is required.

NOTE

If the machine is equipped with the optional booster pump and water filter, the inlet water must be maintained at a minimum pressure of 35 psi (2.4 bar) at all times.

Optional Drain

Cutting water released through the optional safety dump valve or the relief valve on the booster pump is discharged from the drain port. The discharge is considered wastewater and must be piped to an appropriate location, i.e. a sewer line. The volume of water released will be minimal and does not require high pressure plumbing, however, piping must comply with local, regional and national codes.

Optional Plant Air

The facility compressed air connection should provide clean, dry air regulated to 85 psi (5.9 bar). Air usage is minimal, normally less than 1 scf/m.

2.6 Flow Requirements

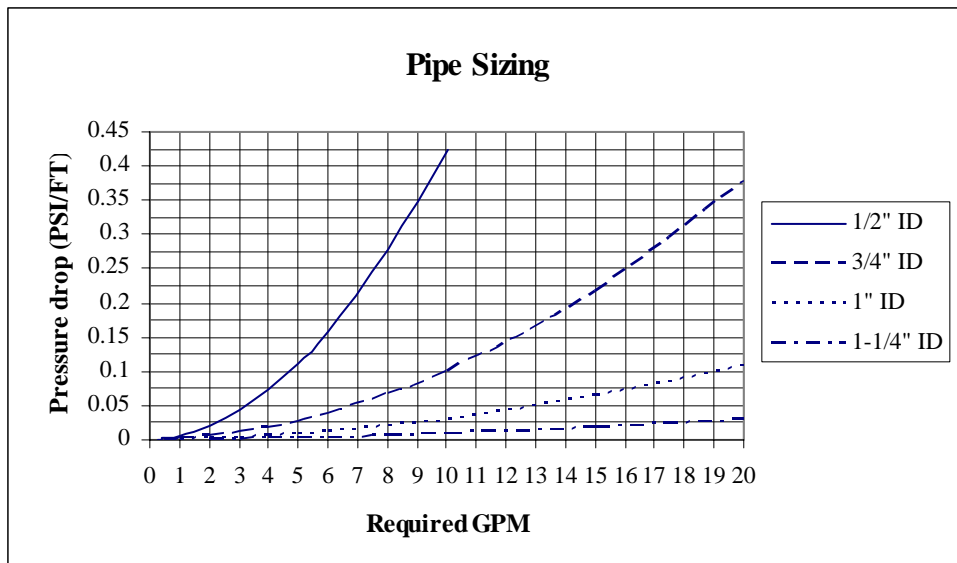
Figure 2-4, Pressure Drop Values, illustrates the pressure drop for four different pipe sizes. The graph can be used to calculate the minimum source water pressure.

1. Enter the graph at the required GPM and note the pressure drop figures for the different pipe sizes.

2. Multiply the pressure drop (PSI/FT) by the length in feet of each pipe size used from the water source to the intensifier. Add the values together for a total pressure drop value.
3. Add 30 to the total pressure drop to determine the minimum flowing, source water pressure required to provide adequate supply to the intensifier.

Cutting water and cooling water capacity should be calculated separately. Note that the cutting water requirements represent instantaneous, not average, demand.

Figure 2-4: Pressure Drop Values



2.7 High Pressure Piping

High pressure piping is used to transport high pressure cutting water from the machine to the cutting station. High pressure piping and fittings must be properly rated and sized. When transporting high pressure water over long distances, tubing and fittings with an outside diameter of 9/16-inch are recommended. The large tubing size reduces vibration, strain and motion; as well as reducing pressure drop and pulsation.



High pressure tubing and fittings must be rated for 60,000 psi (4,136 bar). Failure to use properly rated components may result in component failure causing equipment damage, personal injury or death.

High pressure tubing lengths must be coned and threaded prior to installation. KMT Waterjet provides both hand and power tools for coning and threading high pressure tubing. Tool descriptions and part numbers are provided in Table 2-4.



Table 2-4
Coning and Threading Tools

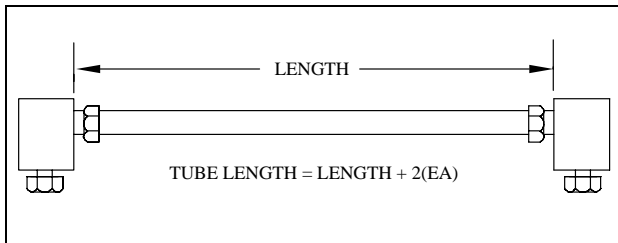
	Part Number	
	Hand Tools	Power Tools
1/4" Coning Tool	05108832	05109897
3/8" Coning Tool	05108857	05109889
9/16" Coning Tool	05108840	05109871
1/4" Threading Tool	05108865	05122742
3/8" Threading Tool	05108873	05120258
9/16" Threading Tool	05108881	05122759
1/4" Tube Vise	05108782	
3/8" Tube Vise	05108790	
9/16" Tube Vise	05108774	

Measurements and Dimensions

Tubing must be cut to the proper length, both ends of the tubing must then be coned, threaded and deburred.

To determine the tube length, measure the distance between the fittings, and add two times the engagement allowance shown in Table 2-5. Table 2-6 lists the required cone and thread dimensions illustrated in Figure 2-6.

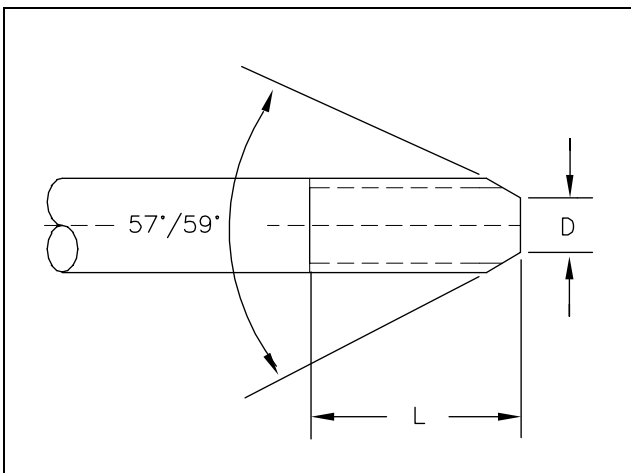
Figure 2-5: Tube Length



**Table 2-5
Engagement Allowance (EA)**

1/4" Tubing	0.49" (12.4 mm)
3/8" Tubing	0.68" (17.3 mm)
9/16" Tubing	0.86" (21.8 mm)

Figure 2-6: Cone and Thread Dimensions

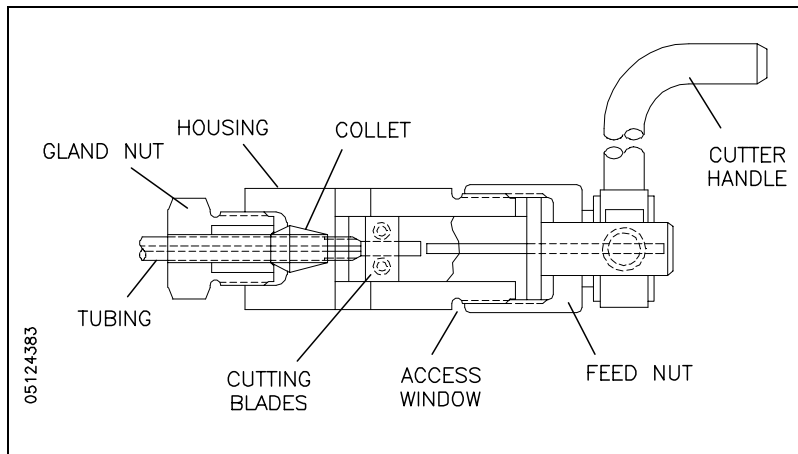


**Table 2-6
Cone and Thread Dimensions**

Tube OD	Tube ID	D (Maximum)	L (Maximum)	Thread UNF-LH
1/4" (6.35 mm)	0.083" (2.11 mm)	0.125" (3.2 mm)	0.562" (14.3 mm)	1/4" - 28
3/8" (9.52 mm)	0.125" (3.18 mm)	0.219" (5.6 mm)	0.750" (19.1 mm)	3/8" - 24
9/16" (14.29 mm)	0.188" (4.78 mm)	0.281" (7.1 mm)	0.938" (23.8 mm)	9/16" - 18

Hand Coning

Figure 2-7: Hand Coning Tool



1. Place the body of the coning tool in a vise allowing adequate clearance for the rotation of the cutter handle. Position the tool so the cutter handle is elevated slightly so the lubricant will flow to the cutting blades.
2. Turn the feed nut counter-clockwise to retract the cutting blades past the access window.
3. Loosen the gland nut and insert the tubing through the collet. The end of the tubing should just make contact with the cutting blades. Loosely tighten the gland nut to slightly grip the tubing.
4. Turn the feed nut counter-clockwise 1/4 turn to retract the cutting blades away from the tubing, and tighten the gland nut with a wrench.
5. Apply a liberal amount of cutting oil to the exposed end of the tubing, the cutting blades and through the lubrication channel at the cutter handle.

Apply cutting oil frequently and liberally throughout the cutting operation. A medium weight cutting oil with high sulfur content is recommended.

6. Turn the feed nut clockwise until the cutting blades contact the end of the tubing.
7. In a smooth, continuous motion, turn the cutter handle in a clockwise direction. Simultaneously turn the feed nut in a clockwise direction to establish a constant feed. Do not remove too much material at once; the cutting blades should make light, uninterrupted cuts.

NOTE

Before interrupting the cut, back the cutter blades away from the tubing. Use compressed air or a small brush to remove the accumulation of chips from the blades and the tubing throughout the coning operation.

8. Continue the operation until the feed nut bottoms on the housing. Turn the cutter handle several more rotations to face-off the end of the cone.
9. Retract the cutter blades, loosen the gland nut and remove the tubing. Inspect the cone for surface finish and completeness.

NOTE

Clean the machining chips from the blade and from the collet before coning the next tube.

Power Coning

1. Secure the tubing in a tube vise. No more than the recommended length of tubing should extend beyond the face of the vice. See Table 2-7, Recommended Extension Length.
2. Mount the coning tool in a 3/8-inch or 1/2-inch, variable speed power drill. Apply cutting oil to the end of the tube and slide the coning tool on the tubing.
3. Apply steady pressure against the end of the tubing while the cone is being cut.

Apply cutting oil frequently and liberally throughout the cutting operation. A medium weight cutting oil with high sulfur content is recommended.

4. The tool will stop cutting when the tube angle and facing is complete.

NOTE

Clean the machining chips from the blade and body of the tool before coning the next tube.

Table 2-7
Recommended Extension Length

1/4" Tubing	1.25-1.50" (31.8-38.1 mm)
3/8" Tubing	1.25-1.50" (31.8-38.1 mm)
9/16" Tubing	1.75-2.00" (44.5-50.8 mm)

Hand Threading

1. Secure the coned tubing in a tube vise. No more than the recommended length of tubing should extend beyond the face of the vice. See Table 2-7, Recommended Extension Length.
2. Apply cutting oil to the end of the tube and slide the threading tool on the tubing.
3. Grip the handles of the tool firmly, apply steady pressure and turn the tool counter-clockwise. Approximately every half turn, reverse direction to break off and remove the chips.

Apply cutting oil frequently and liberally throughout the cutting operation. A medium weight cutting oil with high sulfur content is recommended.

4. Continue threading until the proper thread length is reached, see Table 2-6, Column L. Remove the tool from the end of the tubing.

NOTE

Clean the machining chips from the die and body of the tool before threading the next tube.

Power Threading

1. Secure the coned tubing in a tube vise. No more than the recommended length of tubing should extend beyond the face of the vice. See Table 2-7, Recommended Extension Length.
2. Mount the threading tool in a 3/8-inch or 1/2-inch, variable speed power drill. Apply cutting oil to the end of the tube and slide the threading tool on the tubing.
3. Make sure the drill is set to turn counter-clockwise. Apply steady pressure against the end of the tubing while the threads are being cut.

Apply cutting oil frequently and liberally throughout the cutting operation. A medium weight cutting oil with high sulfur content is recommended.

4. Continue threading until the proper thread length is reached, see Table 2-6, Column L. Reverse the direction of the drill and remove the threading tool.

NOTE

Clean the machining chips from the die and body of the tool before threading the next tube.

2.8 High Pressure Connections

When installing high pressure discharge piping it is essential that all burrs be carefully removed and the tubing sections purged with clean compressed air prior to assembly. Lightly spraying the inside of the tube with a carrier fluid, such as WD-40, before purging with air will help carry the burrs.

High pressure piping must be installed without torsional or bending stresses and proper supports and guides must be provided. Torsional stress will cause premature component failure.

Pure Goop anti-seize compound must be applied to the threads and contact surfaces of all stainless steel components prior to assembly. Failure to lubricate components with Pure Goop will result in galling, rendering the components useless.

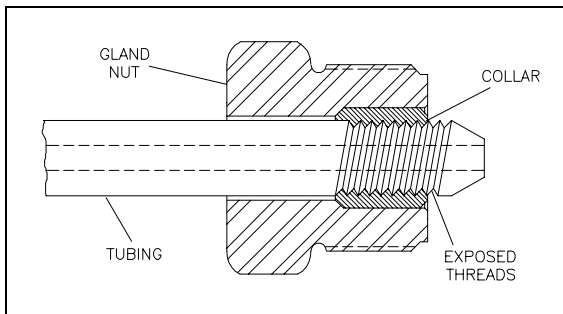


Do not use any other anti-seize compound. Apply Pure Goop **only to stainless steel** components.

Standard Connections

Standard connections are used for general applications where internal pressure is the only load on the tubing.

Figure 2-8: Standard High Pressure Connections



1. Deburr the tubing ID and thoroughly clean the tubing threads.

2. Slip the gland nut onto the tubing.
3. Apply Pure Goop to the threads on the tubing. Screw the collar onto the threaded end of the tubing leaving 1-1/2 to 2-1/2 threads exposed on the tubing between the collar and the coned tubing.
4. Apply Pure Goop to the male threads on the gland nut and insert the tubing into the connection. Engage the gland nut and tighten finger tight.
5. Tighten the gland nut to the torque specifications in Table 2-8.



Proper piping supports and guides must be provided. End connections will not support the tubing load alone.

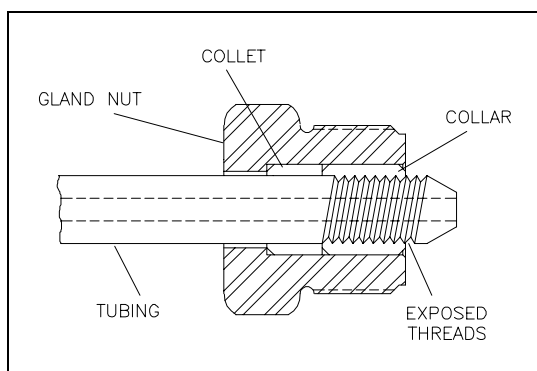
Table 2-8
Torque Specifications
High Pressure Connections

1/4" Tubing	25 ft-lb (34 Nm)
3/8" Tubing	50 ft-lb (68 Nm)
9/16" Tubing	110 ft-lb (149 Nm)

Anti-Vibration Connections

The bending stresses resulting from excessive vibration or shock on the threaded area of the tubing can cause premature failure at the back of the thread. When tubing will be subjected to vibration, rotation and movement, anti-vibration connections must be used. The anti-vibration collet gland transfers the stress to the unthreaded section of the tubing, and the gripping action of the collet strengthens the entire assembly.

Figure 2-9: Anti-Vibration Connections



1. Deburr the tubing ID and thoroughly clean the tubing threads.
2. Slip the gland nut and the collet onto the tubing.
3. Apply Pure Goop to the threads on the tubing. Screw the collar onto the threaded end of the tubing leaving 1-1/2 to 2-1/2 threads exposed on the tubing between the collar and the coned tubing.
4. Apply Pure Goop to the male threads on the gland nut and insert the tubing into the connection. Engage the gland nut and tighten finger tight.
5. Tighten the gland nut to the torque specifications in Table 2-8.

When a flexible whip is used to allow cutting nozzle movement, anti-vibration fittings and proper supports and guides must be provided to prevent failures from non-water related stresses. The whip will only flex in a single plane without being subjected to torsional stress. The use of high pressure swivels is strongly recommended.

2.9 Commissioning

When the machine has been positioned, all service connections installed, and the high pressure plumbing has been installed to the cutting area, the machine is ready to be commissioned.



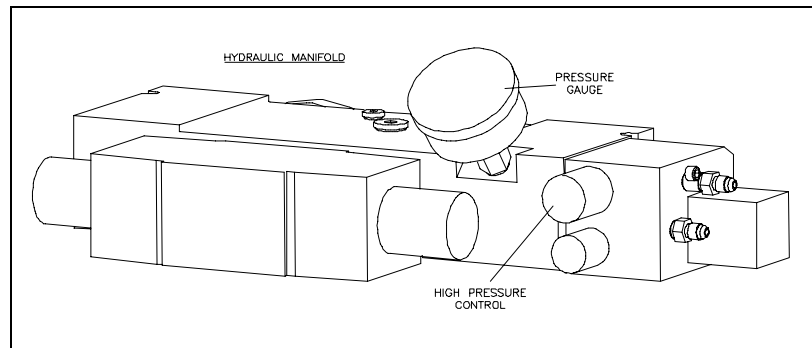
If normal operating pressure will not exceed 50,000 psi (3,447 bar), the alternate inlet poppet valve must be installed before proceeding. Follow the procedure Low Pressure Inlet Check Valve, Section 8, High Pressure Water System. Refer to Table 11-4, Section 11, Parts List.

The following procedure is used for the initial startup and testing of the machine.

1. Check all areas in and around the pump for foreign objects and debris. Remove all tools, parts, etc. from the area.
2. Check the hydraulic fluid level. The hydraulic system is pre-filled prior to shipping. If the hydraulic fluid is low or empty due to leakage during transit, the system must be filled. Follow the instructions in Section 5, Recirculation System.
3. Prior to shipping, a plug was installed in the breather location on the reservoir. Remove the plug and install the breather.
4. Open the shutoff valves on the service connections and check for leaks.
5. Check the connection between the customer supplied, main power disconnect and the machine. Verify the proper voltage supply. Turn the control power on and select low pressure operation.

6. To avoid a sudden increase in pressure, it is necessary to adjust the high pressure setting. The high pressure adjustment is made at the high pressure control valve on the hydraulic manifold. Refer to Section 6, Hydraulic System, for additional information.

Loosen the locking nut on the high pressure control valve by turning counter-clockwise. Turn the high pressure control valve counter-clockwise, decreasing the pressure to the lowest setting.



If the machine is equipped with proportional pressure control, the high pressure adjustment is made from the controller.

7. Check the motor rotation. Start the motor and observe the pressure gauge on the hydraulic manifold. If the motor rotation is correct, pressure will begin to build in just a few seconds. If the rotation is not correct, the gauge will not move.

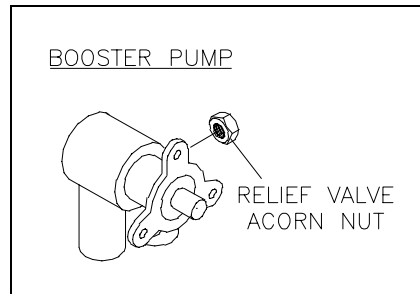
If the motor shaft is rotating in the wrong direction turn the control power off. The electrical power phase must be reversed to any two motor leads. The leads can be reversed at the electric motor, or at the main power disconnect.



Do not allow the motor to run backward. Incorrect motor rotation will result in damage to the hydraulic pump.

8. Remove the cutting orifice and open the nozzle valve.
9. Activate the control power and start the motor. Run the machine in low pressure for approximately five minutes with the orifice removed to purge the system.
10. Check for any leaks in the plumbing, or around the high pressure cylinders. If leaks are detected, stop the machine and correct any problems.
11. If the pump is equipped with an optional booster pump, observe the pressure gauge on the outlet manifold to ensure the discharge cutting water pressure is between 90-120 psi (6-8 bar). If not, the booster pump pressure must be adjusted. Refer to Section 4, Low Pressure Water System, for additional information.

Remove the acorn nut on the side of the booster pump and use a flat blade screwdriver to turn the adjustment screw. Turn the screw clockwise to increase the pressure or counter-clockwise to decrease the pressure.



12. Install a large, inexpensive orifice and start the machine.
13. Select high pressure operation. Increase the high pressure setting in gradual increments, checking for leaks at each interval. Continue increasing the pressure until the operating pressure is reached.

The high pressure setting is increased by turning the high pressure control valve on the hydraulic manifold clockwise, or from the controller if equipped with proportional pressure.

NOTE

It is strongly recommended that the high pressure plumbing be purged under high pressure operating conditions, using a large, inexpensive orifice. Contamination can be released when the tubing expands under pressure. Early orifice failures could be experienced if the piping is not adequately purged.

2.10 Decommissioning

All local regulations must be adhered to when the intensifier is decommissioned and taken out of service for any reason.



SECTION 3

MAINTENANCE

3.1 Overview

The S30 has been designed to fail safely. Systems fail gradually; seals and connections can begin to leak slowly or suddenly through specially designed weep holes. Water or oil dripping from a weep hole indicates internal seals or valves are beginning to fail, a warning that maintenance will be required.

3.2 Maintenance

The waterjet system has been designed for ease of maintenance and long, reliable operation. In order to keep the equipment in optimum operating condition, routine and preventive maintenance is essential. Detailed maintenance procedures for specific systems are provided in subsequent sections of this manual.

Daily Inspection

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

- Prior to startup, inspect the area around the machine, the high pressure piping and connections for indications of leaks.
 - Make sure there is no maintenance work in process.
 - Check the hydraulic oil level.
- As the machine is started and water pressure increases, listen for unusual sounds.
 - Check for water or oil leakage.
 - Check the condition of the hydraulic oil filter
 - Check the condition of the low pressure water filter if applicable.

Periodic Maintenance

A number of factors can contribute to component failure; poor water quality, operating conditions, or improper maintenance procedures. Maintaining a service log can be a useful method of tracking component life and maintenance trends. Analyzing service intervals will assist in preparing a preventive maintenance schedule tailored to your specific application and production 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.

- Maintain a clean, dust and dirt free work area for maintenance.
- Use only clean, dry air and clean, filtered solvent when flushing parts.
- Use lint free cloths for cleaning.
- Use extreme care when aligning close tolerance parts for assembly. Do not force the parts together. If parts bind during assembly, they must be disassembled and re-aligned.
- Use only original KMT Waterjet replacement parts for consistent performance and reliability; and to protect equipment warranty.

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 System Maintenance

The high pressure system is conveniently mounted on a drip pan. All service components are readily accessible, and can be removed from the unit easily for maintenance and service.

- High pressure fittings, valves and tubing must be rated for 60,000 psi (4,137 bar). Failure to use properly rated components may result in component failure, equipment damage and personal injury.
- Do not over-torque fittings to stop leakage.
- Ensure all components are clean, free of burrs, metal particles, dirt and dust prior to assembly.

After servicing high pressure components the high pressure water system must be thoroughly flushed to remove any debris or contaminants.

1. Operate the intensifier for a short period with the nozzle valve open and the orifice removed.
2. Turn the intensifier off and install an orifice.
3. Turn the machine on and increase the operating pressure in gradual increments. Check all high pressure connections for leaks.

Many components are lubricated prior to assembly. Table 3-1 lists the recommended lubricants and their applications. Substitutions are not recommended.

Table 3-1
Lubrication Specifications

Description	Application	Part Number
Pure Goop	Stainless steel threads	10084440
FML-2 Grease	O-rings, backup rings, bearing rings, seal components	10087385
JL-M Grease	Non-stainless steel threads	49832199

3.3 Maintenance Precautions

Make sure all safety devices are operational. Each device should be checked on a specified schedule. If the device does not function, it must be replaced before operating the machine.

Before performing any maintenance on the equipment, take the system out of service and make sure the controls are properly locked and marked. Never perform any maintenance on the equipment without making sure the main control power is locked out in the OFF position.

- **Never service or maintain the equipment while it is operating.**
- All high pressure leaks must be repaired immediately. Turn the control power off and bleed off the high pressure water from the intensifier **before** performing maintenance.
- Never service or maintain any high pressure component, or loosen any high pressure fitting when it is pressurized. Turn the control power off and bleed off the high pressure water from the intensifier before servicing.
- If leakage occurs at a sealing surface, high pressure water is released through weep holes. If a pressurized fitting is loosened, a jet of high pressure water will exit the nearest weep hole with **possible hazardous results**.



SECTION 4

LOW PRESSURE WATER SYSTEM

4.1 Overview

The low pressure water system, cutting water supply circuit, supplies the intensifier with the required cutting water flow and pressure.

4.2 Cutting Water Supply Quality

The quality of the inlet cutting water supply is one of the most important factors affecting component life and performance. Impurities in the water create grinding and corrosive effects on all components. See Section 10, Specifications, for details regarding water quality standards.

4.3 Operation

Cutting water is introduced through the 1/2-inch NPT connection on the bulkhead of the machine and passes through the normally closed, inlet water solenoid valve. When the control power is turned on, the solenoid valve opens and allows water to flow through the valve and then to the sealing head check valves on each end of the intensifier. Inlet cutting water pressure should be a minimum of 60 psi (4 bar) flowing.

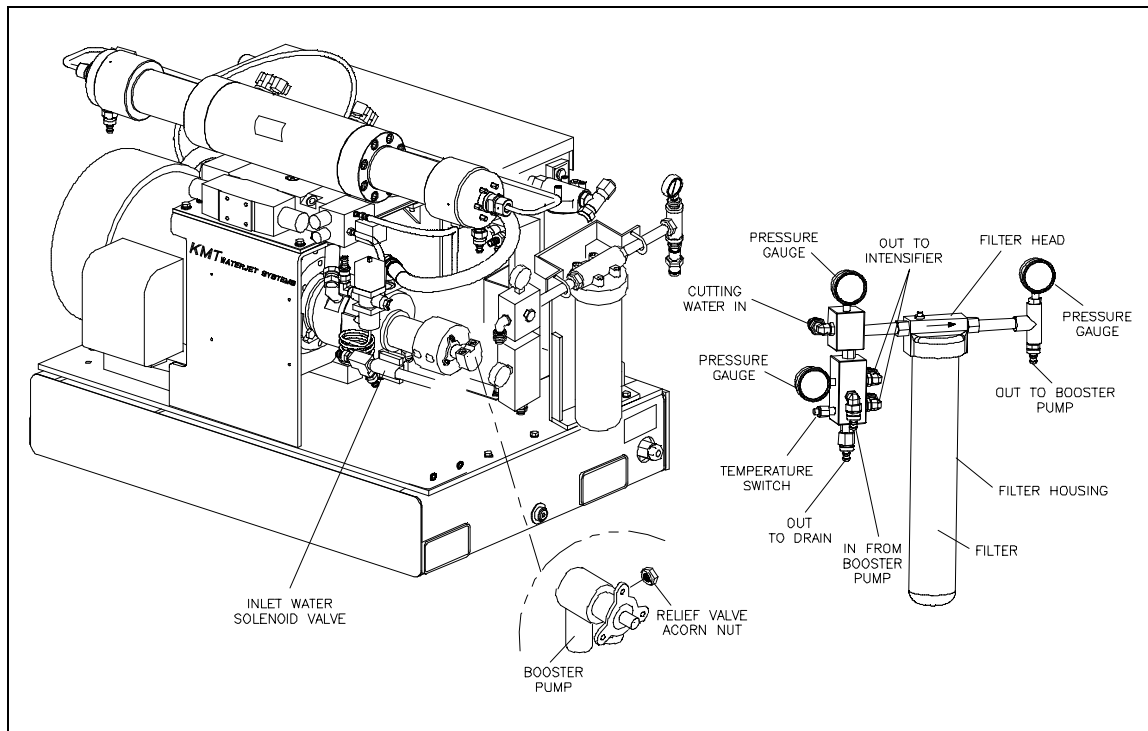
4.4 Optional System Components

An optional low pressure water filter removes debris from the inlet cutting water to prevent contaminants from damaging the check valves and seals in the intensifier. The optional booster pump increases the inlet cutting water pressure to ensure proper supply to the intensifier assembly.

Operation with Optional Booster Pump and Water Filter

Inlet cutting water pressure, passing through the water solenoid valve, is displayed on the supply gauge mounted on the inlet manifold. Inlet cutting water pressure should be a minimum of 35 psi (2.4 bar) flowing.

Cutting water then passes through the filter assembly, consisting of a filter body and a 10-micron absolute filter. A bleed valve on the top of the filter body releases air inside the housing.

Figure 4-1: Low Pressure Water System with Optional Booster Pump and Water Filter

The filtered water is routed to the booster pump where the pressure is increased to the relief valve setting, up to a maximum of 120 psi (8 bar). Pressurized water from the booster pump proceeds to the outlet manifold.

If the booster pump pressure entering the outlet manifold exceeds 125 psi (8.6 bar) a relief valve opens allowing water to exit through the 1/2-inch drain connection on the bulkhead. It is still possible to operate the machine; however, excess water will continue to be released through the drain.

Discharge pressure is displayed on the pressure gauge mounted on the outlet manifold. The gauge should read approximately 120 psi (8 bar) while the machine is idling. When it strokes, the pressure drop should be no greater than 30 psi (2 bar). The water pressure range should remain between 90-120 psi (6-8 bar) during operation.

NOTE

While the intensifier assembly reverses direction, the boosted pressure will fluctuate slightly above and below the normal setting.

A relief valve built into the booster pump prevents excessive discharge pressure and typically operates when the machine is in a deadhead condition. The booster pump is factory set to deliver 120 psi (8 bar) with an inlet pressure of 58 psi (4 bar). The pump may require adjustment to satisfy system requirements.

A temperature sensor, mounted on the outlet manifold, monitors the discharge temperature. To reduce overheating during a deadhead condition, water is re-circulated through the orifice and check valve, and routed back through the filter to the booster pump inlet.

From the outlet manifold, cutting water is routed to the sealing head inlet check valves on each end of the intensifier.

4.5 Service and Maintenance Procedures

There are no routine service and maintenance procedures associated with the low pressure system on base models. When pumps are equipped with the optional booster pump and low pressure water filter, the filter element and booster pump will require routine servicing and maintenance.

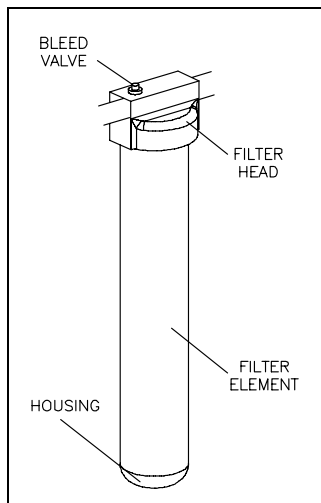
NOTE

Refer to Section 11, Parts List for a complete listing of replacement parts and part numbers.

Filter Assembly Maintenance

The life of the filter element is directly related to the quality of the inlet water. The condition of the filter element can be monitored by observing the pressure gauge on the inlet manifold. Document the pressure reading when the filter element is new. The element should be replaced when the pressure drops to 15 psi (1 bar) below the original value.

Figure 4-2: Filter Element



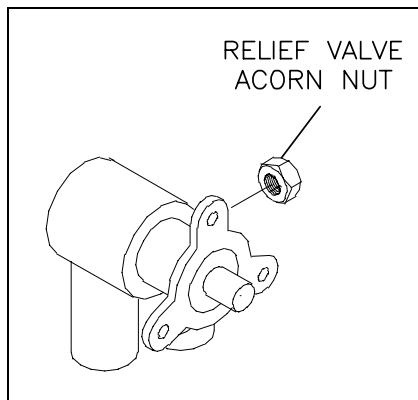
1. Turn the cutting water supply off.
2. Press the red bleed valve on the filter head to release any pressure trapped inside the housing.
3. Use a filter wrench to unscrew the housing and remove the old element.

4. Install the new element. Apply FML-2 grease to the o-ring in the filter housing and use the filter wrench to replace the housing.
5. Turn the cutting water supply on.
6. Press the red bleed valve to remove any air inside the housing.
7. Start the machine and verify satisfactory pressure readings.

Booster Pump Adjustment

If the discharge pressure from the booster pump is less than 90 psi (6 bar), the relief valve on the booster pump should be adjusted.

Figure 4-3: Booster Pump



1. Turn the cutting water supply on.
2. Start the machine and observe the discharge pressure from the booster pump.
3. Remove the acorn nut on the side of the pump to access the adjustment screw. It is normal for water to leak out when the acorn nut is removed.
4. Use a flat screwdriver and turn the adjustment screw clockwise to increase the discharge pressure or counter-clockwise to decrease the pressure. Adjust the pressure to the highest desired pressure, within the normal booster pump range.



If the adjustment screw is turned too far out (counter-clockwise) an internal spring and relief will fall down inside the pump. If this occurs, the pump must be removed and the parts must be reinstalled to avoid component damage.

5. Replace the acorn nut and resume normal operation.



SECTION 5

RECIRCULATION SYSTEM

5.1 Overview

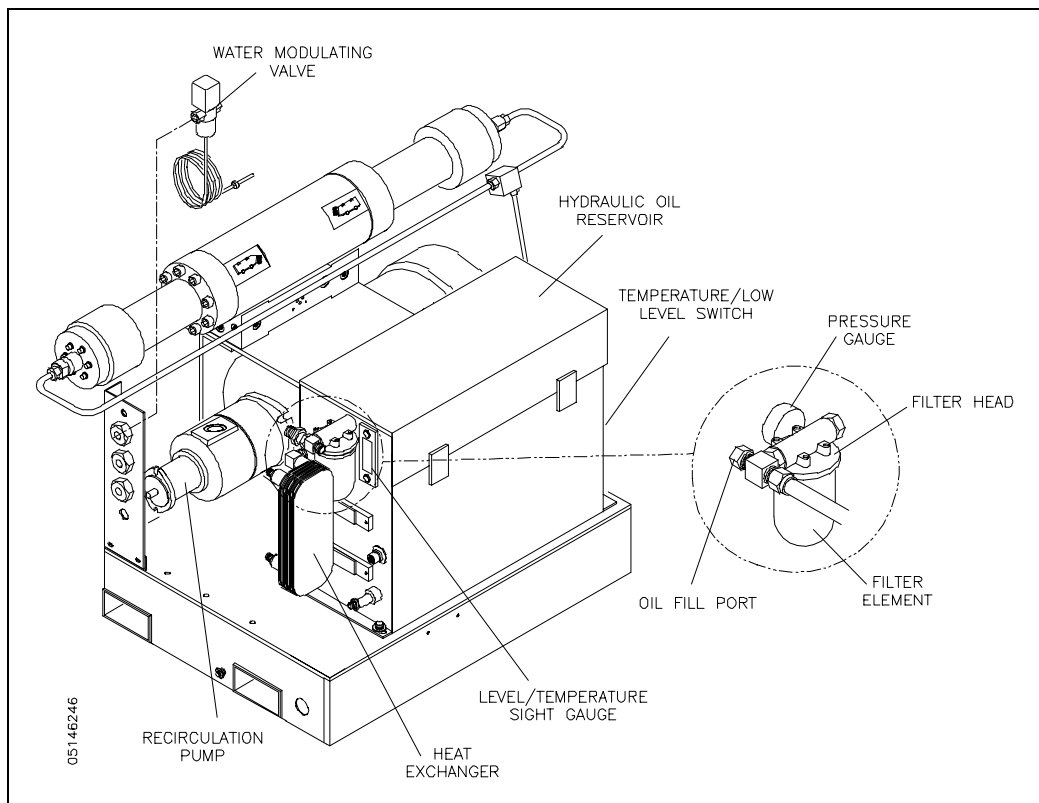
The oil recirculation circuit is a cooling and filtration system that provides properly conditioned oil to the main hydraulic system. Hydraulic oil is maintained at the proper operating temperature and condition by continuous recirculation.

System components include the water modulating valve, recirculation pump, heat exchanger, oil filter assembly and the hydraulic oil reservoir.

5.2 Operation

Cooling water is introduced through the 1/2-inch NPT connection on the bulkhead of the machine where the water modulating valve regulates the cooling flow to the heat exchanger. The valve is factory set, but may require adjustment to maintain the operating oil temperature at 115° F (46° C). Oil temperature can be visually monitored from a dual scale level/temperature sight gauge on the side of the hydraulic oil reservoir.

Figure 5-1: Recirculation System Components





The recirculation pump pulls oil from the reservoir and sends it to the heat exchanger. The oil-to-water heat exchanger controls heat build-up in the hydraulic oil. The plate style design allows cooling water and oil to flow side by side through alternating plates.

The cooled oil then passes through the filter element and returns to the reservoir. The cooling water either is discharged to the 1/2-inch NPT drain on the bulkhead or is routed to a customer supplied water chiller.

The hydraulic oil filter assembly consists of the filter head, a filter element, pressure gauge, bypass relief valve and the oil fill port. The filter element should be changed when the gauge reads 30 psi (2.1 bar) at normal operating temperature.

If the element is not replaced, and fills with debris, the bypass relief in the filter head will open to prevent over pressurization. The relief valve opens at 50 psi (3.4 bar). When the valve opens, the oil bypasses the filter and unfiltered oil is allowed to return to the reservoir.

The temperature/low level switch monitors the oil temperature and level in the reservoir.

NOTE

To conserve water usage it is recommended that the cooling water be shut off at the end of the day. A sensor bulb from the modulating valve is submerged in the reservoir. Even when the control power is off, the valve will remain open, allowing water to flow until the oil is cooled.

5.3 Service and Maintenance Procedures

To ensure the supply of properly conditioned oil to the main hydraulic system, the components will require routine servicing and maintenance. The procedures for servicing these components are detailed below.

NOTE

Refer to Section 11, Parts List for a complete listing of replacement parts and part numbers.

Hydraulic Oil Maintenance

The hydraulic oil should be replaced after 3,000 hours or one year of service, whichever comes first. The oil should be replaced sooner if a fluid sample indicates contamination that cannot be rectified by filtering.

An air breather and filter is located on the reservoir. The air breather prevents dirt from being sucked into the reservoir when the oil level drops, and allows air to escape when the level rises. The air breather **must not** be used as a fill point. **Oil must only be added at the fill port on the filter head and removed at the drain valve.**



Do not attempt to fill the reservoir from the air breather. The oil will not be filtered and will not conform to the cleanliness requirements of the system.

Figure 5-2: Hydraulic Oil Reservoir, Single Intensifier

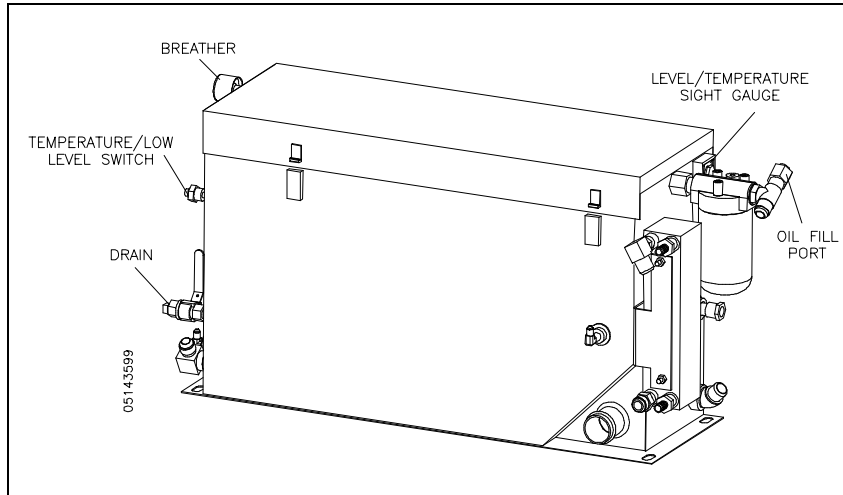
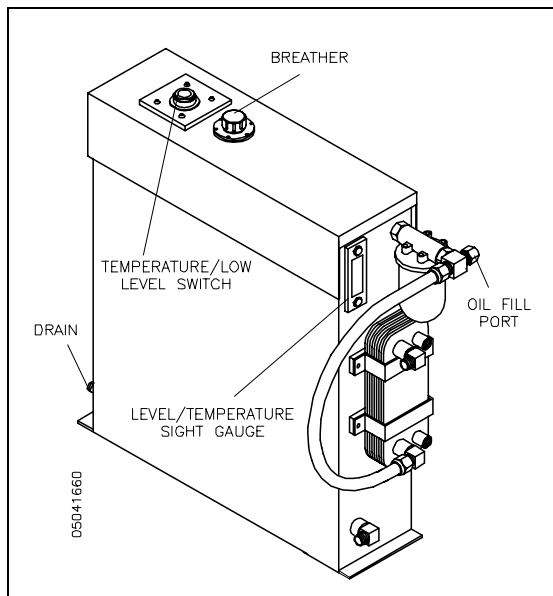


Figure 5-3: Hydraulic Oil Reservoir, Redundant Intensifier



1. Turn the machine off and observe the appropriate Lockout/Tagout procedures.



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

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

2. Drain the oil reservoir by connecting the inlet hose from an oil transfer pump to the drain valve on the reservoir.
3. Open the shutoff valve on the drain and pump the used oil out to a container.

NOTE

It is recommended that the empty reservoir be flushed with a few gallons of clean oil to remove settled debris from the bottom.

4. Close the shutoff valve and remove the inlet hose from the drain valve.

NOTE

Oil from a new drum does not meet the cleanliness requirements of the hydraulic system. For this reason, it is important to use an oil transfer pump that will force oil through the return filter into the reservoir.

5. Remove the cap from the fill port on the oil filter.
6. Connect the discharge hose from the oil transfer pump to the fill port and pump the fresh oil into the reservoir.



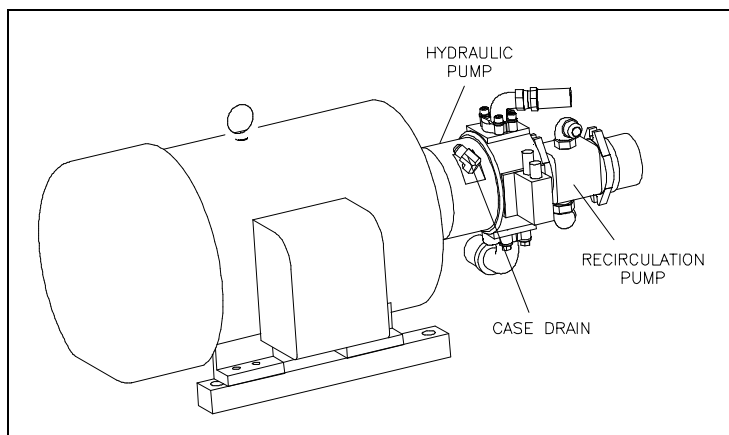
To ensure cleanliness, the oil fill port **must** be used to pump oil into the reservoir. Filling at this point guarantees the hydraulic oil will pass through the oil filter before entering the reservoir.

7. Check the oil sight gauge on the reservoir to ensure proper fill level.
8. Remove the hydraulic hose from the case drain on the main hydraulic pump to make sure the pump case fills with oil. With the hose removed, head pressure from the reservoir will force oil into the pump case.



Oil in the pump case provides internal lubrication for the main hydraulic pump. Failure to fill the pump case with oil will allow air to become trapped inside, damaging the pump.

Figure 5-4: Case Drain



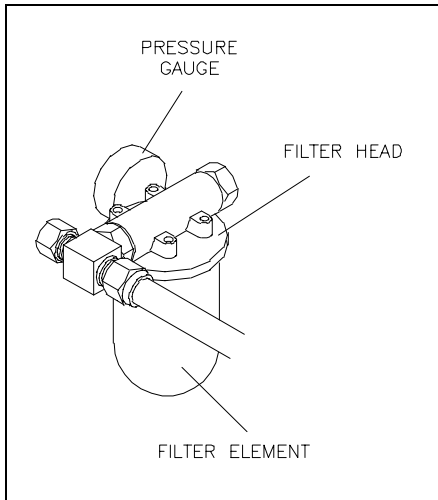
9. Disconnect the discharge hose from the fill port and replace the fill port cap.
10. Check the sight gauge again and follow the same procedure to add additional oil if necessary.

Oil Filter Maintenance

If the filter element is not properly serviced and is allowed to fill with debris, the oil will be forced through the relief valve, bypassing the filter. The bypass relief valve opens at 50 psi (3.4 bar).

The filter element must be replaced when the pressure gauge reading is 30 psi (2.1 bar) or greater during normal operating conditions. Normal operating conditions indicate the machine is running and the oil temperature has reached 115° F (46° C).

Figure 5-5: Oil Filter Assembly

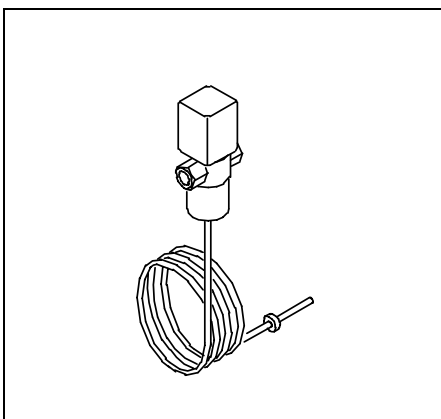


1. Use a filter wrench to unscrew the filter element from the filter head. Ensure the old gasket is removed with the filter.
2. Lubricate the gasket on the new element with fresh oil.
3. Use the filter wrench to screw the new element onto the filter head and hand-tighten. Do not over tighten.
4. Start the machine and check for leaks.

Operating Temperature Adjustment

The cooling water flow to the heat exchanger is regulated by the water modulating valve, a manually adjusted, thermostatic control valve. The valve is factory set to maintain the operating oil temperature at 115° F (46° C). In most cases, adjustment will be required at commissioning, and with seasonal changes to cooling water temperature. The temperature is adjusted by increasing or decreasing the spring tension on the valve.

Figure 5-6: Water Modulating Valve





1. Locate the adjusting knob, a screwdriver slot on the top of the valve.
2. Use a flat screwdriver and turn counter-clockwise to compress the spring, slowing water flow and increasing temperature. Or; turn clockwise to reduce spring tension, increasing water flow and decreasing the temperature.
3. Monitor the sight gauge on the side of the reservoir until the adjusted temperature can be determined. It will take some time for the temperature in the oil reservoir to change.
4. Repeat steps 2 and 3 if necessary.



SECTION 6

HYDRAULIC SYSTEM

6.1 Overview

The main hydraulic power circuit supplies the intensifier assembly with the hydraulic flow required to produce high pressure water. High pressure cutting water is generated from the oil pressure in the hydraulic cylinder.

System components include the electric motor, hydraulic pump, 4-way directional control valve and the hydraulic manifold. The manifold houses the high and low pressure control valves, hydraulic gauge, solenoid valve and the main system relief valve. The system relief valve monitors hydraulic oil pressure and provides system protection by limiting excess pressure.

6.2 Operation

The electric motor drives three pumps mounted in tandem; the main hydraulic pump, the recirculation pump and the optional booster pump. The motor drives the variable displacement, pressure compensated hydraulic pump by means of a flexible coupling.

Hydraulic fluid from the reservoir is drawn into the inlet, low pressure side of the hydraulic pump. Oil delivered to the pump should be maintained at 110-115° F (43-46° C). Hydraulic fluid then enters the bottom of the manifold through an internal anti-rotation check valve. After a shutdown, the anti-rotation check valve prevents the pump from running backwards.

Figure 6-1: Hydraulic System Components, Single Intensifier

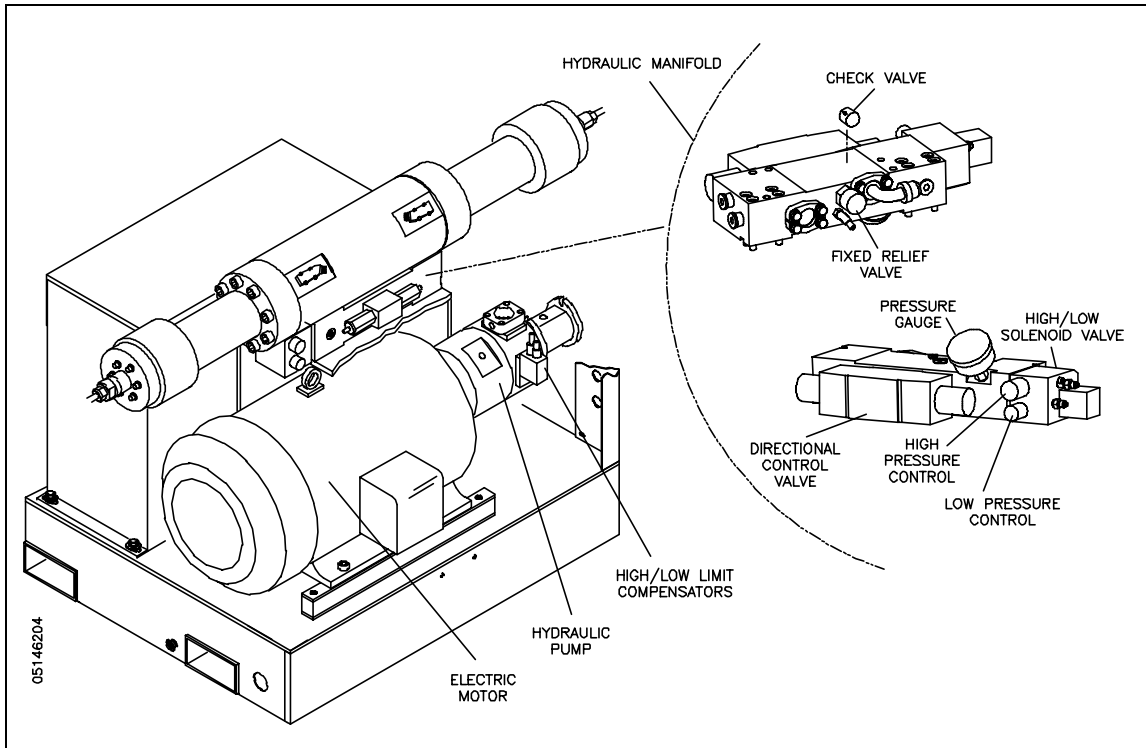
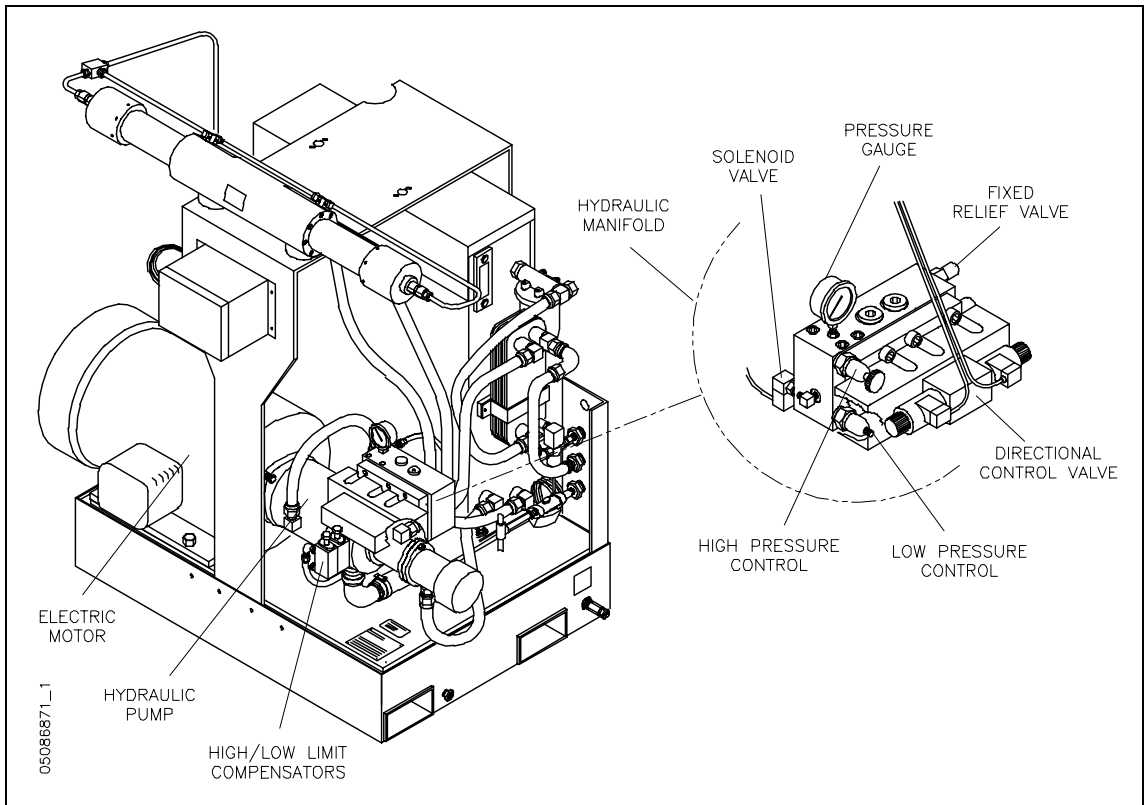


Figure 6-2: Hydraulic System Components, Redundant Intensifier



The main system relief valve provides system protection by monitoring the oil pressure entering the manifold. If the hydraulic pressure exceeds 3,400 psi (234 bar), the valve opens to limit the pressure. The valve is factory calibrated and is not serviceable. A drain line from the valve prevents oil from collecting behind the relief valve to ensure a constant pressure under all operating conditions.

The hydraulic system operates at high or low pressure settings up to the maximum flow capacity of the hydraulic pump. The high and low limit compensators mounted on the pump regulate the flow of hydraulic fluid to maintain constant operating pressures. Operating pressures are set and adjusted at the high and low pressure control valves on the manifold.

If the machine is equipped with proportional pressure control, low pressure is adjusted at the manifold, and the high pressure setting is made from the controller.



The high and low limit compensators regulate the flow of hydraulic fluid to the system by controlling the angle of the swashplate. If the oil is not properly maintained, the compensators can become blocked with debris. As a result, pump control will be lost and you will not be able to create hydraulic oil pressure.

The normally closed, two position solenoid valve is controlled by the operator's selection of high or low pressure. The valve is closed while operating in high pressure and is open during low pressure operation. A light on the solenoid connector indicates low pressure operation.

A reference gauge on the top of the manifold displays hydraulic pressure to the intensifier. When the intensifier shifts, it is normal for the pressure to quickly fall and then rise again.

The directional valve consists of a spool with internal passages that direct hydraulic flow to one end while returning fluid to the reservoir through the opposite end. Spool position is controlled by a pair of solenoids, one at each end of the spool. The solenoids are alternately energized in response to the position of the hydraulic piston as the proximity switch detects the end of the stroke.

On redundant models, the 4-way directional control valve directs pressurized oil to one end of the hydraulic cylinder and returns fluid to the reservoir from the opposite end, causing the intensifier to stroke. The movement is controlled hydraulically by a pilot valve, electrically operated by two solenoids. Indicators light up as each solenoid is energized. The directional control valve sends flow to the hydraulic cylinder in one direction until the hydraulic piston activates the proximity switch at the end of the stroke. The activated switch sends a signal to the controller to reverse the direction of flow. The piston then moves in the opposite direction until it activates the proximity switch at the opposite end of the stroke.

6.3 Service and Maintenance Procedures

The extreme duty cycles demanded of the hydraulic system make routine inspection and maintenance acutely important. Leaks must be detected and remedied as soon as possible.

The operating pressure settings must be checked daily, and the electric motor must be inspected at regular intervals. It is also possible for the flexible coupling to fail and require replacement. The procedures for servicing these components are detailed below.

NOTE

Refer to Section 11, Parts List for a complete listing of replacement parts and part numbers.

Hydraulic Operating Pressure

Hydraulic operating pressure settings should be checked daily and adjusted as necessary. High and low operating pressure is adjusted at the high and low pressure control valves per the specifications in Table 6-1.

If the machine is equipped with proportional pressure control, high pressure adjustments are made from the controller. The following procedure is used for low pressure adjustments.

Table 6-1
Hydraulic Operating Pressure Limits

	Adjustment		Pressure Limits	
	Increase	Decrease	Minimum	Maximum
High Pressure	Clockwise	Counter-clockwise	290 psi (20 bar)	3,000 psi (207 bar)
Low Pressure	Clockwise	Counter-clockwise	290 psi (20 bar)	800 psi (55 bar)
<i>Redundant Model</i>				
High Pressure	Clockwise	Counter-clockwise	290 psi (20 bar)	3,000 psi (207 bar)
Low Pressure	Clockwise	Counter-clockwise	290 psi (20 bar)	1,500 psi (103 bar)

Figure 6-3: High/Low Pressure Controls, Single Intensifier

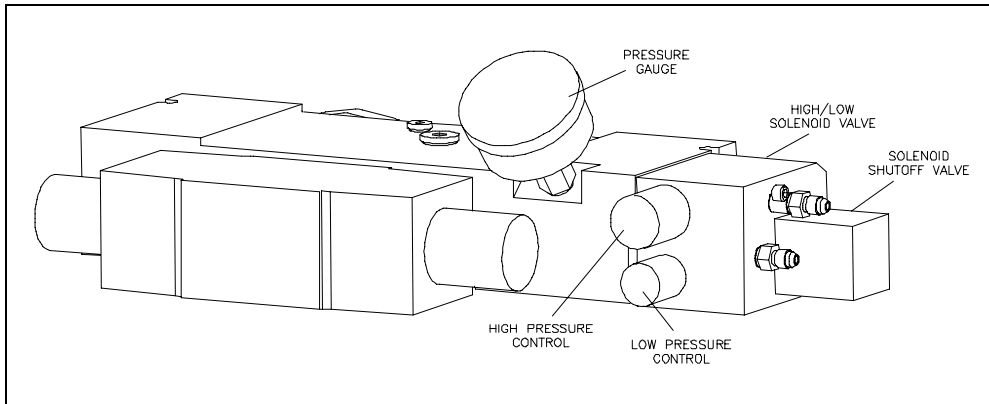
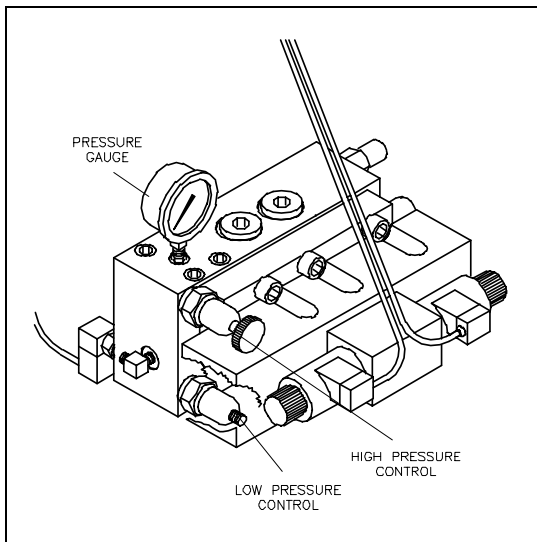


Figure 6-4: High/Low Pressure Controls, Redundant Intensifier



1. Check the operating pressure to determine if adjustment is necessary.
2. If high pressure adjustment is required, loosen the locking thumbscrew on the high pressure control valve by turning counter-clockwise.
3. Turn the knob on the control valve clockwise to increase operating pressure, or turn the knob counter-clockwise to decrease pressure.
4. Tighten the locking nut and verify the high pressure setting.
5. If low pressure adjustment is required, loosen the locking nut on the low pressure control valve by turning counter-clockwise.
6. Turn the hex clockwise to increase operating pressure, or turn the hex counter-clockwise to decrease pressure.
7. Tighten the locking nut and verify the low pressure setting.

Motor Maintenance

The motor should be inspected at regular intervals, approximately every 500 hours of operation or every three months, whichever occurs first. Keep the motor clean and the ventilation openings clear.

NOTE

Motor bearings are sealed for life and require no periodic maintenance.

Flexible Coupling Replacement

When the flexible coupling fails, the pump shaft will not turn and pressure will not be created. Typically, failure will be sudden, without any warning signs.

The electric motor and hydraulic pump are mounted in tandem on both single and redundant models. On redundant models, the hydraulic manifold is mounted on the hydraulic pump and must be removed to replace the flexible coupling as described in the following procedure.

1. Turn the machine off and observe the appropriate Lockout/Tagout procedures.



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

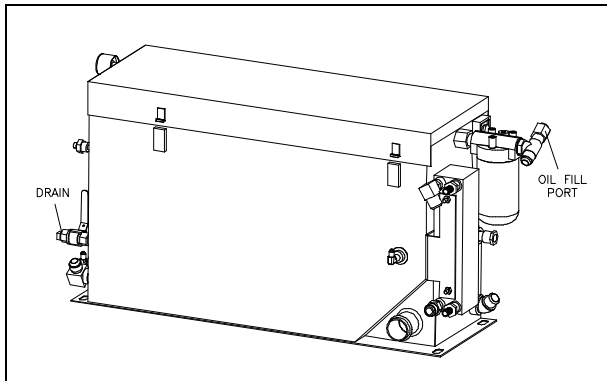
Ensure all pressure is relieved or blocked from the hydraulic and high pressure circuits before proceeding.

2. Drain the hydraulic reservoir by connecting the inlet hose from an oil transfer pump to the drain valve on the reservoir. Open the shutoff valve on the drain and pump the used oil out to a container. Close the shutoff valve and remove the inlet hose from the drain valve.



Do not reuse the removed oil. It is recommended that the empty reservoir be flushed with a few gallons of clean oil to remove settled debris from the bottom.

Figure 6-5: Hydraulic Oil Reservoir



3. Disconnect all hydraulic hoses and connections to the case drain, hydraulic pump and recirculation pump.

REDUNDANT MODELS

Loosen the pressure gauge on the hydraulic manifold and turn it out of the way.
Remove all electrical sensors and connections to the manifold.

Remove the four bolts on the top of the manifold and remove the manifold and o-ring from the hydraulic pump.

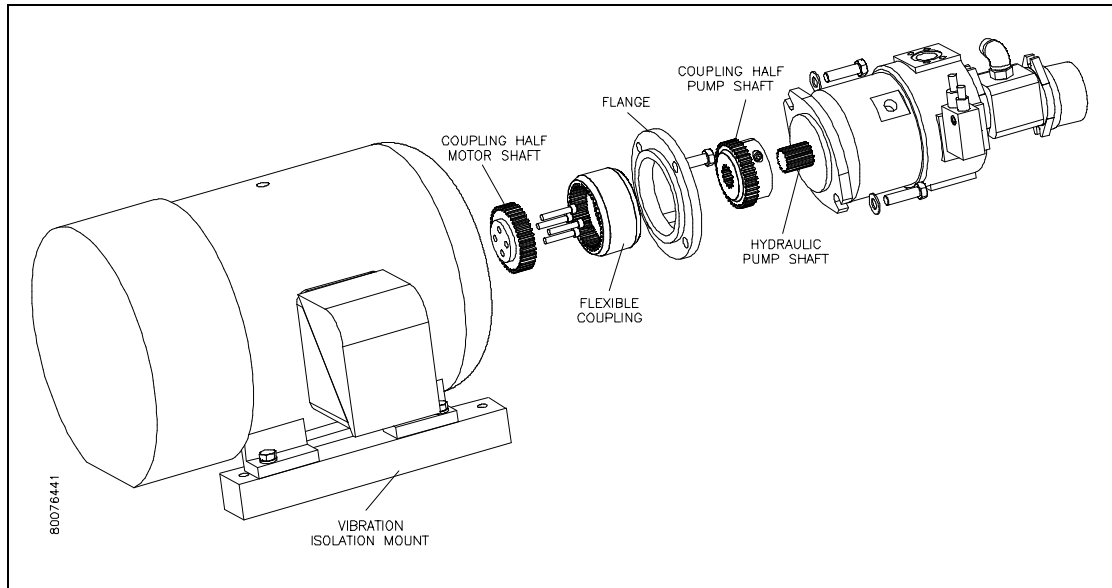
4. Remove all electrical leads to the motor.
5. Remove the bolts attaching the motor vibration mounts to the frame base plate.
6. Remove the motor and pump assembly from the frame.

NOTE

If the unit is equipped with an optional booster pump, disconnect the water lines and remove the booster pump with the motor and pump assembly.

7. Remove the bolts attaching the hydraulic pump to the electric motor. Slide the hydraulic pump away from the motor to expose the flexible coupling. Use wooden blocks to support the hydraulic and recirculation pumps.

Figure 6-6: Coupling Components



8. Remove the failed flexible coupling.
9. Wipe any residue, dirt or oil from the coupling halves on both the motor shaft, and the pump shaft. Avoid damaging the shaft seal on the pump.
10. Inspect the metal splines on the coupling halves for damage.
11. Inspect the shaft cavity of the hydraulic pump for the presence of hydraulic oil or evidence of hydraulic leaks. If a hydraulic leak is detected, the shaft seal must be replaced.
12. Install the new flexible coupling over the coupling half on the motor shaft, aligning the splines. Push the flexible coupling on as far as it will go. The internal band keeps the coupling centered between the motor and pump shafts.
13. Move the motor and pump assembly together to engage the flexible coupling with the coupling half on the pump shaft. You may need to turn the motor shaft to align the splines with the pump shaft. When the motor and pump are rejoined, the coupling will have a small amount of end clearance to allow the coupling to float.
14. Replace the pump mounting bolts and torque to 55 ft-lbs (75 Nm). Remove the wooden blocks.
15. Position the motor and pump assembly in the frame, aligning the vibration isolation mounts with the mounting holes in the frame base plate.
16. Install the vibration mounts to the frame base plate.

REDUNDANT MODELS

Install the hydraulic manifold ensuring that the o-ring is properly positioned.
Torque the mounting bolts to 35 ft-lbs (47 Nm).

Reconnect the sensors and connections to the manifold.

17. Reconnect all hydraulic hoses, connections and electrical leads.
18. Refill the hydraulic reservoir following the procedure, Hydraulic Oil Replacement.
19. Check the motor rotation. If the motor shaft is rotating in the wrong direction, reverse one pair of motor leads.
20. Start the motor and apply full high pressure water pressure. Inspect for hydraulic leaks and note any unusual sounds from the motor or pump assembly.

Hydraulic Oil Replacement

Hydraulic oil **must only** be removed and replaced at the fill port on the filter head.

1. Remove the cap from the fill port on the oil filter.



To ensure cleanliness, the oil fill port **must** be used to pump oil into the reservoir. Filling at this point guarantees the hydraulic oil will pass through the oil filter before entering the reservoir.

2. Connect the discharge hose from an oil transfer pump to the fill port and pump the fresh oil into the reservoir.

NOTE

Oil from a new drum does not meet the cleanliness requirements of the hydraulic system. For this reason, it is important to use an oil transfer pump that will force oil through the return filter into the reservoir.

3. Check the oil sight gauge on the reservoir to ensure proper fill level.
4. Remove the hydraulic hose from the case drain on the hydraulic pump to make sure the pump case fills with oil. With the hose removed, head pressure from the reservoir will force oil into the pump case.



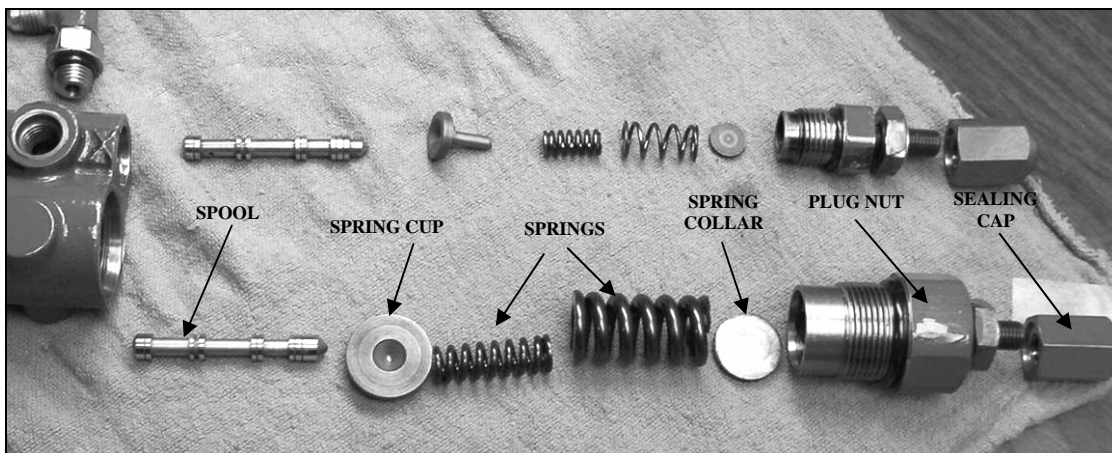
Oil in the pump case provides internal lubrication for the hydraulic pump. Failure to fill the pump case with oil will allow air to become trapped inside, damaging the pump.

5. Disconnect the discharge hose from the fill port and replace the fill port cap.
6. Check the sight gauge again and follow the same procedure to add additional oil if necessary.

Hydraulic Compensator Maintenance

The high and low limit compensators regulate the flow of hydraulic fluid to the system. The compensators can become blocked with debris resulting in loss of pump control.

Figure 6-7: Hydraulic Compensator Components



1. Turn the machine off and observe the appropriate Lockout/Tagout procedures.

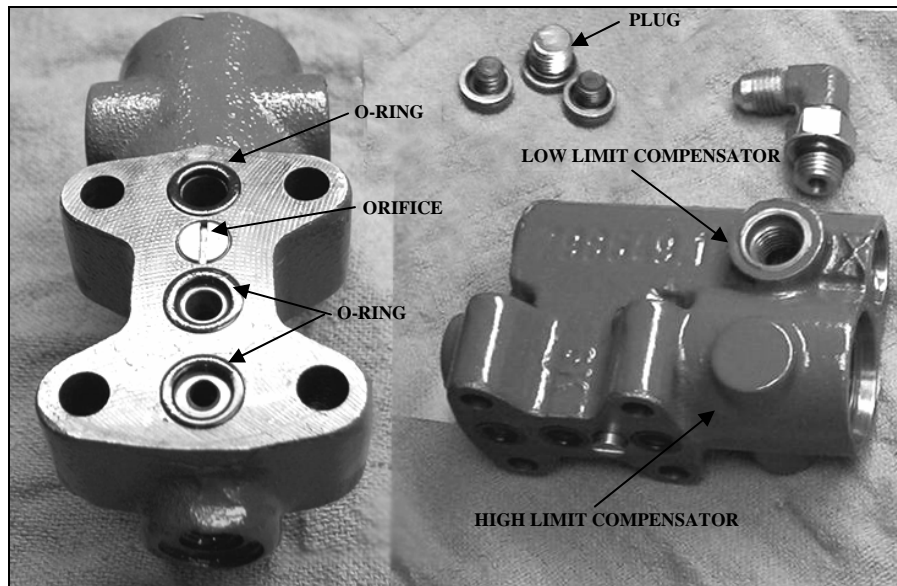


Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before performing maintenance on the system components.

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

2. Remove the hydraulic hose from the low limit compensator.

3. Remove the four socket screws that attach the compensators to the pump.
4. Remove the compensators and then remove the three plugs and o-rings on the back of the housing.

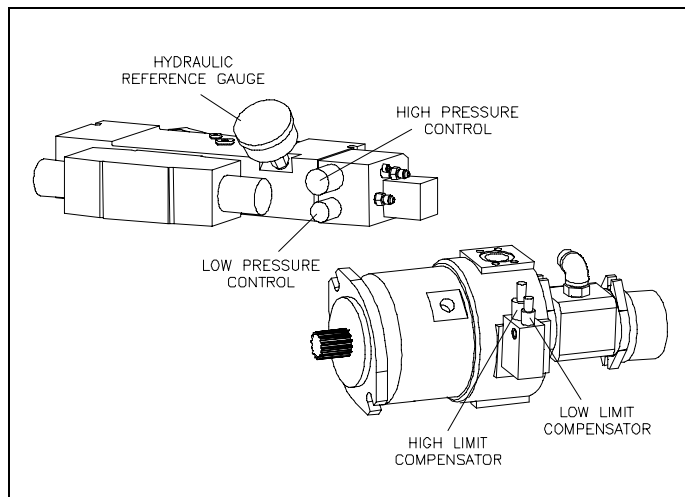


5. Disassemble the compensators one at a time by first removing the hexagon sealing cap.
6. Loosen the lock nut, and then remove the plug nut.
7. Disassemble the plug by removing the spring collar, springs, spring cup and spool.
8. Clean the housing and all components with clean fluid and carefully dry with air.
9. Check and clean the small internal passages in the spools.
10. Check and clean the orifices in both spools.
11. Assemble in the reverse order, ensuring that the screw slot on the orifice is aligned with the long axis of the body.



When the compensators are removed, the machine loses adjustment. The compensators must be reset before operation can begin.

12. Start the machine and select the low pressure operating mode.
13. Deadhead the machine.



14. Set the high and low pressure control valves on the hydraulic manifold to the minimum setting by turning them counter-clockwise.

If the machine is equipped with proportional pressure control, adjust the high pressure setting from the controller.

15. Set the compensators to the minimum setting by turning the adjusting screws counter-clockwise.
16. Select high pressure operating mode and set the high pressure control valve on the hydraulic manifold to the maximum setting by turning the knob clockwise.

If the machine is equipped with proportional pressure control, adjust the high pressure setting from the controller.

17. Turn the adjusting screw on the high limit compensator clockwise until the hydraulic reference gauge reads 2,600 psi (179 bar).
18. Select low pressure operating mode and turn the adjusting screw on the low limit compensator clockwise until the reference gauge reads 290 psi (20 bar). Lock the adjustment screw in place.
19. Select high pressure operating mode and turn the knob on the high pressure control valve counter-clockwise until the reference gauge reads 2,000 psi (138 bar).

If the machine is equipped with proportional pressure control, adjust the high pressure setting from the controller.

20. Open the high pressure water control valve, allowing water to flow. Set the desired high operating pressure by adjusting the high pressure control valve.

If the machine is equipped with proportional pressure control, adjust the high pressure setting from the controller.

21. While the machine is running and high pressure water is flowing, select low pressure operating mode. Set the desired low operating pressure by adjusting the low pressure control valve.

Hydraulic Pump or Electric Motor Replacement

The following procedures are used to replace the hydraulic pump or the electric motor.

The electric motor and hydraulic pump are mounted in tandem on both single and redundant models. On redundant models, the hydraulic manifold is mounted on the hydraulic pump and must be removed to replace the pump or the motor as described in the following procedures.

Hydraulic Pump Replacement

1. Turn the machine off and observe the appropriate Lockout/Tagout procedures.



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

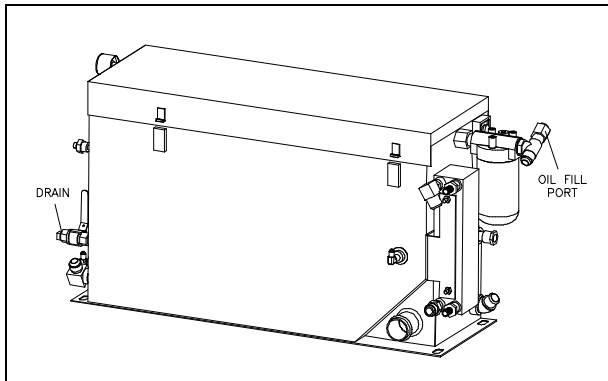
Ensure all pressure is relieved or blocked from the hydraulic and high pressure circuits before proceeding.

2. Drain the hydraulic reservoir by connecting the inlet hose from an oil transfer pump to the drain valve on the reservoir. Open the shutoff valve on the drain and pump the used oil out to a container. Close the shutoff valve and remove the inlet hose from the drain valve.



Do not reuse the removed oil. It is recommended that the empty reservoir be flushed with a few gallons of clean oil to remove settled debris from the bottom.

Figure 6-8: Hydraulic Oil Reservoir



3. Disconnect all hydraulic hoses and connections to the case drain, hydraulic pump and recirculation pump.

REDUNDANT MODELS

Loosen the pressure gauge on the hydraulic manifold and turn it out of the way.
Remove all electrical sensors and connections to the manifold.

Remove the four bolts on the top of the manifold and remove the manifold and o-ring from the hydraulic pump.

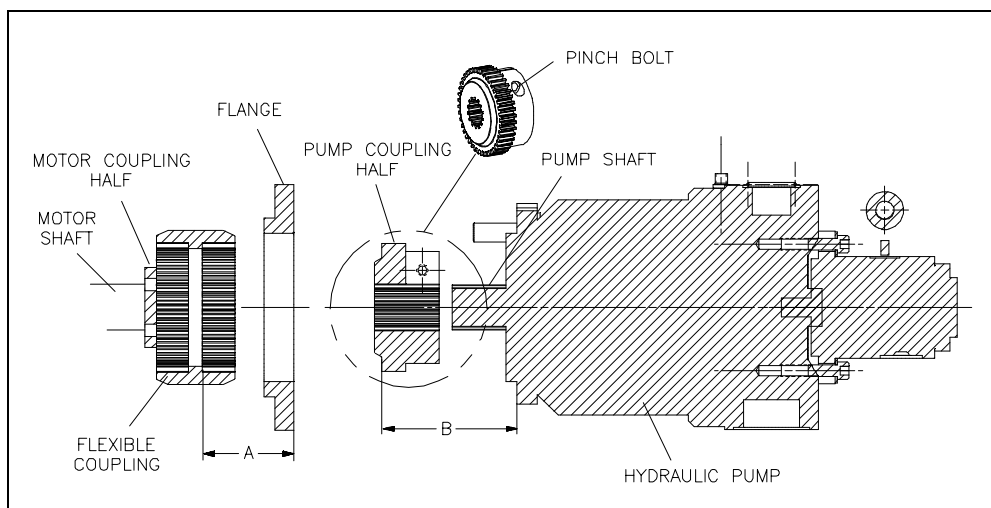
4. Remove the recirculation pump.

NOTE

If the unit is equipped with an optional booster pump, disconnect the water lines and remove the adapter and the booster pump with the recirculation pump.

5. Remove the bolts that attach the hydraulic pump to the electric motor.
6. Support the pump and slide it away from the motor, disengaging the flexible coupling.
7. Inspect the flexible coupling for damage. If the flexible coupling is damaged it must be replaced.
8. Inspect the metal splines on the motor coupling half. Wipe any residue, dirt or oil from the motor coupling and the flexible coupling. Place the flexible coupling on the motor coupling half, pushing it on as far as it will go.
9. Take a measurement from the front face of the electric motor, the pump mounting interface, to the outer face of the solid band inside the flexible coupling, dimension A in Figure 6-9.

Figure 6-9: Pump Coupling Dimension



10. Loosen the pinch bolt in the pump coupling half on the old pump and remove the coupling half. Inspect the metal splines for damage. If the coupling half is not damaged it can be reused on the new pump.

Wipe any residue, dirt or oil from the pump coupling half. Slide the existing coupling half, or a new coupling half if necessary, onto the splined shaft of the new pump.

11. Measure from the pump mounting face to the outer face of the coupling teeth, dimension B in Figure 6-9. Set the position of the pump coupling half using the formula $B = (A - 0.313)$.
12. Tighten the pinch bolt and torque to 36 ft-lbs (49 Nm).
13. Position the hydraulic pump on the motor, ensuring the coupling teeth mesh into the flexible coupling. Force should not be required.
14. Verify that the mating surfaces of the motor and pump meet without resistance from the coupling.
15. Replace the pump mounting bolts and torque to 55 ft-lbs (75 Nm).
16. Install the recirculation pump.

NOTE

If the unit is equipped with an optional booster pump, install the adapter and booster pump with the recirculation pump, and reconnect the water lines.

REDUNDANT MODELS

Install the hydraulic manifold ensuring that the o-ring is properly positioned.
Torque the mounting bolts to 35 ft-lbs (47 Nm).

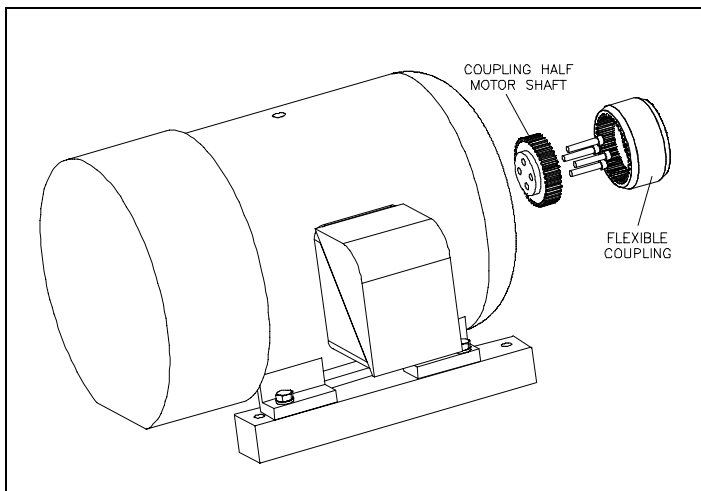
Reconnect the sensors and connections to the manifold.

17. Reconnect all hydraulic hoses and connections.
18. Refill the hydraulic reservoir following the procedure, Hydraulic Oil Replacement, detailed in the Flexible Coupling Replacement procedure.
19. Start the motor and apply full high pressure water pressure. Inspect for hydraulic leaks and note any unusual sounds from the motor or pump assembly.

Electric Motor Replacement

1. Complete Steps 1-7 in the previous procedure.
2. Remove all electrical leads from the motor.
3. Remove the bolts attaching the vibration isolation mounts to the frame base plate and remove the old motor from the frame.
4. Stand the new motor on the fan cowl with the shaft pointing upward.

Figure 6-10: Motor Coupling Half



5. Apply Loctite 222 to the bolts and attach a new motor coupling half to the motor shaft. Torque to 36 ft-lbs (49 Nm).



6. Place the flexible coupling on the motor coupling half. Follow Step 9 and 11 in the previous procedure to determine if the coupling half on the hydraulic pump is properly positioned. If necessary, adjust the position of the pump coupling half.
7. Place the hydraulic pump on the motor, ensuring the coupling teeth mesh into the flexible coupling. Force should not be required.
8. Verify that the mating surfaces of the motor and pump meet without resistance from the coupling.
9. Replace the pump mounting bolts and torque to 55 ft-lbs (75 Nm).
10. Position the motor and pump in the frame, aligning the vibration isolation mounts with the mounting holes in the frame base plate. Attach the vibration isolation mounts to the frame base plate.
11. Reconnect the electrical leads.
12. Complete steps 16-18 in the previous procedure.
13. Check the motor rotation. If the motor shaft is rotating in the wrong direction, reverse one pair of motor leads.
14. Start the motor and apply full high pressure water pressure. Inspect for hydraulic leaks and note any unusual sounds from the motor or pump assembly.



SECTION 7

ELECTRICAL SYSTEM

7.1 Overview

Major components of the electrical system for the S30 include the electric motor and the wiring harness that connects the sensors and solenoid valves to the customer supplied controller.

The 12-lead electric motor can be wired for either wye-delta or across-the-line starting. The motor includes a 9-post terminal block for the junction of motor and starter wire leads.

7.2 Optional System Components

The following system options are available at the time of purchase, or as upgrade kits for existing equipment.

- The individual cables in the wiring harness are connected to terminals blocks inside the optional junction box.
- Proportional pressure control allows the operator to select or vary the high pressure hydraulic operating pressure from the controller.

7.3 Sensors and Solenoids

Sensors monitor operating conditions and electronically operated solenoids provide basic intensifier shift control. The cables connected to these sensors and solenoids are bundled into a wiring harness with a 37-pin connector, see Figure 7-2, Electrical Harness. Table 7-1 lists the recommended shutdown settings.

Table 7-1
Recommended Shutdown Settings

Label	Sensor	Shutdown Setting
3S3/4	Low hydraulic oil level	21 gal (80 L)
3S3/4	High hydraulic oil temperature	144° F (62° C)
3S2	Booster pump overheat, optional	128° F (53° C)

Figure 7-1: Sensors and Solenoids

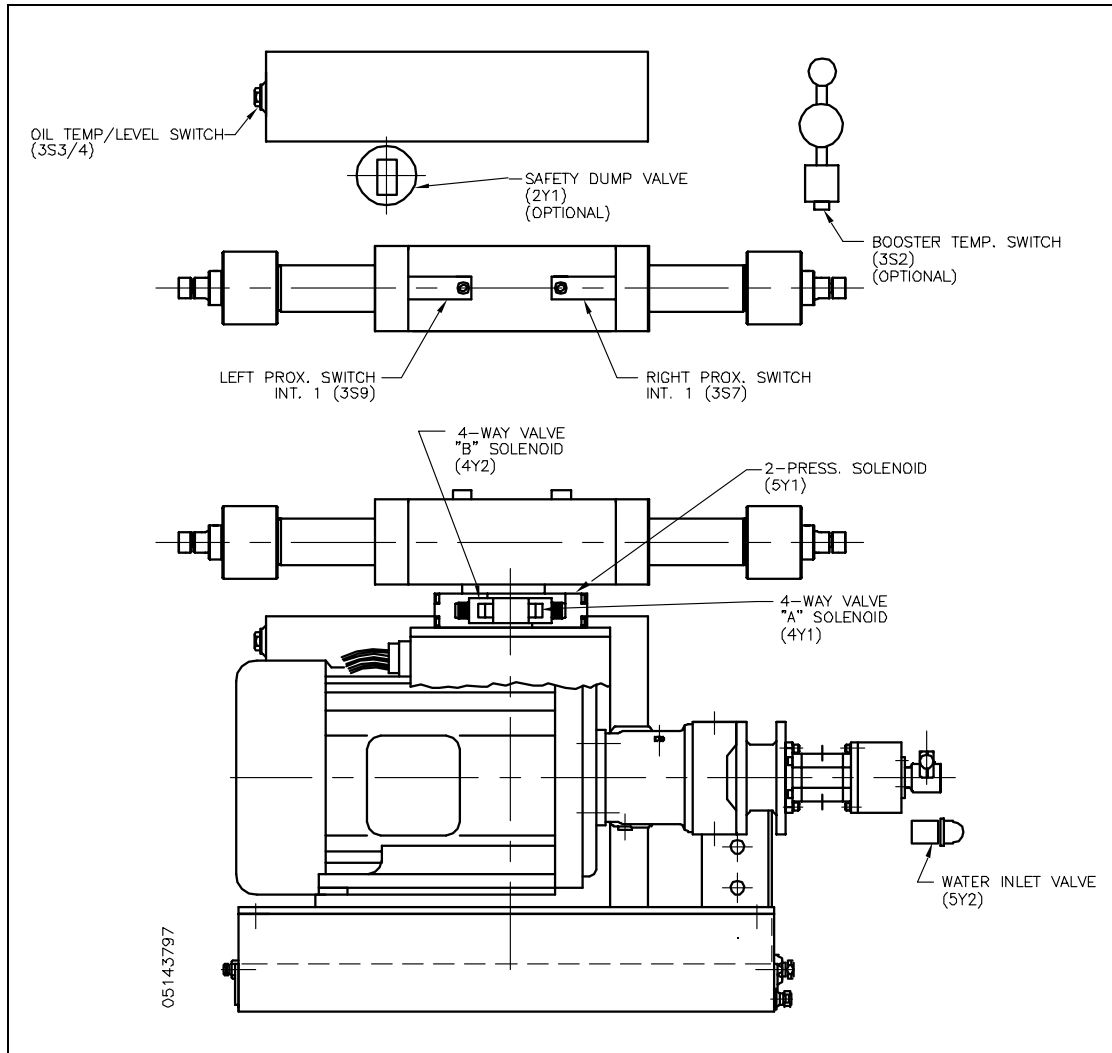


Table 7-2
Sensors and Solenoids

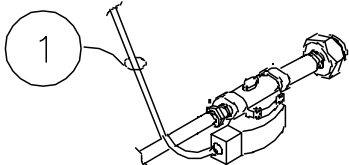
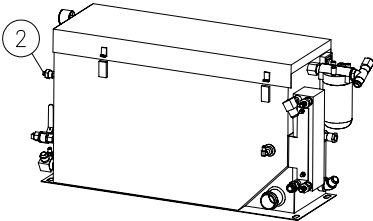
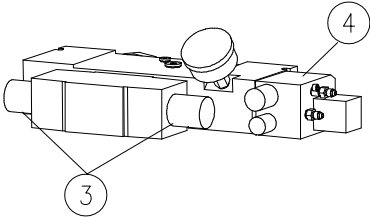
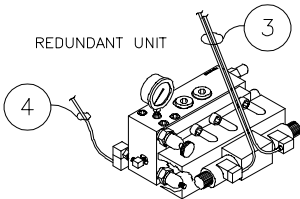
Component	Function
<i>Inlet Water Solenoid Valve</i>	
	<p>1 The normally closed, inlet water solenoid valve is located at the service bulkhead. When the control power is turned on, the valve opens and allows low pressure cutting water to enter.</p>
<i>Hydraulic Reservoir</i>	
	<p>2 The temperature/low level switch monitors the oil temperature and level in the reservoir. Although the float switch and the temperature switch are combined in a single unit, the two switches function independently.</p>
<i>Hydraulic Manifold</i>	
	<p>3 The 4-way directional control valve shifts the hydraulics back and forth to the intensifier. A shift valve directs pressurized oil to one end of the hydraulic cylinder and returns fluid to the reservoir from the opposite end, causing the intensifier to stroke. The movement is controlled hydraulically by a pilot valve that is electronically operated by two solenoids. As power is directed from one solenoid to the other, LEDs are alternately illuminated.</p>
 <p>REDUNDANT UNIT</p>	<p>4 When low pressure is selected, a normally closed, solenoid valve is activated. The valve remains closed while operating in high pressure and is held open electrically during low pressure operation. An illuminated LED on the solenoid indicates low pressure operation.</p>

Table 7-2
Sensors and Solenoids

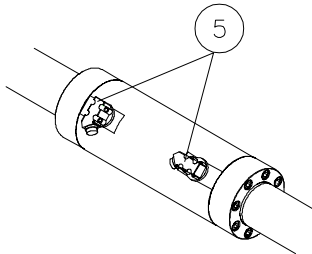
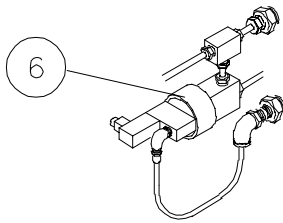
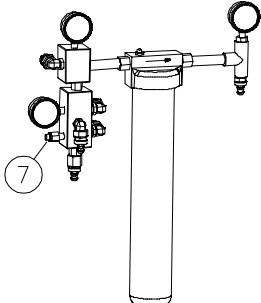
Component	Function
Hydraulic Cylinder	
	<p>5 As pressurized hydraulic oil is sent to one side of the hydraulic cylinder, it pushes against the piston, moving it in one direction until it activates the proximity switch at the end of the stroke. The hydraulic flow is then sent to the opposite side of the cylinder, and the piston reverses direction until it activates the proximity switch at the opposite end of the stroke.</p> <p>The green light on the proximity switch indicates there is power to the switch. The light turns red when the switch is activated. The proximity switches are magnetically activated by the presence of the metallic surface of the piston. When the switch is activated, it sends a signal to the controller to change the flow of the directional control valve and reverse direction.</p>
High Pressure Safety Dump Valve	
	<p>6 When control power is removed, the optional safety dump valve releases the stored pressure in the intensifier and high pressure delivery lines. The high pressure dump valve assembly includes a normally open high pressure water valve and a solenoid operated air valve.</p> <p>The normally open pneumatic dump valve is held closed by air pressure. When the air supply is interrupted, the valve opens and allows water to flow through the valve. Pressure is released in the intensifier and the high pressure water stream exits through the drain.</p>
Low Pressure Water Filter Assembly	
	<p>7 A temperature switch on the optional water filter assembly monitors the temperature of the cutting water from the booster pump.</p>

Table 7-2
Sensors and Solenoids

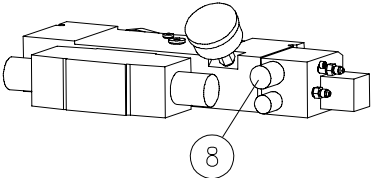
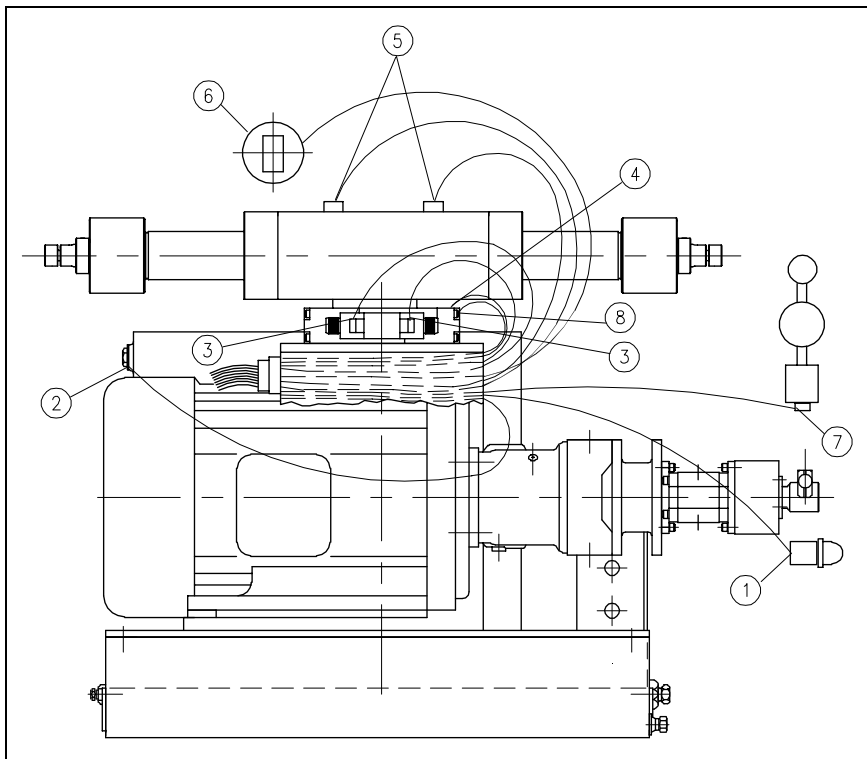
Component	Function
<i>Proportional Pressure Control</i>	
	<p>8</p> <p>When the unit is equipped with optional proportional pressure control, an electronically controlled hydraulic cartridge valve, mounted on the hydraulic manifold, allows the operator to select or vary the high pressure hydraulic operating pressure from the controller.</p>

Figure 7-2: Electrical Harness



7.4 Service and Maintenance Procedures

Electrical components require minimal service. The proximity switches on the hydraulic cylinder may require replacement.

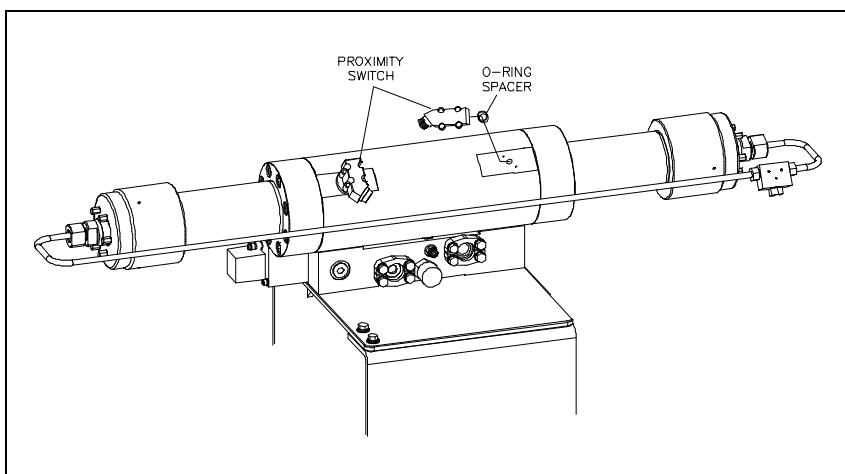
NOTE

Refer to Section 11, Parts List for a complete listing of replacement parts and part numbers.

Proximity Switch Maintenance

A proximity switch has failed and needs to be replaced if the LEDs do not change state, indicating they are not sensing the piston, or if an LED flashes continuously.

Figure 7-3: Proximity Switch



1. Turn the machine off and observe the appropriate Lockout/Tagout procedures.



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

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

2. Remove the electrical cable from the failed proximity switch.
3. Remove the two socket head screws, the failed switch and the o-ring spacer.

4. Install a new proximity switch by positioning the o-ring spacer and the switch. Ensure the o-ring is correctly oriented.
5. Apply JL-M grease to the threads on the screws and tighten to 140-160 in-lbs (16-18 Nm).



Ensure that the proximity switch is properly installed and secured prior to starting the machine. Failure to tighten the two hold down screws will result in the spray of hydraulic oil.



SECTION 8

HIGH PRESSURE WATER SYSTEM

8.1 Overview

The high pressure water system is supported by both the cutting water supply circuit and the hydraulic circuit. Cutting water of sufficient flow and pressure is routed from the cutting water supply circuit to the intensifier where it is pressurized up to 60,000 psi (4,137 bar) and delivered to the cutting head.

The directional control valve in the hydraulic system creates the stroking action of the intensifier by sending pressurized hydraulic oil to one side of the hydraulic cylinder or the other. As the flow is sent to one side, hydraulic fluid is returned to the reservoir from the opposite side.

System components include a double-ended hydraulic cylinder; reciprocating piston assembly; high pressure cylinders attached to each end of the hydraulic cylinder; two plungers, sealing heads and hard seal end caps; and a one liter capacity attenuator. Sophisticated check valves and seal assemblies ensure hydraulic oil, and the low pressure and high pressure water travel in the appropriate direction.

8.2 Optional System Components

The optional high pressure dump valve instantly releases high pressure from the system and is available at the time of purchase, or as upgrade kit for existing equipment.

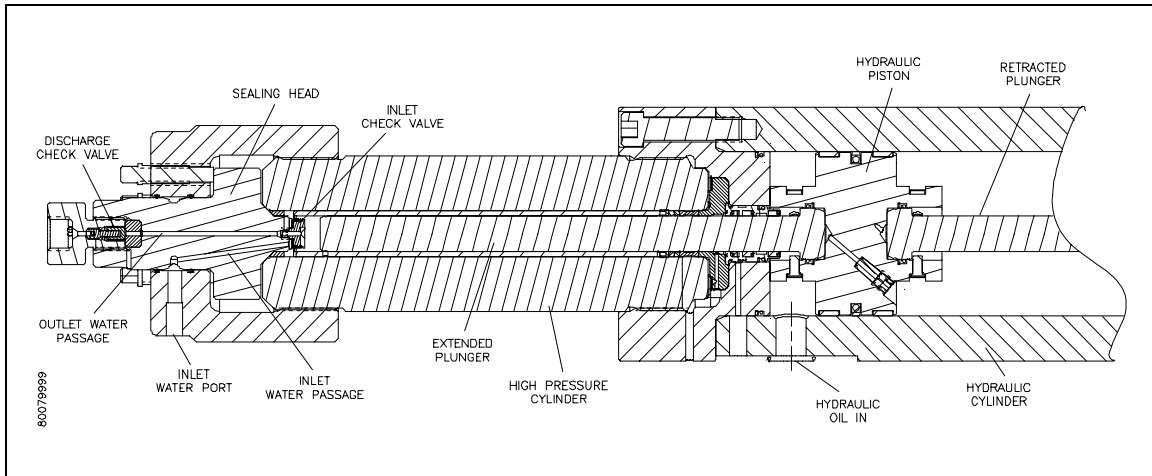
8.3 Operation

The directional control valve sends pressurized hydraulic oil to one side of the hydraulic cylinder. The pressurized oil pushes against the piston, moving it in one direction until it activates the proximity switch at the end of the stroke. The hydraulic flow is then sent to the opposite side of the cylinder, and the piston reverses direction until it activates the proximity switch at the opposite end of the stroke.

The green light on the proximity switch indicates there is power to the switch. The red light illuminates when the switch is activated. The proximity switches are magnetically activated by the presence of the metallic surface of the piston. When the switch is activated, the flow of the directional control valve is changed and the direction is reversed.

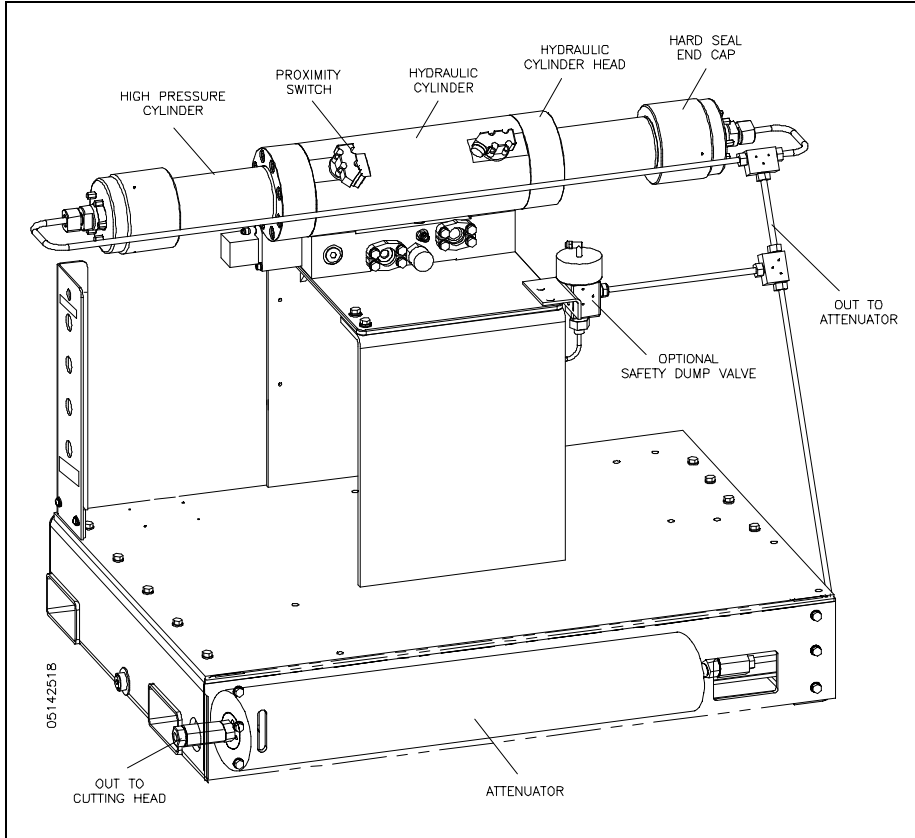
As the pressurized oil pushes the piston in one direction, the plunger on that end extends and pushes against the water in the high pressure cylinder, increasing the pressure up to 60,000 psi (4,137 bar). When the piston reverses direction, the plunger retracts and the plunger in the opposite cylinder extends to deliver the high pressure water.

Figure 8-1: High Pressure Cylinder



Low pressure water is routed through the inlet water ports to the inlet passages in the sealing heads. When the plunger retracts, the inlet check valve opens to allow water to fill the high pressure cylinder. When the plunger extends to create high pressure water, the inlet valve closes to seal the inlet passage and the discharge check valve opens to allow the high pressure water to exit the cylinder. As the plunger retracts, the discharge check valve closes.

Figure 8-2: High Pressure Water System



The intensifier is a reciprocating pump. As the piston and plungers move from one side to the other, high pressure water exits one side of the intensifier as low pressure water fills the opposite side.

The high pressure water is then routed to the attenuator. The attenuator acts as a shock absorber to dampen pressure fluctuations and ensure a steady and consistent supply of water. From the attenuator, the high pressure water exits to the cutting head.

High Pressure Dump Valve

The optional high pressure dump valve releases the stored pressure in the intensifier and high pressure delivery lines. The high pressure dump valve assembly includes a normally open high pressure water valve and an electrically controlled air valve.

The normally open pneumatic dump valve is held closed by air pressure. When the air supply is interrupted and exhausted, the valve opens and allows water to flow through the valve. Pressure is released in the intensifier and the high pressure water stream exits through the drain.

Redundant Models

On redundant models, the cutting water supply lines are manually connected to the inlet water ports on the active intensifier. Manual hydraulic valves are opened or closed to direct the hydraulic flow to the active intensifier. Manual high pressure water valves are also opened or closed to direct the high pressure water flow from the active intensifier.



When a machine is equipped with redundant intensifiers, operation can continue on the secondary unit if the primary unit requires maintenance. However, maintenance **must not** be performed while the machine is in operation.

Maintenance **must never** be performed on any high pressure components while the machine is operating. All pressure must be relieved or blocked from the hydraulic and high pressure circuits and the main control power must be locked out before performing maintenance.

The following example describes the procedure for changing from one intensifier to the other. In this example, intensifier 2 will become the active intensifier and intensifier 1 will become inactive.

1. Make sure the main control power is off.
2. Disconnect the low pressure water supply lines from intensifier 1 and connect them to intensifier 2.
3. Close the two hydraulic shutoff valves to intensifier 1.

4. Close the high pressure water shutoff valve to intensifier 1 and open the high pressure water shutoff valve to intensifier 2.
5. Open the two hydraulic shutoff valves, and the high pressure water shutoff valve to intensifier 2.
6. Disconnect the cables from both proximity switches on intensifier 1. Connect the cables to the proximity switches on intensifier 2.
7. Ensure all cooling water, water supply and cutting water valves are open.
8. Ensure all hydraulic and high pressure fittings, and the proximity switches are properly tightened on intensifier 2.
9. Start the machine in low pressure mode and inspect the hydraulic, high pressure fittings, valves and hoses for leaks.

8.4 System Components

The following figures illustrate the individual high pressure water system components.

Figure 8-3: High Pressure Cylinder Assembly

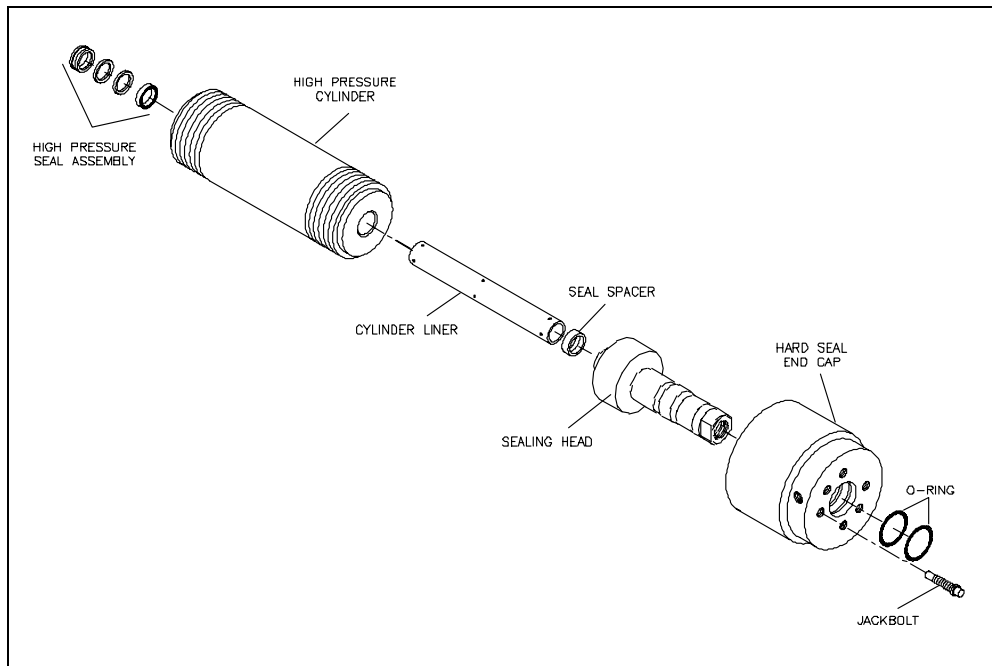


Figure 8-4: Hydraulic Cylinder Assembly

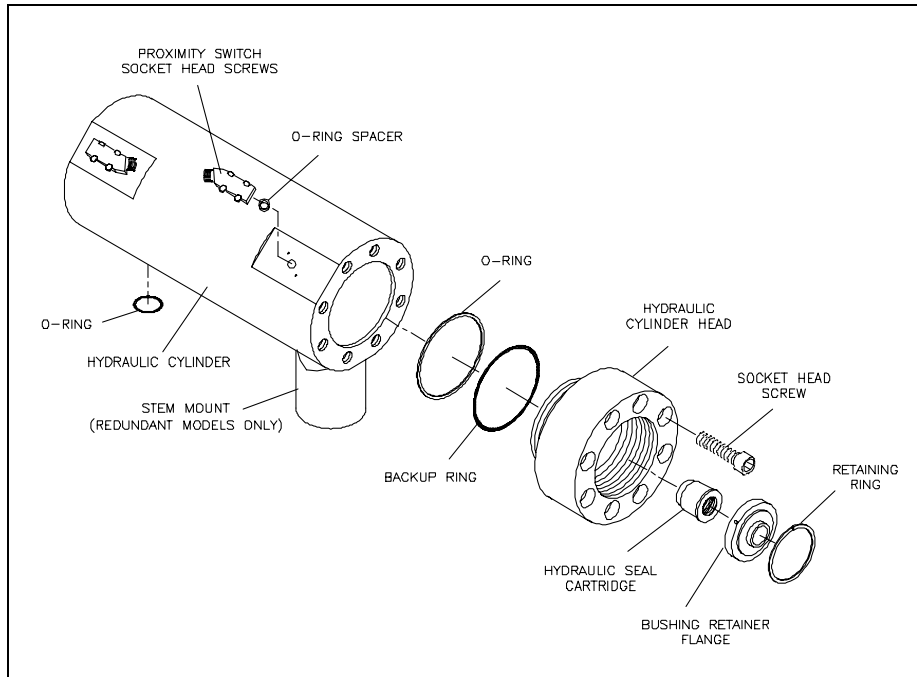
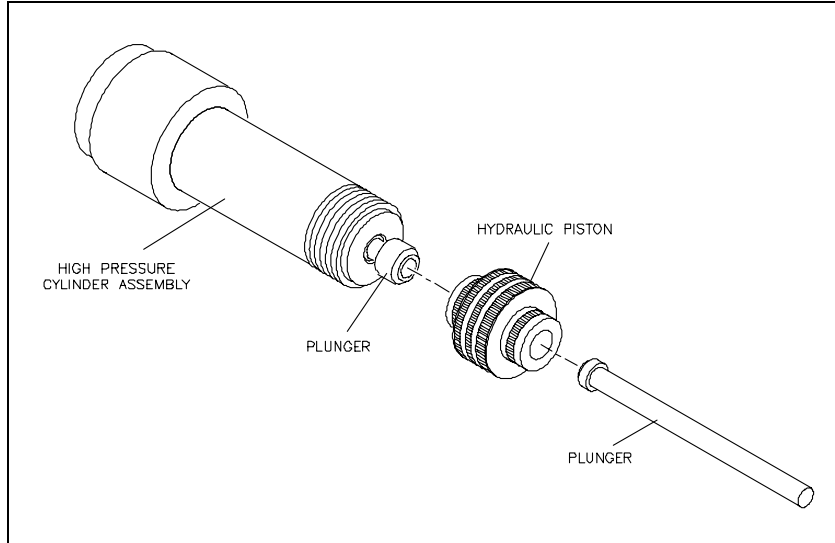


Figure 8-5: Hydraulic Piston





8.5 Service and Maintenance Overview

Never perform any type of maintenance on the high pressure water system while it is pressurized. Always turn the main control power off and bleed the high pressure water before servicing.

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

Some high pressure components are not serviceable at the customer level, others require precise refinishing. KMT Waterjet Systems offers maintenance and refinishing services for these components.

NOTE

Refer to Section 11, Parts List for a complete listing of replacement parts and part numbers.

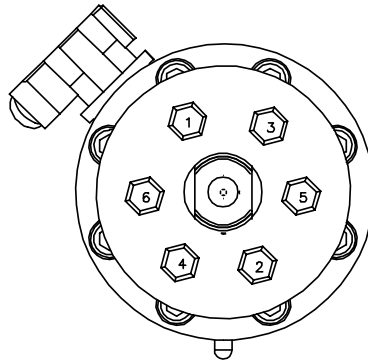
Torque Specifications

Table 8-1, Torque Specifications, details the torque specifications and tightening sequences for the high pressure components and connections.

Table 8-1
Torque Specifications
High Pressure Water System

Hard Seal End Cap	
Jackbolts	6 (7/16") each
1st Stage	Hand Tight
2nd Stage	20 ft-lbs (27 Nm) Crossing Pattern*
3rd Stage	32-35 ft-lbs (43-47 Nm) Crossing Pattern
4th Stage	32-35 ft-lbs (43-47 Nm) Clockwise Pattern From Bolt 1
Socket Wrench Size	3/8 inch

6-Bolt Crossing Pattern



* **Note:** Crossing Pattern: 1, 2, 3, 4, 5, 6

Hydraulic Cylinder Head	
Socket Head Screws	8 (14M) each
Torque	75-80 ft-lbs (102-108 Nm)
Hex Key	M12



Table 8-1
Torque Specifications
High Pressure Water System

Proximity Switch	
Socket Head Screws	2 (M6) each
Torque	140-160 in-lbs (16-18 Nm)
Hex Key	M5
Sealing Head	
Discharge Gland Nut	130 ft-lbs (176 Nm)
Poppet Retainer	25-30 in-lbs (2.8-3.4 Nm)
Optional Pneumatic Control Valve	
3/8" HP Inlet Gland Nut	50 ft-lbs (68 Nm)
1/4" Outlet to Drain	25 ft-lbs (34 Nm)
Pneumatic Actuator	5 ft-lbs (7 Nm)
9/16"-1/4" HP Adapter	50 ft-lbs (68 Nm)

Specialized Maintenance Tools

KMT Waterjet has designed tools to facilitate the removal and installation of specialized system components. These tools are illustrated in Figure 8-6, Specialized Maintenance Tools, and part numbers are provided in Table 8-2.

Figure 8-6: Specialized Maintenance Tools

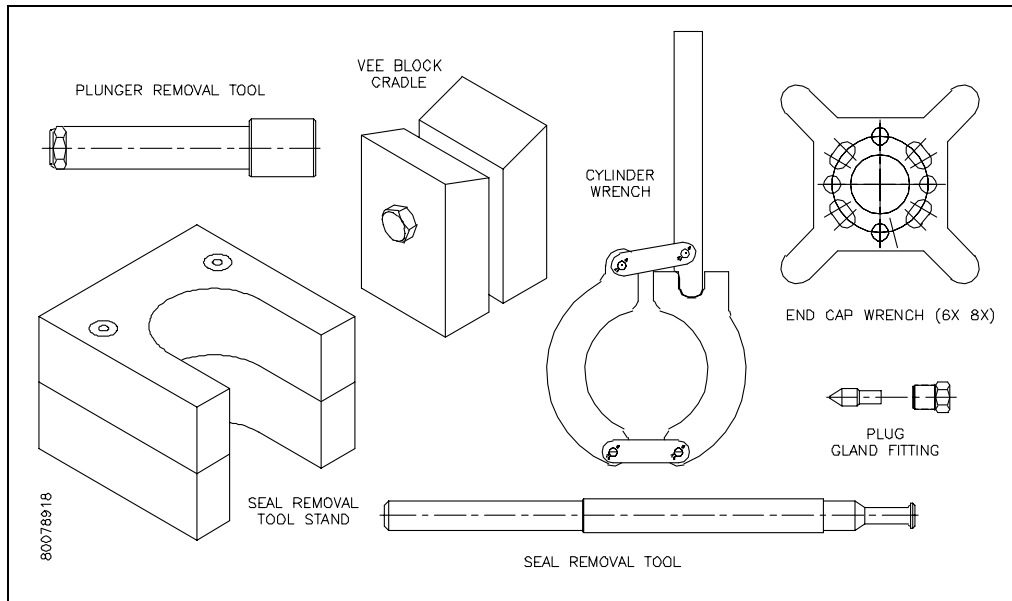


Table 8-2
Specialized Maintenance Tools
High Pressure Water System

	Part Number
Plunger Removal Tool	05004924
Vee Block Cradle	05149877
Plug	10079523 (3/8")
Gland Fitting	10078129 (3/8")
Seal Removal Tool	10148674
End Cap Wrench (6x8x)	80079239
Cylinder Wrench	05066139
Seal Removal Tool Stand	80078330

8.6 High and Low Pressure Water Piping

Before performing any maintenance on the high pressure components, it is necessary to remove the high and low pressure water piping. The following procedure should be used to remove and install the piping.



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

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

1. Turn the cutting water supply off.
2. Loosen and remove the high pressure gland fitting connected to the discharge high pressure check valve. Move the tubing to clear the work area.
3. Loosen and remove the low pressure piping connected to the inlet water port on the hard seal end cap.
4. When the required maintenance has been completed and the components reassembled, connect the low pressure water piping to the inlet water port on the hard seal end cap.
5. Apply Pure Goop to the threads on the high pressure gland fitting. Before installing the high pressure fitting, ensure proper collar position, 1-1/2 to 2-1/2 threads should be exposed. Install and tighten the fitting to the torque specifications in Table 8-1.
6. Turn the cutting water supply on and check for low pressure leaks.
7. Remove the cutting orifice and start the machine. Operate in low pressure mode to flush the high pressure passages.
8. Install the orifice and operate at high pressure to check for leaks.

8.7 High Pressure Cylinder Assembly

KMT Waterjet recommends removing the high pressure cylinder, sealing head and end cap as an assembly for servicing the plunger, high pressure seals, hydraulic piston and seal cartridge. Removing the jackbolts in the hard seal end cap is not recommended except to service the inlet check valve and cone seat on the sealing head.

High Pressure Cylinder Assembly Removal

Prior to removing electrical power or any high or low pressure piping, start the machine and extend the plunger on the end to be serviced to allow full exposure when the unit is disassembled.

1. Turn the machine off and observe the appropriate Lockout/Tagout procedures.



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

Ensure all pressure is relieved or blocked from the hydraulic and high pressure circuits before proceeding.

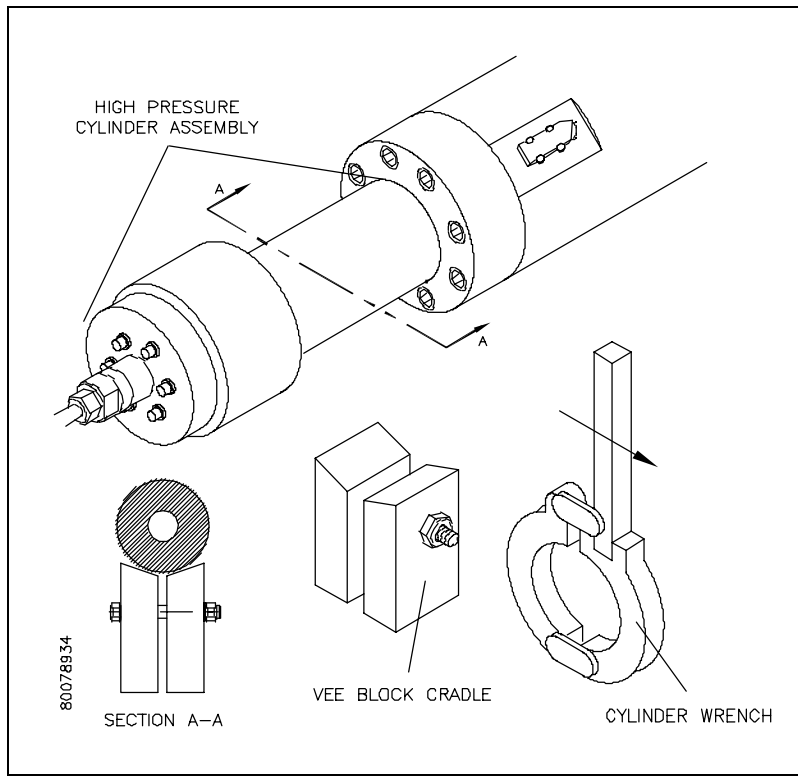
2. Disconnect the high and low pressure water piping, following the procedure, High and Low Pressure Water Piping.



Due to the weight of the cylinder assembly, adequate support must be provided to prevent damage to the plunger or seals during removal and installation. See Figure 8-6, Specialized Maintenance Tools for tools available to support the high pressure assembly for this procedure.

3. Position the vee block cradle tool under the cylinder assembly. Unthread and remove the assembly from the hydraulic cylinder head and plunger. The assembly can be rotated with the cylinder wrench or by hand.

Figure 8-7: High Pressure Cylinder Assembly Removal and Installation



NOTE

If thread or metal surface galling is detected during removal, galled surfaces and threads must be filed, sanded and lubricated prior to reassembly. See the procedure, High Pressure Cylinder Maintenance.

High Pressure Cylinder Assembly Installation

1. Verify that the high pressure cylinder threads and alignment surfaces are adequately cleaned and lubricated with Pure Goop, and that the threads have been sanded and dressed if galling was encountered during removal.
2. Verify that the high pressure seal assembly and cylinder liner are correctly installed. Align the cylinder assembly with the plunger and the hydraulic cylinder head, using the cradle tool to support the weight. Carefully push and lift the assembly into position until the threads are ready to engage.
3. Thread the cylinder assembly into the hydraulic cylinder head.

NOTE

If galling occurs during threading, remove the high pressure cylinder assembly and inspect the mating surfaces and threads. Repair surfaces, thoroughly clean, lubricate and thread the cylinder assembly into the hydraulic cylinder head.

4. Connect the high and low pressure water piping, following the procedure, High and Low Pressure Water Piping.
5. Start the machine in low pressure mode to flush air from the high pressure components and to check for obvious leaks. After 5-10 strokes, switch to high pressure operation and check for leaks.

If leaks are detected, turn the machine off and remedy the problem. When the problem has been remedied, repeat the startup procedure, moving from low to high pressure soon after the intensifier starts pumping water. There is no further need to flush air from the system.

High Pressure Cylinder Maintenance

The plunger seal area in the high pressure cylinder bore should be inspected and cleaned each time the high pressure seal assembly is replaced.

1. Clean the sealing area on the inside diameter of the high pressure cylinder and inspect the bore for rings, scratches, pits, residue or other potential leak paths.

Seal material or residue can build up, forming a ring. Running a fingernail across the buildup will cause it to appear as a surface flaw. Grooves or ridges are typically seal debris buildup rather than marks on the inside diameter wall of the cylinder.

2. Polish the inside diameter of the cylinder where the seal will locate with 600-grit wet/dry sandpaper. Hold the sandpaper on the end of your finger and move in a cylindrical wiping motion. Polish in a circumferential motion only. Do not polish or drag the sandpaper along the length of the cylinder.
3. Clean the residue from the inside diameter of the cylinder and re-inspect for surface defects.

NOTE

The high pressure cylinders are manufactured with an inner and an outer cylinder. The inner cylinder has a spiral groove cut into it and is press-fit inside the outer cylinder. This manufacturing process increases the fatigue strength and extends the life of the cylinder.

The ends of the high pressure cylinder often show a 'step' where the inner sleeve extends slightly beyond the outer sleeve, and the spiral groove could appear to be a crack on either end of the cylinder. These characteristics are normal and do not indicate a flaw in the cylinder.

8.8 Hard Seal End Caps

KMT Waterjet recommends loosening the jackbolts and removing the hard seal end caps (HSEC) only to service the inlet check valve and the cone seat on the sealing head.

Hard Seal End Cap Removal

Prior to removing electrical power or any high or low pressure piping, start the machine and retract the plunger on the opposite end to be serviced to allow full exposure when the unit is disassembled.

1. Turn the machine off and observe the appropriate Lockout/Tagout procedures.



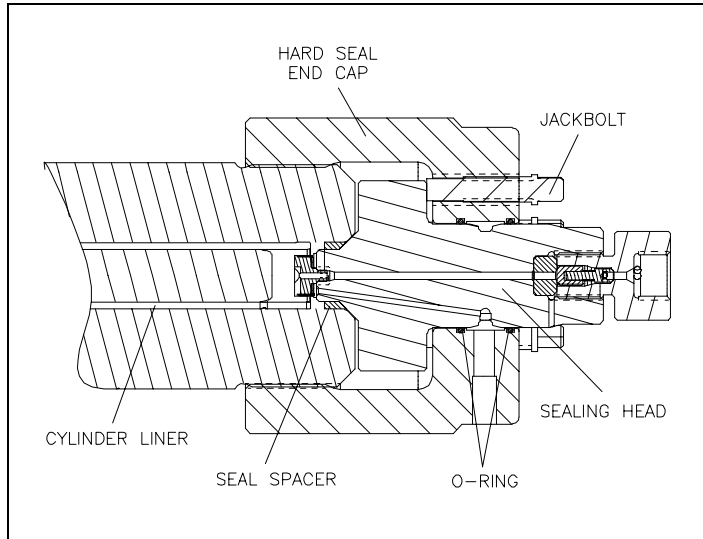
Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before proceeding.

Ensure all pressure is relieved or blocked from the hydraulic and high pressure circuits before proceeding.

2. Disconnect the high and low pressure water piping, following the procedure, High and Low Pressure Water Piping.
3. Loosen the jackbolts in the hard seal end cap.
4. Unscrew and remove the HSEC from the high pressure cylinder.
5. Remove the sealing head. The sealing head may be removed with the HSEC or after the end cap has been removed.
6. Verify the removal of the white plastic seal spacer used to position the sealing head relative to the high pressure cylinder. The spacer may come out with the sealing head. If

not, it must be removed from the cylinder bore prior to reinstalling the sealing head to avoid pushing it farther into the bore.

Figure 8-8: Hard Seal End Cap



Hard Seal End Cap Installation

1. Apply FML-2 grease to the two o-rings and verify they are properly installed in the inside diameter grooves of the HSEC. Check the high pressure cylinder bore to verify the presence of the cylinder liner and to ensure the old seal spacer has been removed from the bore.
2. Apply FML-2 grease to the inside and outside diameter of the seal spacer and position the spacer on the inlet end of the sealing head.
3. Place the sealing head and the spacer in the end of the high pressure cylinder and press the sealing head into the cylinder by hand.
4. Apply JL-M grease to the threads on the jackbolts. Ensure the jackbolts are slightly less than flush with the inner face of the end cap.
5. Slide the end cap over the sealing head until it makes contact with the sealing head. Fully engage the threads on the end cap with the high pressure cylinder. The cone seal on the sealing head should be in contact with the cylinder.
6. Unscrew the HSEC until the inlet water port is properly oriented to facilitate the low pressure water connection. **Do not** unscrew the HSEC more than one full turn.
7. Hand-tighten the jackbolts until they make contact with the sealing head.
8. Tighten the jackbolts following the tightening sequence and torque specifications in Table 8-1.

9. Connect the high and low pressure water piping and turn the low pressure water supply on.
10. Start the machine in low pressure mode to flush air from the high pressure components and to check for obvious leaks. After 5-10 strokes, switch to high pressure operation and check for leaks.

If leaks are detected, turn the machine off and remedy the problem. When the problem has been remedied, repeat the startup procedure, moving from low to high pressure soon after the intensifier starts pumping water. There is no further need to flush air from the system.

8.9 Sealing Head

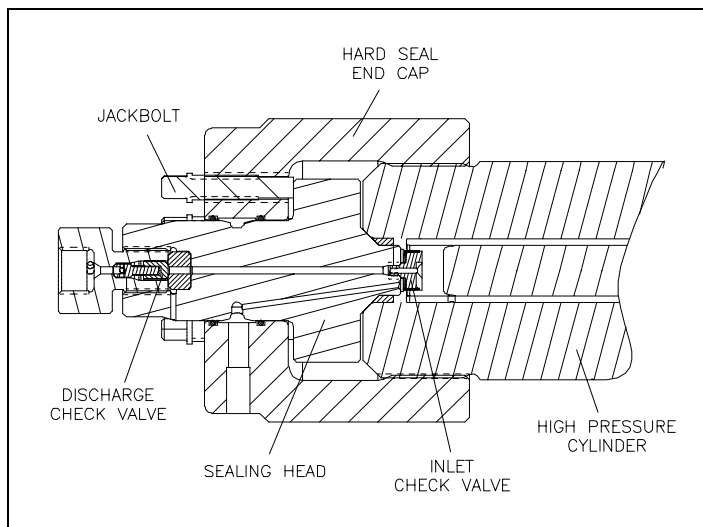
The sealing head is sealed to the outboard end of the high pressure cylinder by a 45-degree metal-to-metal compression seal. The pre-loading jackbolts in the hard seal end cap hold the sealing head against the end of the cylinder.

The inlet and discharge check valves in the sealing head ensure the low pressure and high pressure water only travels in the appropriate direction.



If normal operating pressure will not exceed 50,000 psi (3,447 bar), the alternate inlet poppet valve must be installed prior to operation. Follow the procedure Low Pressure Inlet Check Valve. Refer to Table 11-4, Section 11, Parts List.

Figure 8-9: Sealing Head



High Pressure Discharge Check Valve

The high pressure discharge check valves should be serviced on a regular, preventive maintenance schedule. Service is recommended every 1,500 hours. The discharge check valve can be serviced with the sealing head either installed or removed from the high pressure cylinder.

1. Turn the machine off and observe the appropriate Lockout/Tagout procedures.



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

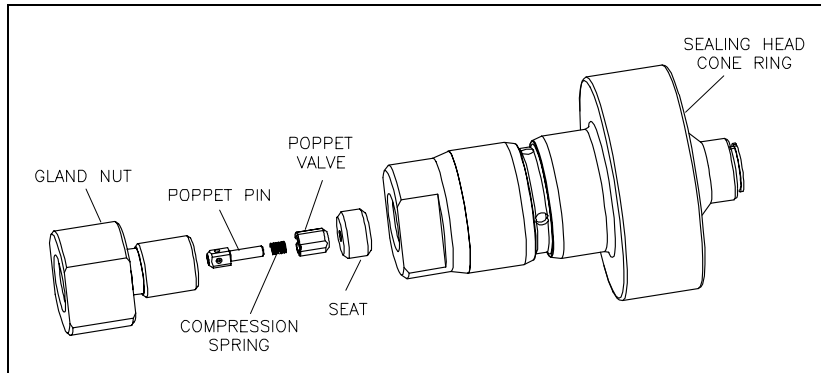
Ensure all pressure is relieved or blocked from the hydraulic and high pressure circuits before proceeding.

2. Disconnect the high pressure water piping, following the procedure, High and Low Pressure Water Piping.
3. Use two, 1-3/16" wrenches to remove the gland nut. The poppet pin, spring and poppet check valve will normally remain in the gland nut when it is removed. Remove the components from the gland nut.
4. Use a magnet to remove the seat from the sealing head.
5. Inspect the poppet pin for wear and replace the pin if worn.
6. Inspect both faces of the seat for damage or cracking. A cracked or damaged seat must be replaced. The seat can be installed with either face toward the poppet valve. If one face is worn, but the opposite is not, the seat can be reversed, placing the new surface toward the poppet valve. A slight burr at the hole edge identifies the used side of the seat. If both faces are worn, the seat must be replaced.

NOTE

The seat, spring and poppet valve should be replaced as a set. If one component requires replacement, replace all components.

Figure 8-10: High Pressure Discharge Check Valve



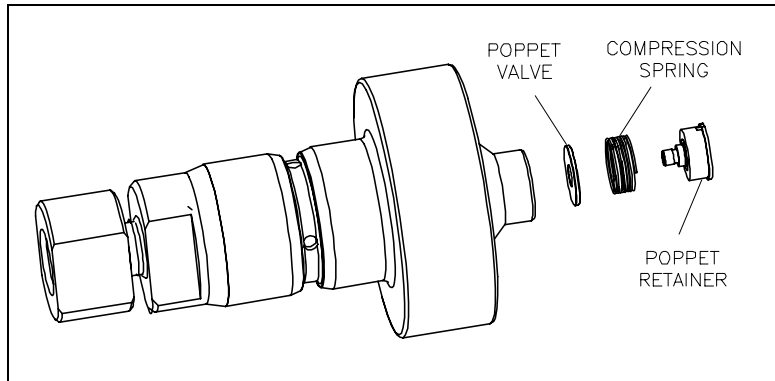
7. Apply a thin film of Pure Goop to the face of the seat opposite the poppet check valve and install the seat into the sealing head. If the existing seat is reused, install the seat with the new surface facing the poppet valve.
8. Install the poppet pin and the spring, with the larger end of the spring facing the poppet valve, and then install the poppet valve into the gland nut.
9. Apply Pure Goop to the sealing face and the threads on the gland nut and thread the gland nut into the sealing head. Hand tighten until there is a 0.20 inch (5 mm) gap between the gland nut and the sealing head. **No threads should show.** If the gap exceeds 0.20 inch (5 mm), the poppet or seat has slipped out of position. The parts must be removed, inspected and re-assembled.
10. Use a crowfoot/torque wrench combination and tighten the gland nut to the torque specifications in Table 8-1.

Low Pressure Inlet Check Valve

The inlet check valves should be serviced on a regular, preventive maintenance schedule. Service is recommended every 1,500 hours. The hard seal end cap must be removed to service the inlet check valve. Follow the procedure, Hard Seal End Cap Removal. When the end cap has been removed, proceed with Step 1 below.

1. Use a 1/2-inch flat blade screwdriver to remove the poppet retainer from the sealing head.
2. Inspect the sealing head for scratches or wear on the cone ring contact surface, and on the inlet poppet valve contact surface. If defects are detected, the surfaces must be refinished. See the procedure, Sealing Head Maintenance.

Figure 8-11: Low Pressure Inlet Check Valve



3. Inspect both faces on the inlet poppet valve. The poppet valve can be installed with either face toward the sealing head. If one face is worn, but the opposite is not, the poppet can be reversed, placing the best surface toward the sealing head. If both faces are worn, the poppet valve must be replaced.
4. Assemble the spring and the inlet poppet valve on the poppet retainer. Apply a small amount of Loctite 222 to the poppet retainer threads only. **Do not** get any Loctite on the poppet or any other surfaces on the inlet check valve.
5. Use the flat blade screwdriver to tighten the poppet retainer. Tighten the poppet retainer to the torque specifications in Table 8-1.
6. Inspect the assembled unit to ensure:
 - The poppet moves freely
 - The spring is fully guided on the poppet retainer
 - The spring end is 90 degrees from the screwdriver slot on the retainer
 - The poppet retainer is seated against the sealing head

Sealing Head Maintenance

The sealing head should be inspected for scratches, excessive sealing damage or erosion marking on the cone ring contact surface, and on the inlet poppet valve contact surface. If defects are detected, the surfaces must be refinished. The sealing head can be returned to KMT Waterjet for refinishing.

1. Clean the 45-degree surface on the cone ring with 600-grit wet/dry sandpaper, using a radial motion. It will not be possible to fully remove the main sealing marks.
2. Inspect the inlet poppet valve sealing surface for pits, scratches or jetting erosion. If necessary, refinish the surface.

Place a piece of 1/4-1/2" thick plate glass, not window glass, on a sturdy table to provide an absolutely flat surface. Place a piece of 400-grit wet/dry sandpaper on the glass. Use even, deliberate strokes, rotating the sealing head approximately 10-15 degrees after each

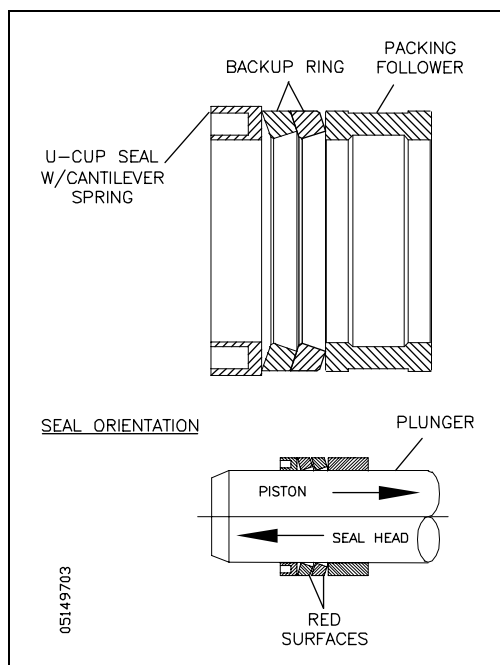
stroke. Polish the sealing head until it is flat and smooth. Be careful not to cause additional damage by tilting or tipping the part while polishing.

- When the sealing head is flat and smooth, perform a final polish with 600-grit wet/dry sandpaper.

8.10 High Pressure Seal Assembly

The following procedure should be used to replace the high pressure seal assembly.

Figure 8-12: High Pressure Seal Assembly



Prior to removing electrical power or any high or low pressure piping, start the machine and extend the plunger on the end to be serviced to allow full exposure when the unit is disassembled.

- Turn the machine off and observe the appropriate Lockout/Tagout procedures.



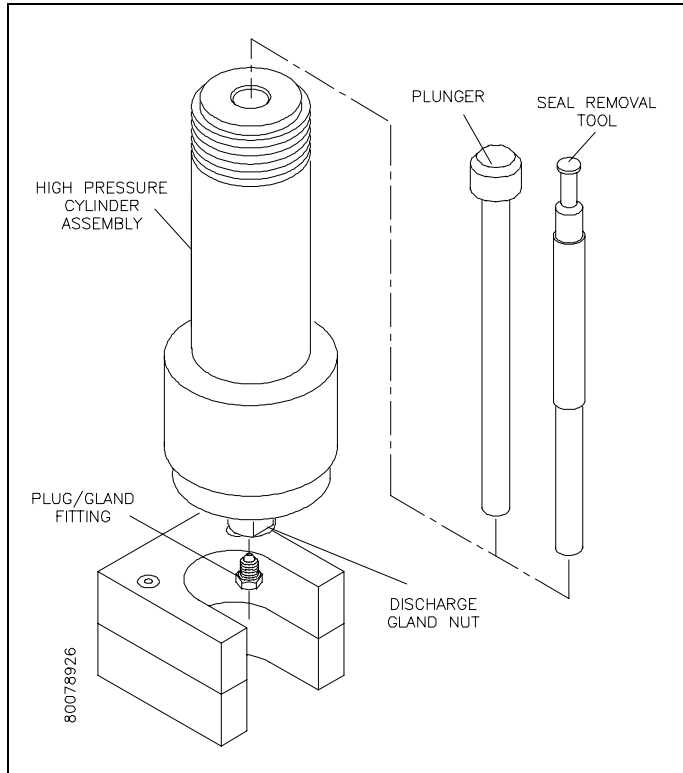
Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before proceeding.

Ensure all pressure is relieved or blocked from the hydraulic and high pressure circuits before proceeding.

- Disconnect the high and low pressure water piping, following the procedure, High and Low Pressure Water Piping.

3. Remove the high pressure cylinder assembly, following the procedure, High Pressure Cylinder Assembly Removal.

Figure 8-13: High Pressure Seal Removal



4. Apply Pure Goop to the threads on the high pressure plug and gland fitting. Thread the plug and gland fitting into the discharge gland nut on the sealing head and hand tighten.
5. Position the cylinder assembly upright in the seal removal tool stand. If a tool stand is not available, position the cylinder on a platform of wooden blocks with the jackbolts resting on the platform.



Do not stand the cylinder assembly on the top pan of the machine. The assembly is heavy and must be properly supported to prevent it from falling.

6. Fill the cylinder with water and slide the seal removal tool or a used plunger into the bronze packing follower to ensure a good seal for the removal of the seal assembly.
7. Place a shop towel around the plunger or seal removal tool to avoid splash back. Use a dead blow hammer to drive the removal tool or plunger into the cylinder until the seal components move up and out of the cylinder.

8. Remove the cylinder liner from the bore and inspect for possible heat or wear damage, or for debris. If cracks or brittleness are detected on the tabs on the ends of the liner, the liner must be replaced.
9. Feel approximately one inch into the cylinder bore for obvious ridges or grooves. If seal debris is present, follow the procedure, High Pressure Cylinder Maintenance.
10. Inspect the plunger surface for flaws. Rotate the plunger 360 degrees by hand while viewing light reflection on the surface to detect any dullness, streaks, pits or other defects. Run a fingernail perpendicular to the direction of the suspected flaws to determine the severity of defects. Depending on the seal life achieved with the removed seal assembly, make a judgment regarding plunger and/or cylinder replacement. If seal debris is present on the plunger, polish with 600-grit wet/dry sandpaper, using a radial motion.
11. Lightly coat the new seal components with FML-2 grease and install the new components on the plunger. Ensure the proper orientation of the backup rings as illustrated in Figure 8-12, High Pressure Seal Assembly.

The cantilever spring inside the u-cup seal is easily distorted. Verify that the spring, lips and cavity appear uniform prior to installation.

12. Slide the cylinder liner over the plunger.
13. Install the high pressure cylinder assembly into the hydraulic cylinder head, following the procedure, High Pressure Cylinder Assembly Installation.
14. Reconnect the high and low pressure water piping and turn the low pressure water supply on.

8.11 Hydraulic Cartridge Seal and Plunger Removal

The following procedure is used to remove the hydraulic cartridge seal and the plunger.

Prior to removing electrical power or any high or low pressure piping, start the machine and extend the plunger on the end to be serviced to allow full exposure when the unit is disassembled.

1. Turn the machine off and observe the appropriate Lockout/Tagout procedures.



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

Ensure all pressure is relieved or blocked from the hydraulic and high pressure circuits before proceeding.

2. Disconnect the high and low pressure water piping, following the procedure, High and Low Pressure Water Piping.

3. Remove the proximity switch on the end of the hydraulic cylinder to be serviced.
4. Remove the high pressure cylinder assembly, following the procedure, High Pressure Cylinder Assembly Removal.
5. Use a flat screwdriver to remove the retaining ring from the hydraulic cylinder head.
6. Remove the bushing retainer flange and clean the surfaces, weep holes and grooves. Check the retainer flange for cracks.
7. Replace the proximity switch by positioning the o-ring spacer and the switch. Apply JL-M grease to the threads on the socket head screws and tighten, following the torque specifications in Table 8-1.

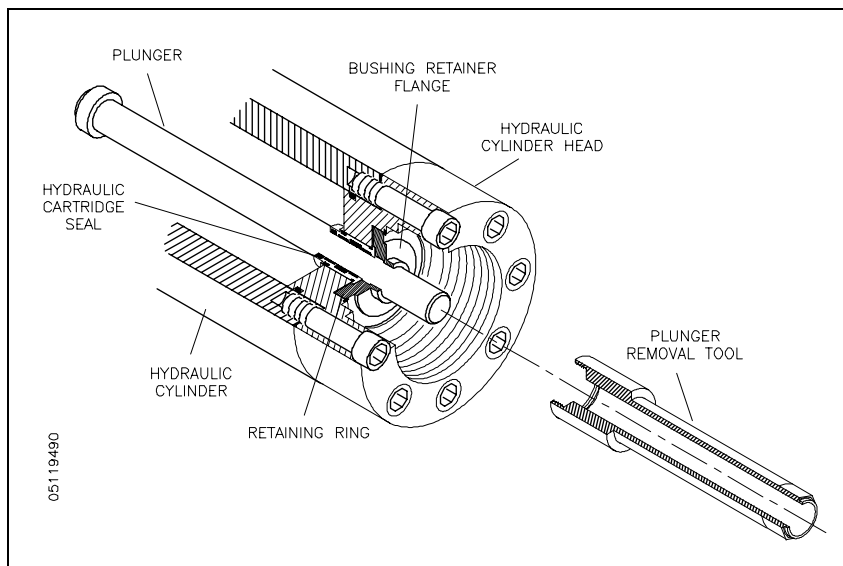


It is recommended that the proximity switch be reinstalled as soon as practical. Removal of the switch presents the potential of an oil spray hazard.

Ensure that the proximity switch is properly installed and secured prior to starting the machine. Failure to tighten the two hold down screws on the switch will result in the spray of hydraulic oil.

8. Thread the large end of the plunger removal tool onto the hydraulic cartridge seal and pull the cartridge out, over the plunger.

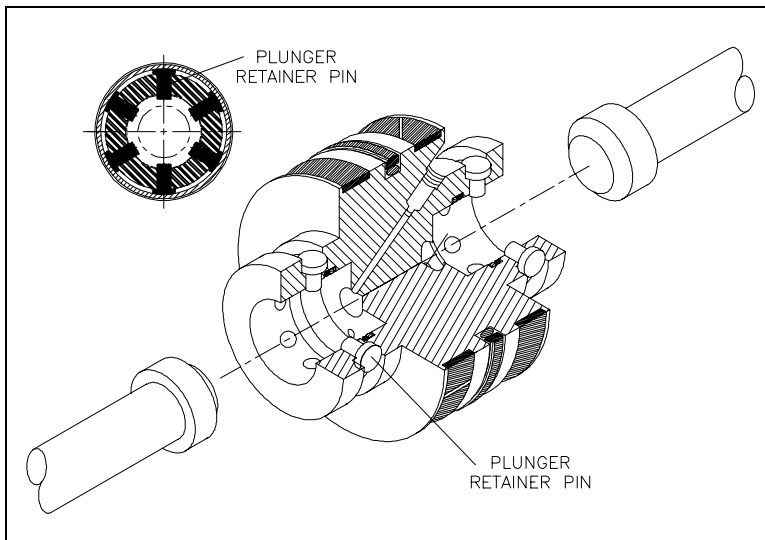
Figure 8-14: Hydraulic Cartridge Seal Removal



9. With the cartridge removed, the plunger can now be removed with the hydraulic cylinder head in place. The plunger is held in position by six retainer pins. The pins close around the plunger button to retain the plunger, and retract to release the plunger.

Slide the removal tool over the plunger with the hex shaped end toward the plunger button. Note the orientation of the retainer pins on the plunger button. Align the hex flats on the tool with the retainer pins and force the tool, by hand or with a dead blow hammer, under the pins. Rotate the tool slightly, causing the pins to retract and release the plunger. The plunger can now be removed from the hydraulic piston.

Figure 8-15: Plunger Retainer Pins

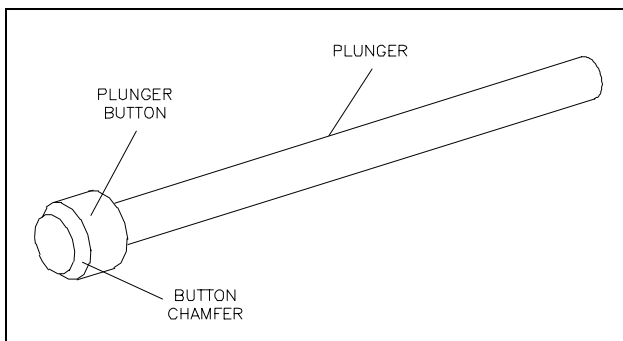


Plunger Maintenance

Plunger surfaces can become streaked with longitudinal scratches or flaws, and discolored or dull in appearance. If any of these conditions become severe, the high pressure seal assembly and possibly the hydraulic cartridge seal will leak.

Accumulation of debris on the surface of the plunger can be removed by polishing in a radial direction with 600-grit sandpaper. However, plunger surface flaws usually cannot be repaired on site. The plunger can be returned to KMT Waterjet for reconditioning.

Figure 8-16: Plunger



Plunger Installation

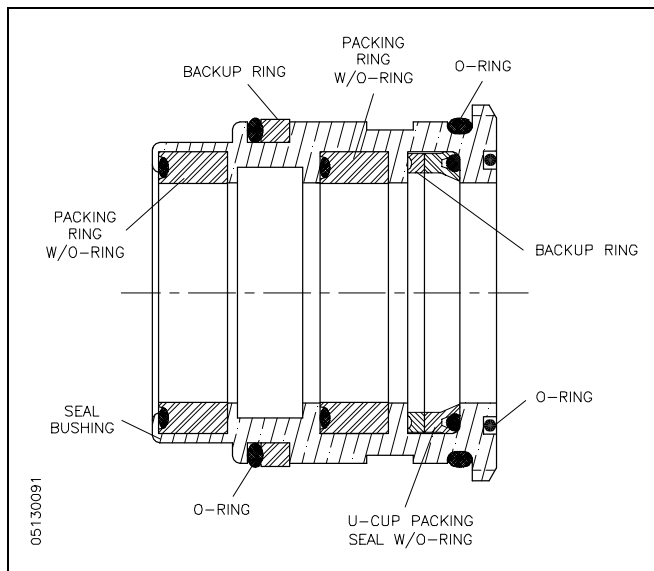
To install the plunger, slide the plunger removal tool over the plunger with the hex shaped end toward the plunger button to help center the plunger in the hydraulic cylinder head. Position the plunger in the button socket of the piston and force the plunger into place by hand. Use a flashlight to verify that all six pins are equally extended to grip the plunger button.

Hydraulic Cartridge Seal

Seals in the hydraulic cartridge can be removed and replaced, or the complete cartridge can be replaced.

Use caution during the removal and installation of the seal components to avoid scratching the surface of the cartridge. The seal removal tool, a plastic or wooden dowel, or similar object can be used for seal removal. **Do not** use screwdrivers, wires or other metal objects that could damage the cartridge. To avoid damaging the new seals, the seal installation tool can be used for installation.

Figure 8-17: Hydraulic Cartridge Seal



1. Carefully remove the worn seals and o-rings from the cartridge by pushing them with a plastic or wooden dowel, or similar object. Remove the seals closest to the open ends first, and work toward the center.
2. Inspect the seals for unusual wear, deformation or cuts. Note any unusual buildup of solid material or debris creating possible leak paths.
3. Inspect the surface of the cartridge body for scratches, deformation, signs of metal-to-metal contact or other unusual wear. Carefully examine the surface of the grooves on the inside diameter. Note any scratches in the axial direction that could create a leak path.



4. Apply FML-2 grease to the inside and outside diameter of the cartridge body, and to the individual seal components.
5. Install the seals, starting in the center and working toward the ends. See Figure 8-17 for the proper orientation of the u-cup seals. If available, use the seal installation tool to install the u-cup seals. See Figure 8-22, Pneumatic Valve Seal Tools.
6. Verify that the u-cup o-rings are properly positioned after installation.
7. When the seal components are properly installed, apply FML-2 grease to the exposed surfaces of the seals and slide the hydraulic cartridge seal over the plunger, into the cavity of the hydraulic cylinder head.
8. Thoroughly clean the bushing retainer flange, including the cross-drilled weep holes. Install the retainer flange over the plunger.
9. Install the retaining ring, ensuring the retaining ring fully seats inside the groove in the hydraulic cylinder head.

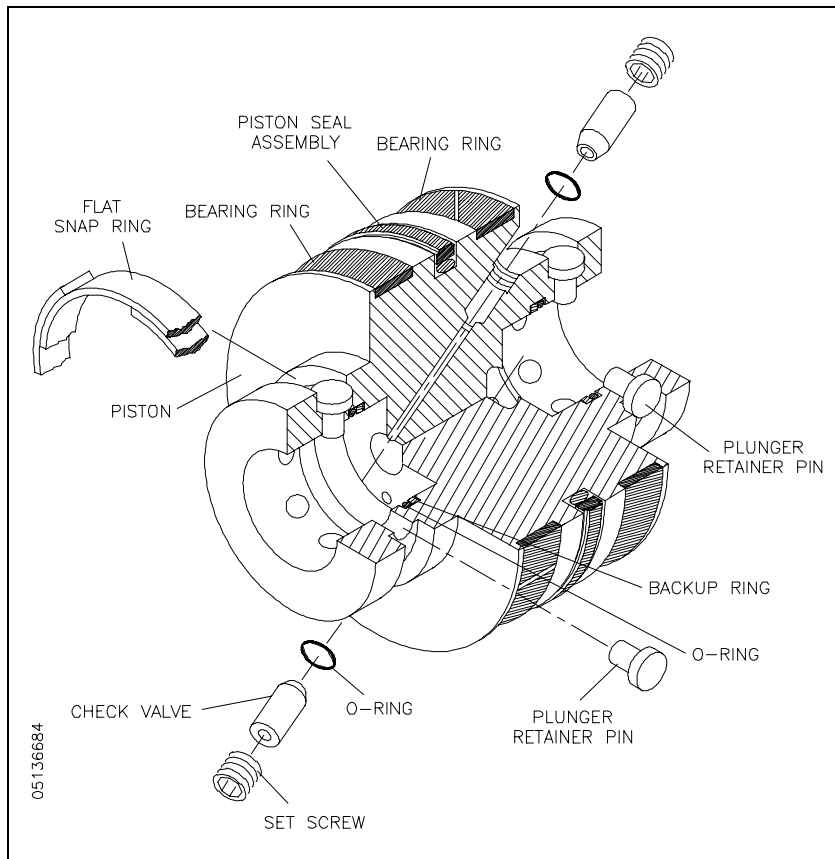
The o-rings on the hydraulic cartridge will take up clearance. Tap lightly on the bushing retainer flange with the plunger removal tool to compress the o-rings enough to start the retaining ring in the groove. Use a flat blade screwdriver to push on the outer edge of the retainer flange while working one end of the retaining ring into the groove. The retainer flange should tilt or tip enough to allow the retaining ring to move into the groove. Continue working the ring into the groove while tilting the retainer flange until the ring is fully seated.

10. Install the high pressure cylinder assembly into the hydraulic cylinder head, following the procedure, High Pressure Cylinder Assembly Installation.
11. Connect the high and low pressure water piping and turn the low pressure water supply on.

8.12 Hydraulic Piston

Two bearing rings provide wear contact between the piston and the inside diameter of the hydraulic cylinder. On each end of the piston, six retainer pins hold the plunger in position. The plunger retainer pins are held in place by a flat snap ring. Two internal check valves vent unwanted hydraulic pressure from one side of the piston to the other, preventing pressure from building behind the plunger button.

Figure 8-18: Hydraulic Piston Components



Hydraulic Piston Removal

The following procedure is used to remove the hydraulic piston.

1. Turn the machine off and observe the appropriate Lockout/Tagout procedures.

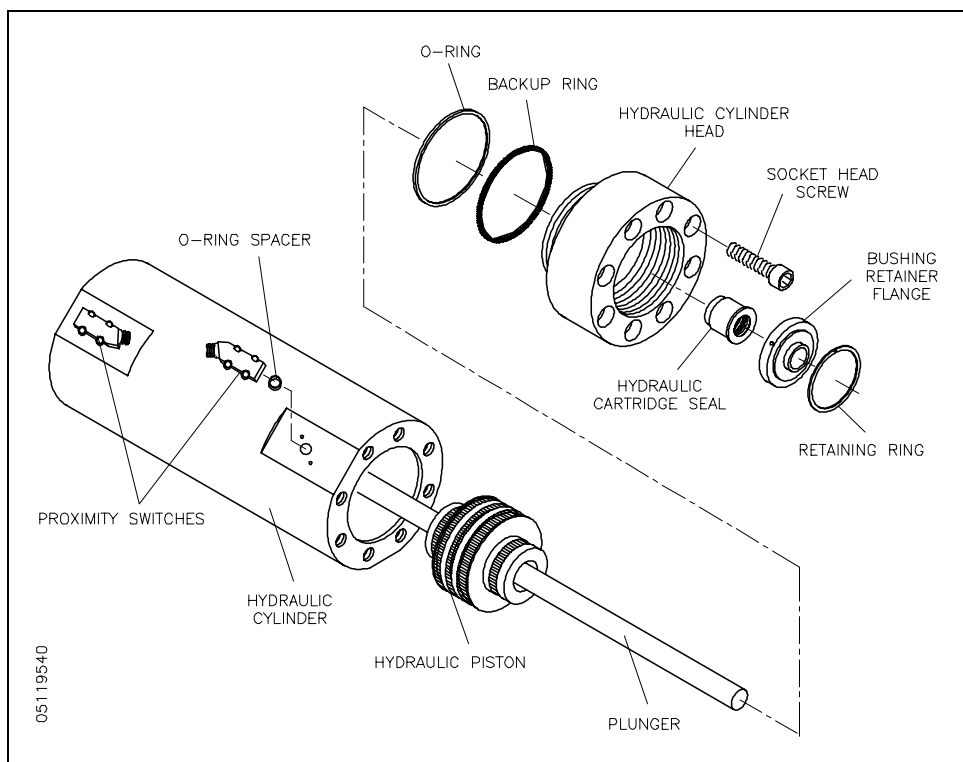


Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before proceeding.

Ensure all pressure is relieved or blocked from the hydraulic and high pressure circuits before proceeding.

2. Disconnect the high and low pressure water piping from both ends of the intensifier, following the procedure, High and Low Pressure Water Piping.
3. Remove the high pressure cylinder assembly on each end of the intensifier, following the procedure, High Pressure Cylinder Assembly Removal.

Figure 8-19: Hydraulic Piston Removal



4. Remove both of the proximity switches to prevent interference.
5. Remove the retaining ring, bushing retainer flange and the hydraulic cartridge seal from both hydraulic cylinder heads. It is not necessary to remove the plunger.
6. Loosen and remove the socket head screws in one of the hydraulic cylinder heads.

7. Remove the hydraulic cylinder head with the o-ring and backup ring. The mounting flat for the proximity switch provides a small lip for loosening the cylinder head.
8. Grasp the plunger firmly and pull the piston out of the hydraulic cylinder.

Bearing Rings and Seal Assembly

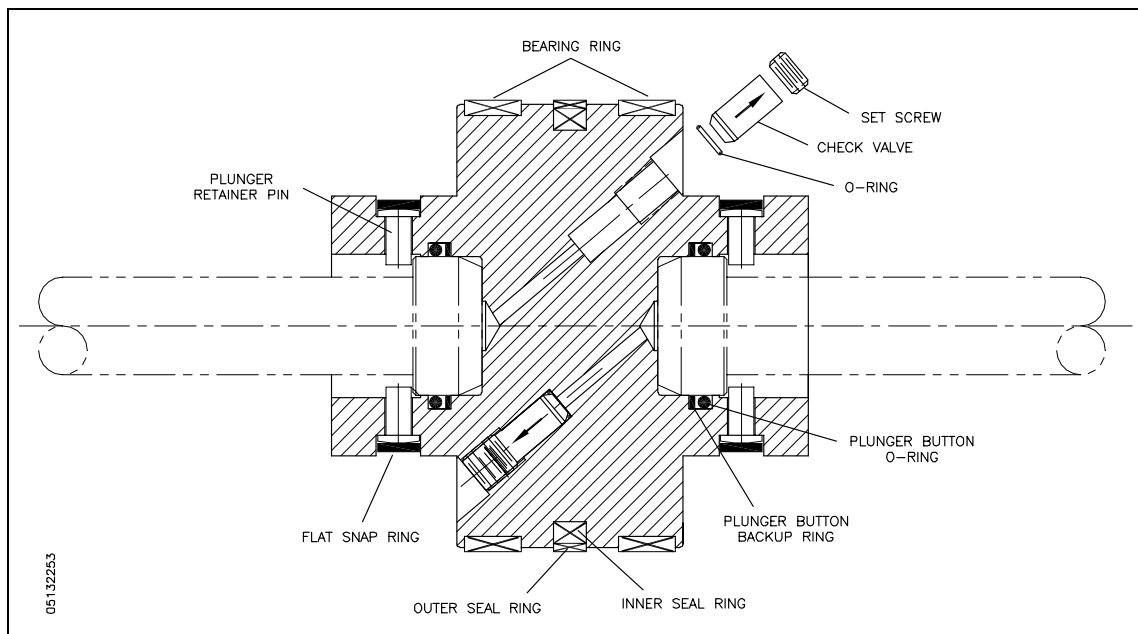
1. Remove the plungers.
2. Use a smooth, dull-edged blade made of brass or similar soft metal material to remove the two bearing rings and the seal assembly.

NOTE

Do not scratch the surfaces of the piston seal groove. Scratches on the sides or bottom of the groove can result in hydraulic leaks.

3. Inspect the bottom of the seal grooves for marks, scratches and residue buildup. Clean and/or repair the groove surfaces as required.
4. Apply FML-2 grease to the new bearing rings and install the rings.
5. The piston seal assembly consists of an inner and an outer seal ring. Apply FML-2 grease to both rings. Use the smooth, dull-edged blade to install the inner ring, ensuring the ring is not twisted after installation. Slide the outer seal ring over the metal edges and ease it into position over the inner ring.

Figure 8-20: Hydraulic Piston



Plunger Button Sockets, Seals and Retainer Pins

1. Remove the flat snap rings and plunger retainer pins on both ends of the piston.
2. Inspect the snap rings and the pins for unusual wear or deformation. Clean and inspect the pin holes for unusual wear, deformation or hole enlargement.
3. Remove the plunger button o-ring and backup ring from each plunger socket. Take care not to scratch or damage the seal groove surfaces.
4. Clean and inspect the seal grooves for residue buildup or surface marks that could cause seal leaks.
5. Inspect the plunger button sockets for unusual wear.

NOTE

Due to the high contact force between the piston and the plunger, the plunger may make an impression in the bottom of the socket. This compression mark or indentation is normal.

6. Apply FML-2 grease to new plunger button backup rings and o-rings. Install the rings in the internal groove in the plunger socket. If the backup ring is not installed the plunger can be forced out of the plunger socket.
7. Install the retainer pins, verifying that each pin moves freely without excess side play in the pin holes.
8. Install the flat snap rings over the pins.
9. Install the plungers and check the snap-in feature of the plunger attachment. Use the plunger removal tool to ensure the pins retract to release the plunger, and close to retain the plunger in a uniform manner.

Internal Check Valves

It is not necessary to service the internal check valves unless a problem is suspected. If the check valves or the internal passages in the piston require service, plunger button, seal and pin servicing is also recommended. See Figure 8-20, Hydraulic Piston.

1. Loosen the set screw and remove the check valves and o-rings. Clean the internal passages.
2. Apply FML-2 grease to a new o-ring and install the new o-ring in the check valve passage. Use a blunt, pencil-like instrument to position it in the bottom of the passage.
3. Clean and install a new check valve with the chamfered end toward the o-ring.

4. Sparingly apply Loctite, threadlocker adhesive to the set screw. Thread the screw over the check valve cartridge and tighten.

NOTE

Excess threadlocker adhesive can clog the check valve or block the internal passage. To avoid excess adhesive, position the set screw on an allen wrench and apply the adhesive. Hold the screw horizontal on a paper towel and rotate the screw to remove excess adhesive.

Hydraulic Piston Installation

1. Ensure that the hydraulic cylinder bore is free of grit or contamination.
2. Lubricate the bearing rings and seal assembly, and lightly lubricate 2-3 inches of the cylinder bore with FML-2 grease.
3. Install the piston into the hydraulic cylinder bore. If necessary, use a plastic head hammer to drive the piston into position between the holes for the proximity switches.
4. Install the plungers and check the snap-in feature of the plunger attachment. Use the plunger removal tool to ensure the pins retract to release the plunger, and close to retain the plunger in a uniform manner.
5. Verify that the o-ring and backup ring are properly positioned in the groove on both hydraulic cylinder heads, and that they are sufficiently lubricated with FML-2 grease.
6. Position the cylinder heads in the ends of the hydraulic cylinder. Apply JL-M grease to the threads on the socket head screws. Install the screws in each hydraulic cylinder head and tighten, following the torque specifications in Table 8-1.
7. Replace the hydraulic cartridge seal, bushing retainer flange and retaining ring in both hydraulic cylinder heads.
8. Replace the proximity switches by positioning the o-ring spacers and the switches. Apply JL-M grease to the threads on the socket head screws and tighten, following the torque specifications in Table 8-1.



Ensure that the proximity switches are properly installed and secured prior to starting the motor. Failure to tighten the two hold down screws on each switch will result in the spray of hydraulic oil.

9. Install the high pressure cylinder assemblies into the hydraulic cylinder heads, following the procedure, High Pressure Cylinder Assembly Installation.



10. Connect the high and low pressure water piping. And turn the low pressure water supply on.

8.13 Hydraulic Cylinder Maintenance

The inside diameter surface of the hydraulic cylinder should be inspected for wear grooves and surface finish whenever the hydraulic cylinder heads are removed. Excessive grooving is indicative of piston seal wear.

8.14 High Pressure Attenuator

The high pressure attenuator is not serviceable at the customer level. KMT Waterjet Systems tests the seals in the attenuator at pressures exceeding normal operating pressure, making disassembly difficult. If the attenuator develops a high pressure water leak, it should be replaced.

8.15 Optional High Pressure Dump Valve

The high pressure dump valve assembly includes a normally open high pressure water valve and a solenoid operated air valve. The following procedure is recommended for servicing the high pressure dump valve. Failure to follow this procedure will cause damage to the stem, valve seat, or both.



The high pressure dump valve is a safety device designed to instantly release high pressure from the system. **Proper maintenance is imperative** to prevent potential personal injury.

Figure 8-21: High Pressure Dump Valve

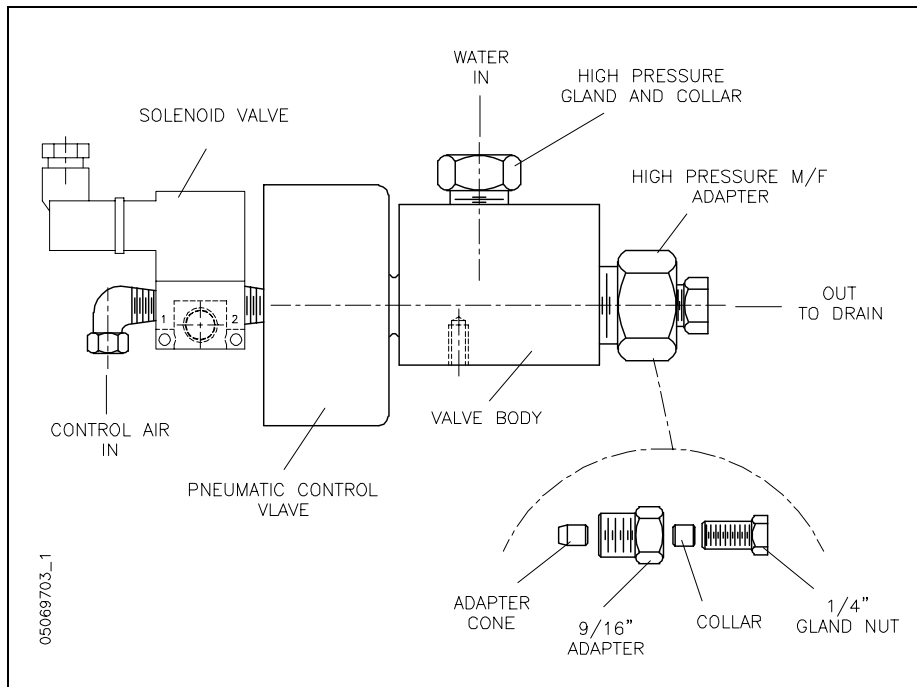
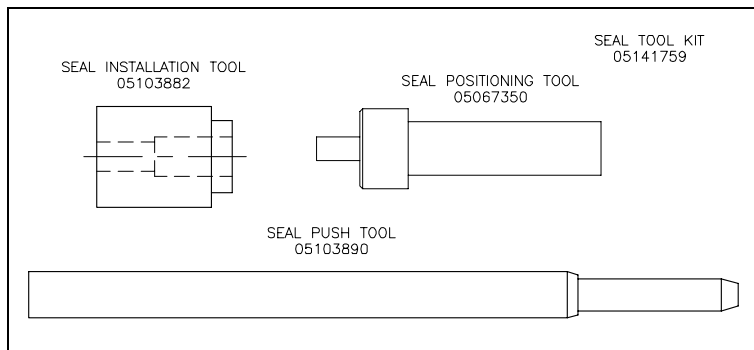


Figure 8-22, Pneumatic Valve Seal Tools, illustrates the special seal tools recommended for this procedure.

Figure 8-22: Pneumatic Valve Seal Tools



Pneumatic Control Valve

For reliable operation, it is recommended that the valve seat, seal assembly, brass backup ring and stem always be replaced at the same time. The SST backup ring can be reused.

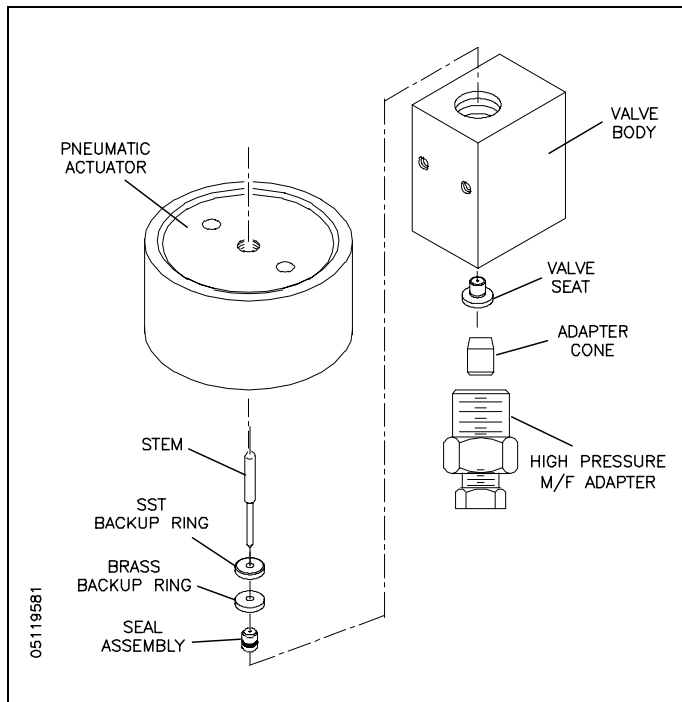


Severe injury can result if the machine is not properly locked out. Observe electrical Lockout/Tagout procedures before proceeding.

Ensure all pressure is relieved or blocked from the hydraulic and high pressure circuits before proceeding.

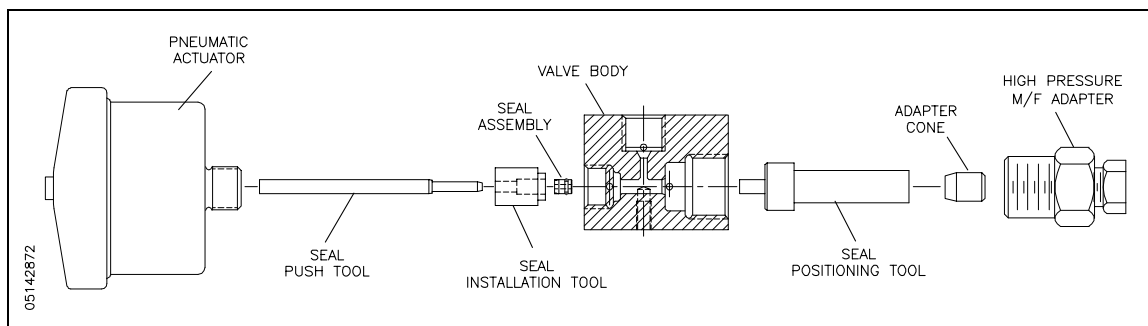
1. Turn the air supply off.
2. Remove the air supply hose, and the electrical connection to the solenoid valve.
3. Loosen and remove the high pressure gland connection and the drain connection.
4. Remove the valve and actuator assembly from the machine.

Figure 8-23: Pneumatic Control Valve Components



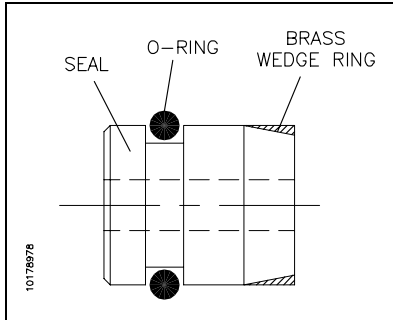
5. Loosen the cylinder head on the actuator. Unscrew and remove the actuator from the valve body.
6. Unscrew the high pressure adapter and remove the adapter, adapter cone and valve seat.
7. Remove the stem, SST backup ring and brass backup ring from the valve body.
8. Remove the seal assembly by pushing it with a dowel rod made of wood, plastic or brass. The seal push tool can also be used to remove the seal assembly. The assembly must be pushed out through the actuator port in the top of the valve body.
9. Clean the valve body, being careful not to damage or scratch the bore.

Figure 8-24: Valve Seal Installation



10. To replace the seal assembly, first remove the brass wedge ring. Lubricate a new seal and o-ring with FML-2 food grade grease. Insert the seal and o-ring into the seal installation tool, inserting the tapered end of the seal first.

Figure 8-25: Seal Assembly



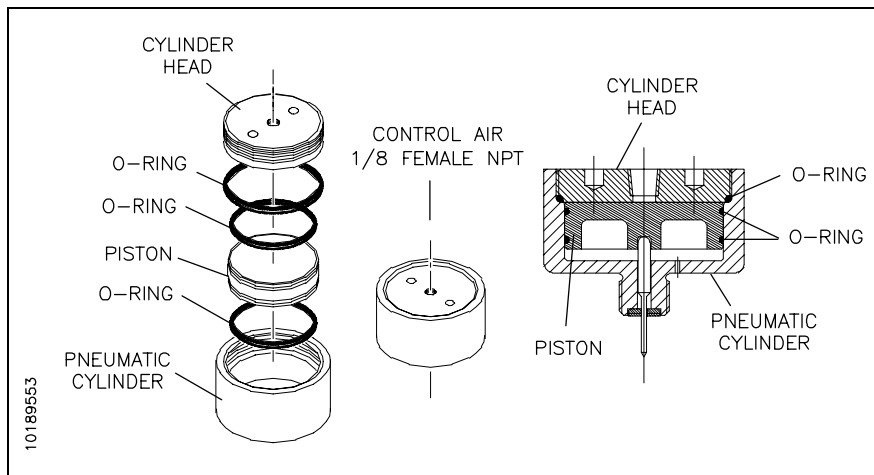
11. Place the seal positioning tool into the opposite end of the valve body, using the high pressure adapter to hold the positioning tool.
12. With the seal in position, place the seal installation tool into the mating cavity of the valve body. Hold the positioning tool in place and use the seal push tool to push the seal into the bore of the valve body until the shoulder of the push tool contacts the seal installation tool.
13. Remove the push tool, installation tool and positioning tool.
14. Place the brass wedge ring, thick end first, onto the seal push tool and use it as a guide to position the wedge ring onto the seal. Remove the push tool and ease the wedge ring lightly onto the seal with the tip of your finger.
15. Install the existing SST backup ring and a new brass backup ring on a new stem. The vee groove on the SST backup ring should face toward the brass backup ring. The small OD of the brass backup ring should face toward the seal assembly. See Figure 8-23, Pneumatic Control Valve Components.
16. Insert the assembly into the top of the valve body so the stem enters the ID of the seal assembly.
17. Apply anti-seize compound to the threads of the actuator and carefully thread it into the valve body, guiding the stem head into the hole in the actuator. Turn the actuator clockwise until resistance is felt. Reverse the actuator 1/4 turn, and give it a quick spin clockwise to seat it. **Hand tighten only, 5 ft-lbs (7 Nm).**
18. Apply anti-seize compound to all surfaces, except the ID, of a new valve seat. Install the seat into the valve body, inserting the small OD first.
19. Apply anti-seize compound to the threads on the high pressure adapter, and on the back side of the adapter cone. Position the adapter cone in the adapter, install the adapter and torque to 50 ft-lbs (68 Nm).
20. Replace the 1/4-inch drain gland nut and collar and torque to 25 ft-lbs (34 Nm).

21. Apply anti-seize compound to the threads on the 3/8-inch high pressure gland fitting. Install the collar and the gland fitting and torque to 50 ft-lbs (68 Nm).
22. Install the air supply hose and the electrical connection to the solenoid valve. Turn the air pressure to the actuator on and test the valve for leaks and proper operation.

Pneumatic Actuator

The following procedure is used to service the pneumatic actuator.

Figure 8-26: Pneumatic Actuator



1. Unscrew and remove the cylinder head. Remove the piston from the cylinder.
2. Remove the o-ring on the cylinder head. Apply FML-2 grease to a new o-ring and install.
3. Remove the two o-rings on the piston. Apply FML-2 grease to two new o-rings and install.
4. Install the piston in the pneumatic cylinder. Apply anti-seize compound to the threads on the cylinder head and screw it into the pneumatic cylinder.

8.16 Weep Holes

High pressure seals and connections fail gradually and begin leaking slowly. Weep holes are located at every threaded high pressure connection to provide a vent for internal leaks. Water or oil dripping from a weep hole indicates one or more internal components are beginning to fail.

Table 8-3 lists the location of the weep hole, the possible source of the leak and the corrective action required.

Table 8-3
Weep Holes
High Pressure Water System

Location	Indication	Comments
<i>Hydraulic Cylinder Head</i>		
Hydraulic oil leaking from the weep hole in the hydraulic cylinder head	Failed hydraulic cartridge seal	Replace the cartridge seal. If the leak persists, check the plunger for linear scratches or scoring.
Water leaking from the weep hole on the hydraulic cylinder head flange	Failed high pressure seal assembly	Replace the high pressure seal assembly.
	Damaged plunger	Check the plunger for longitudinal scratches or flaws. If detected, replace the plunger or return to KMT for evaluation and rework.
	Seal material buildup on plunger	Polish the plunger surface following the procedure, Plunger Maintenance.
	Damaged high pressure cylinder	Check for scratches, grooves or material buildup on the inside diameter of the cylinder. If detected, polish the bore following the procedure, High Pressure Cylinder Maintenance.
		Check the inside diameter of the cylinder for expansion where the high pressure seal assembly is located. If detected, replace the cylinder.



Table 8-3
Weep Holes
High Pressure Water System

Location	Indication	Comments
<i>Sealing Head</i>		
Water leaking from the weep hole in the sealing head	Seat in the discharge check valve is not sealing properly	Make sure the gland nut is tightened to the proper torque specification.
		Inspect the seat, sealing head and gland nut for scratches, erosion or cracks.
	Internal crack in sealing head	Replace the sealing head. <i>A cracked sealing head can result in water leaking from the high pressure outlet passage to the low pressure inlet passages.</i> <i>The sealing head body can become extremely hot.</i>
	Improper torque on gland nut	Tighten the gland nut to the proper torque specification.
	Erosion or scratches on the contact surface of the sealing head, or on the gland nut where the seat makes contact	Polish the surfaces following the procedure, Sealing Head Maintenance.
Water leaking from the weep hole in the gland nut	High pressure piping gland nut is not tight and is not sealing properly	Tighten the gland nut to the proper torque specification.
	Improper high pressure piping connection	Check the number of exposed threads past the collar on the high pressure piping. Only 1-1/2 to 2-1/2 threads should be exposed.
		Check high pressure piping for damage, cracks or deformation.
		Inspect the gland nut for deformation of the threads.
	Damaged sealing head gland nut	Check the gland nut for cracks due to fatigue. If cracks are detected, replace the gland nut.



Table 8-3
Weep Holes
High Pressure Water System

Location	Indication	Comments
<i>Hard Seal End Cap</i>		
Water leaking from the weep holes in the hard seal end cap	Damaged high pressure cylinder	Check for scratches or grooves on the 45-degree cone seal surface. If detected, polish to remove following the procedure, High Pressure Cylinder Maintenance.
		Replace the high pressure cylinder.
	External crack in sealing head	Replace the sealing head.
	Damaged sealing head	Check for scratches or grooves on the 45-degree surface of the sealing head. If detected, polish the surface following the procedure, Sealing Head Maintenance.
	Improper torque on jackbolts	Torque the jackbolts to the proper torque specification.



SECTION 9

TROUBLESHOOTING

9.1 Overview

The troubleshooting guide will help identify the probable cause of a system malfunction and assist in providing corrective action. The following symptoms are discussed in this section:

1. High oil temperature
2. Low oil level
3. Restricted or no cooling flow
4. Hydraulic pressure but no high pressure water pressure
5. No hydraulic oil pressure
6. Pump shaft will not turn
7. Pump will not start
8. Pump quits running
9. Abnormal fluctuations in high pressure water signal
10. Hot surfaces on the high pressure cylinder components
11. Low cutting water supply pressure
12. Low cutting water pressure
13. Hydraulic oil leaking from the weep hole in the hydraulic cylinder head
14. Water leaking from the weep hole on the hydraulic cylinder head flange
15. Water leaking from the weep hole in the sealing head
16. Water leaking from the weep hole in the sealing head gland nut
17. Water leaking from the weep holes in the hard seal end cap

Optional Booster Pump and Low Pressure Water Filter

18. High boosted water temperature
19. Booster pump pressure drop is greater than 30 psi (2 bar) during stroke condition
20. Outlet booster pump pressure is falling below 60 psi (4 bar)
21. Inlet water flow is poor and the filter housing is not filling completely
22. Water is leaking around the bleed valve on the filter head



9.2 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 KMT Customer Service Department for assistance.

S30 Troubleshooting Guide

	Malfunction	Indication	Comments
1.	High oil temperature	Cooling water flow is restricted	Check cooling water source for proper temperature and flow rate.
		Water modulating valve is stuck open or closed	Replace the valve.
		Scale build up in the heat exchanger has restricted the flow	The heat exchanger will need to be flushed or replaced.
2.	Low oil level		Check the level gauge.
			Check for hydraulic leaks.
			Check the level switch.
3.	Restricted or no cooling flow	Check cooling water flow to and from the heat exchanger	The water pressure differential across the heat exchanger requires a minimum of 35 psi (2.4 bar) for flow through the exchanger.
		Water modulating valve is stuck or out of adjustment	Replace the valve.
			Adjust the valve.
4.	Hydraulic pressure but no high pressure water pressure	Proximity switch failure	Jog the intensifier left and right and verify that the red light comes on at both proximity switches.
		Coil failure on the directional control valve	Check the coils on the directional valve with a volt meter to verify if they are good or bad.

S30 Troubleshooting Guide

	Malfunction	Indication	Comments
5.	No hydraulic oil pressure	The high and low limit compensators on the hydraulic pump are blocked with debris and are not controlling the swashplate	Disassemble the compensators, clean and inspect the components following the maintenance procedure in Section 6, Hydraulic System.
		Incorrect motor rotation	Check the motor rotation.
6.	Pump shaft will not turn	The flexible coupling has failed	Replace the flexible coupling.
		Hydraulic pump has seized	Replace the hydraulic pump.
7.	Pump will not start	Emergency stop button is depressed	Check all remote E-STOP buttons.
		Main power is disconnected	Check the main power and verify that the main power disconnect is on.
8.	Pump quits running	Electrical power has been interrupted	Check the power supply circuit for a tripped breaker.
			Verify that power is available at the main power source.



S30 Troubleshooting Guide

	Malfunction	Indication	Comments
9.	Abnormal fluctuations in high pressure water signal	Large, worn or damaged orifice	Make sure the orifice does not exceed the capacity of the pump.
			Make sure the orifice is in good working condition. Verify that the jewel is installed in the orifice mount.
		Check valve leakage	Inspect the discharge check valves in the sealing heads.
			Inspect the inlet check valves in the sealing heads.
		Seal leakage	Inspect the high pressure seal on the plunger.
			Inspect the sealing head-to-cylinder sealing surfaces.
		Hydraulic control malfunction	Check the operation of the hydraulic relief valve.
			Verify that the directional control valve is shifting properly.
			Check the operation of the proximity switches.

S30 Troubleshooting Guide

	Malfunction	Indication	Comments
10.	Hot surfaces on the high pressure cylinder components	Leaking discharge check valve	Inspect the condition of the seat, poppet valve, spring, poppet pin and sealing head surface on the discharge end of the sealing heads.
		Leaking inlet check valve	Inspect the condition of the poppet valve, poppet retainer and the spring on the inlet end of the sealing heads.
		Damaged sealing head	Check the cone flange surface of the sealing head for scratches or mechanical damage and replace if necessary.
		Damaged high pressure cylinder	Check the high pressure cylinder for cracks.
11.	Low cutting water supply pressure	Restricted water supply	Check cutting water supply flow and pressure.
		Clogged water filter <i>Not applicable for base units.</i>	Check the condition of the low pressure water filter and replace the filter element if necessary.
		Trapped air <i>Not applicable for base units.</i>	Bleed the air from the cutting water plumbing.
12.	Low cutting water pressure	Low hydraulic pressure setting	If operating in low pressure, switch to high pressure operation and check the hydraulic pressure setting.
			Clean the high pressure adjustment valve.
			Clean the compensators on the hydraulic pump.
13.	Hydraulic oil leaking from the weep hole in the hydraulic cylinder head	Failed hydraulic cartridge seal	Replace the cartridge seal. If the leak persists, check the plunger for linear scratches or scoring.



S30 Troubleshooting Guide

	Malfunction	Indication	Comments
14.	Water leaking from the weep hole on the hydraulic cylinder head flange	Failed high pressure seal assembly	Replace the high pressure seal assembly.
		Damaged plunger	Check the plunger for longitudinal scratches or flaws. If detected, replace the plunger or return to KMT Waterjet for evaluation and rework.
		Seal material buildup on plunger	Polish the plunger surface following the procedure, Plunger Maintenance, detailed in Section 8, High Pressure Water System.
		Damaged high pressure cylinder	Check for scratches, grooves or material buildup on the inside diameter of the cylinder. If detected, polish the bore following the procedure, High Pressure Cylinder Maintenance, detailed in Section 8, High Pressure Water System.
			Check the inside diameter of the cylinder for expansion where the high pressure seal assembly is located. If detected, replace the cylinder.

S30 Troubleshooting Guide

Malfunction		Indication	Comments
15.	Water leaking from the weep hole in the sealing head	Seat in the discharge check valve is not sealing properly	Make sure the gland nut is tightened to the proper torque specification.
			Inspect the seat, sealing head and gland nut for scratches, erosion or cracks.
		Improper torque on gland nut	Tighten the gland nut to the proper torque specification.
		Erosion or scratches on the contact surface of the sealing head, or on the gland nut where the seat makes contact	Polish the surfaces following the procedure, Sealing Head Maintenance, detailed in Section 8, High Pressure Water System.
		Internal crack in sealing head	<p>Replace the sealing head.</p> <p><i>A cracked sealing head can result in water leaking from the high pressure outlet passage to the low pressure inlet passages.</i></p> <p><i>The sealing head body can become extremely hot.</i></p>
16.	Water leaking from the weep hole in the sealing head gland nut	High pressure piping gland nut is not tight and is not sealing properly	Tighten the gland nut to the proper torque specification.
		Improper high pressure piping connection	Check the number of exposed threads past the collar on the high pressure piping. Only 1-1/2 to 2-1/2 threads should be exposed.
			Check high pressure piping for damage, cracks or deformation.
			Inspect the gland nut for deformation of the threads.
		Damaged sealing head gland nut	Check the gland nut for cracks due to fatigue. If cracks are detected, replace the gland nut.

S30 Troubleshooting Guide

S30 Troubleshooting Guide			
Malfunction		Indication	Comments
17.	Water leaking from the weep holes in the hard seal end cap	Damaged high pressure cylinder	Check for scratches or grooves on the 45-degree cone seal surface. If detected, polish to remove following the procedure, High Pressure Cylinder Maintenance, detailed in Section 8, High Pressure Water System.
			Replace the high pressure cylinder.
		External crack in sealing head	Replace the sealing head.
		Damaged sealing head	Check for scratches or grooves on the 45-degree surface of the sealing head. If detected, polish the surface following the procedure, Sealing Head Maintenance, detailed in Section 8, High Pressure Water System.
		Improper torque on jackbolts	Torque the jackbolts to the proper torque specification.
Optional Booster Pump and Low Pressure Water Filter			
18.	High boosted water temperature	Orifice is blocked with debris	
		Long deadhead condition	
		Insufficient water supply	
		Booster pump temperature switch malfunction	
19.	Booster pump pressure drop is greater than 30 psi (2 bar) during stroke condition	Inlet water pressure or flow is low	
		Filter element is dirty and needs to be replaced	
		Booster pump is starting to fail	If the pressure consistently drops below 60 psi (4 bar) the pump will need to be replaced.



S30 Troubleshooting Guide

S30 Troubleshooting Guide			
Malfunction		Indication	Comments
20.	Outlet booster pump pressure is falling below 60 psi (4 bar)	Inlet water pressure is low	
		Filter element is dirty and needs to be replaced	
		Booster pump needs to be adjusted or replaced	Booster pump should be adjusted to 120 psi (8 bar) when deadheaded.
21.	Inlet water flow is poor and the filter housing is not filling completely	Pipe sizing for inlet cutting water should be checked for pressure and flow	Cutting water supply will be lacking capacity or flow.
22.	Water is leaking around the bleed valve on the filter head	O-ring that closes the passage has deteriorated	A small o-ring under the valve can deteriorate causing the passage to remain open. The o-ring can be replaced by removing the screw and spring on the underneath side.



SECTION 10

SPECIFICATIONS

10.1 Overview

Comprehensive listings of specifications for the Streamline S30 are provided in this section.

Table 10-1
Streamline S30

Model	Motor Horsepower Rating	
	HP	Kw
S30	30	22

10.2 Installation Specifications

Environment

Installation location	Indoors
Air borne dust/contaminants	Minimal
Ambient temperature	
Minimum storage	36° F (2° C)
Minimum operating	40° F (5° C)
Maximum operating	104° F (40° C)
Maximum relative humidity* (at maximum operating temperature)	95%

***Note:** When the relative humidity is above 50%, the oil in the reservoir should be checked frequently for water content.



Equipment Dimensions and Weights

Total Length	Base Length	Width	Height	Weight
53.50" (1,359 mm)	44.00" (1,117 mm)	32.39" (823 mm)	37.00" (940 mm)	1,750 lbs (794 kg)
<i>Redundant Model</i>				
	39.07" (992 mm)	28.25" (718 mm)		2,030 lbs (921 kg)

Service Connections

Cutting Water Out	9/16" HP Connection
Plant Air In (optional)	1/4" NPT Connection
Cooling Water In	1/2" NPT Connection
Cooling Water Out	1/2" NPT Connection
Cutting Water In	1/2" NPT Connection
Drain (optional)	1/2" NPT Connection

10.3 Water Specifications

Cutting Water Supply (Low Pressure Water System)

Minimum inlet flow	2.5 gpm (9.5 L/min)
Minimum inlet water pressure	35 psi (2.4 bar) flowing, with optional booster pump 60 psi (4 bar) flowing, without booster pump
Maximum inlet water pressure	100 psi (6.9 bar)
Maximum booster outlet water pressure	120 psi (8.3 bar)
Booster pump factory set inlet pressure	58 psi (4 bar)
Booster pump factory set outlet pressure	120 psi (8.3 bar)
Optimum inlet water temperature	65° F (18° C)
Maximum inlet water temperature	85° F (29° C)
Booster pump overheat, recommended	128° F (53° C), with optional booster pump

Recirculation System

Reservoir capacity	28 gal (106 L)
Low oil level shutdown, recommended	21 gal (80 L)
Maximum cooling water consumption at 75° F (24° C)	2.5 gpm (9.5) L/min
Total heat rejection	5.3 HP (4.0 kW)
Minimum operating oil temperature	60° F (15° C)
Optimum operating oil temperature	115° F (46° C)
Hot oil shutdown (maximum operating oil temperature), recommended	144° F (62° C)
Minimum inlet cooling water pressure	35 psi (2.4 bar)
Maximum inlet cooling water pressure	100 psi (6.9 bar)
Oil filtration rating (Beta filtration rating)	$\beta_{10} \geq 100^*$
Fluid cleanliness rating (ISO fluid cleanliness rating))	17/14**
Nominal recirculation pressure	30 psi (2 bar)

Recommended oil type

General service	Mobil #DTE Heavy Medium, No. 021029 Conoco Hydroclear TM multi- purpose R&O
Food service	Anderol PQ AA-20 Food Grade Oil

* **Note:** For each particle per milliliter downstream of the filter greater than 10 microns, there are 100 particles per milliliter larger than 10 microns upstream of the filter.

****Note:** Indicates ISO 4406 range numbers for maximum permissible number of particles per milliliter, greater than 5 and 15 microns.

17 <1,300 particles per milliliter, >5 microns

14 <160 particles per milliliter, >15 microns

Water Quality Standards

The quality of the inlet cutting 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.



Table 10-2
Water Quality Standards

Constituent (mg/l)	Minimum Requirement	Better	Best
Alkalinity	50	25	10
Calcium	25	5	0.5
Carbon Dioxide	0	0	0
Chloride	100	15	1
Free Chlorine	1	1	0.05
Iron	0.2	0.1	0.01
Magnesium as Mg	0.5	0.1	0.1
Manganese as Mn	0.1	0.1	0.1
Nitrate	25	25	10
Oxygen	2	1	0.1
Silica	15	10	1
Sodium	50	10	1
Sulfate	25	25	1
TDS*	200	100	5**
Total Hardness	25	10	1
pH	6.5-8.5	6.5-8.5	6.5-8.5
Turbidity (NTU)	5	5	1
* Note: Total dissolved solids			
**Note: Do not reduce the TDS beyond this amount or the water will be too aggressive.			

Table 10-3
Water Impurities

Constituent	Chemical Formula	Comments
Alkalinity	Bicarbonate (HCO_3) Carbonate (CO_3) Hydrate (OH), expressed as CaCO_3	Acid neutralizing capacity of water. Foaming and carryover of solids, causes embrittlement of steel, can produce CO_2 , a source of corrosion.
Calcium	Ca	When dissolved makes water hard; contributes to the formation of scale.
Carbon Dioxide	CO_2	Causes corrosion
Chloride	Cl	Adds to solid content and increases corrosive character of water; in relative percentage presence with oxygen induces stress corrosion cracking.
Free Chlorine	Cl_2	Oxidizing agent; can attack elastomeric seals and damage reverse osmosis (RO) membranes.
Iron	Fe^{++} (ferrous) Fe^{+++} (ferric)	Discolors water or precipitation; source of scale and erosion.
Magnesium as Mg		When dissolved makes water hard; contributes to the formation of scale.
Manganese as Mn	Mn^{++}	Discolors water or precipitation; source of scale and erosion.
Nitrate	NO_3	Adds to solid content; effect is not generally significant industrially.
Oxygen	O_2	Causes corrosion
Silica	SiO_2	Causes scale
Sodium	Na	Found naturally; introduced to water in the ion exchange water softening process.
Sulfate	SO_4	Adds to solid content; combines with calcium to form calcium sulfate scale.
TDS		Measure of the total amount of dissolved matter in water.
Total Hardness	CaCO_3	Sum of all hardness constituents in water; typically expressed as their equivalent concentration of calcium carbonate; primarily due to calcium and magnesium in solution, but may include small amounts of metal. Carbonate hardness is usually due to magnesium and calcium bicarbonate; non-carbonate hardness is due to sulfates and chlorides.
pH		Intensity of the acidic or alkaline solids in water; pH scale runs from 0, highly acidic, to 14, highly alkaline; with 7 being neutral.



10.4 Electrical Specifications

Electrical System

Motor type TEFC (Totally Enclosed Fan Cooled)

Ampacity and Power Voltage Requirements

Power Voltage	Motor Horsepower	Full Load Amps	Recommended Circuit Breaker Amps
208/3/50-60	30	86	125
230/3/60	30	76	100
400/3/50	30	43	60
415/3/50	30	43	60
460/3/60	30	38	50
575/3/60	30	32	40

10.5 Hydraulic and High Pressure Water System Specifications

Hydraulic System

Maximum operating pressure 3,000 psi (207 bar)

Main system relief valve 3,400 psi (234 bar)



High Pressure Water System

Plunger diameter	0.875" (22 mm)
Piston diameter	4.03" (102.4 mm)
Intensification ratio	20:1
Maximum flow rate	
60,000 psi (4,137 bar)	0.52 gpm (1.97 L/min)
Minimum outlet pressure	5,000 psi (500 bar)
Maximum outlet pressure	60,000 psi (4,137 bar)

Pneumatic Control Valve

Maximum water pressure	60,000 psi (4,137 bar)
Minimum air pressure	85 psi (5.9 bar)
Maximum air pressure	100 psi (6.9 bar)
Maximum air flow rate	1.0 cfm (0.028) m ³ /min

Orifice Capacity

The following tables provide horsepower requirements for some of the more popular orifices.

Table 10-4
Single Orifice Diameter

Model	Motor Horsepower Rating		Maximum Operating Pressure	Maximum Single Orifice Diameter (<i>at full pressure</i>)
	HP	Kw		
S30	30	22	60,000 psi (4,137 bar)	0.010 inch (0.254 mm)

Table 10-5
Horsepower Requirements

Orifice Size inches (mm)	45,000 psi (3,103 bar)	50,000 psi (3,447 bar)	55,000 psi (3,792 bar)	60,000 psi (4,137 bar)
0.003 (0.076)	1.7	2.0	2.3	2.6
0.004 (0.102)	3.0	3.5	4.0	4.6
0.005 (0.127)	4.6	5.4	6.2	7.1
0.006 (0.152)	6.7	7.8	9.0	10.2
0.007 (0.178)	9.1	10.6	12.2	13.9
0.008 (0.203)	11.8	13.9	16.0	18.2
0.009 (0.229)	15.0	17.5	20.2	23.0
0.010 (0.254)	18.5	21.6	25.0	28.5
0.011 (0.279)	22.4	26.2	30.2	34.4
0.012 (0.305)	26.6	31.2	36.0	41.0

The horsepower requirements for operating multiple orifices are determined by adding the requirements in Table 10-5 for each orifice. Examples are shown below.

Orifice Size inches (mm)	Number of Orifices	Operating Pressure	Calculation	Total Horsepower
0.008 (0.203)	2	50,000	2 x 13.9	27.8
0.005 (0.127) 0.008 (0.203)	1 1	60,000	7.1 + 18.2	25.3

Torque Specifications

Measurements are made with lubricated components and a certified calibrated torque wrench. Inconsistencies in wrench settings, lubrication and technique may not produce a leak free seal. If leakage occurs, the torque can be increased to seal the components. However, **do not exceed the recommended torque value by more than 15 percent**. If leakage persists, there is a component problem.

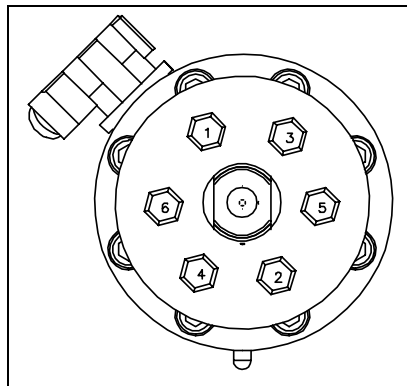


Excessive torque can cause component damage or failure, resulting in potential hazards to equipment and personnel.

Torque Specifications

Hard Seal End Cap	
Jackbolts	6 (7/16") each
1st Stage	Hand Tight
2nd Stage	20 ft-lbs (27 Nm) Crossing Pattern*
3rd Stage	32-35 ft-lbs (43-47 Nm) Crossing Pattern
4th Stage	32-35 ft-lbs (43-47 Nm) Clockwise Pattern From Bolt 1
Socket Wrench Size	3/8 inch

6-Bolt Crossing Pattern



* **Note:** Crossing Pattern: 1, 2, 3, 4, 5, 6

Hydraulic Cylinder Head	
Socket Head Screws	8 (14M) each
Torque	75-80 ft-lbs (102-108 Nm)
Hex Key	M12
Proximity Switch	
Socket Head Screws	2 (M6) each
Torque	140-160 in-lbs (16-18 Nm)
Hex Key	M5



Torque Specifications

Sealing Head

Discharge Gland Nut

130 ft-lbs (176 Nm)

Poppet Retainer

25-30 in-lbs (2.8-3.4 Nm)

Pneumatic Control Valve

3/8-inch HP Inlet Gland Nut

50 ft-lbs (68 Nm)

1/4-inch Outlet to Drain

25 ft-lbs (34 Nm)

Pneumatic Actuator

5 ft-lbs (7 Nm)

9/16"-1/4" HP Adapter

50 ft-lbs (68 Nm)

High Pressure Fittings

1/4-inch Gland Nut

25 ft-lb (34 Nm)

3/8-inch Gland Nut

50 ft-lb (68 Nm)

9/16-inch Gland Nut

110 ft-lb (149 Nm)



SECTION 11

PARTS LIST

11.1 Overview

This section contains a comprehensive list of all standard and optional parts for the S30, maintenance tools, installation and equipment accessories. To facilitate the ordering of replacement parts, item numbers in each table correspond to the identifying numbers in the accompanying figures.

Use the following information to contact the Spare Parts Department at KMT Waterjet Systems.

USA

Parts Department
KMT Waterjet Systems
Production Equipment Group
635 West 12th Street
Baxter Springs, KS 66713-0231

Phone (800) 826-9274
Fax (620) 856-5050
Email wj.parts@kmtwaterjet.com

Europe

Spare Parts Manager
KMT Waterjet Systems GmbH
Wasserstrahl Schneidetechnik
Auf der Laukert 11
D-61231 Bad Nauheim
Germany

Phone +49-6032-997-119
Fax +49-6032-997-271
Email order.spares@kmt-waterjet.com



11.2 Part Nomenclature

The following list explains the abbreviations and numerical sizes used in the following part descriptions.

Abbreviations and Nominal Size Guide

Item	Description
1/4, 9/16, 3/4	Nominal sizes in fractions of an inch
D	Degree
HP or LP	High pressure or low pressure
ID or OD	Inside diameter or outside diameter
JIC	37-degree flared, threaded hydraulic fitting
NO or NC	Normally open or normally closed
NPT	National Pipe Thread, pipe thread and pressure vessel standard
psi or ksi	Pounds per square inch or thousands of pounds per square inch
SAE O-Ring	O-ring threaded port style, Society of Automotive Engineers (SAE) standard
TUV	German pressure vessel code and inspection agency



11.3 Index

Part lists are arranged in the following sequence.

Parts List Index Single Intensifier Models

Table	Description	Part Number	Page	Table	Description	Part Number	Page
11-1	S30 Single Intensifier Unit		11-6	11-13	Electrical Assembly	05143797	11-28
11-2	Intensifier Assembly	80079999	11-8	11-14	Electrical Assembly with Junction Box, Option	49835085	11-30
11-3	Hydraulic Cartridge Seal	05130091	11-10	11-15	Junction Box Configuration, Option	49839277	11-32
11-4	Sealing Head Assembly	80072349	11-11	11-16	Electrical Interface, Option	49833874	11-34
11-5	Hydraulic Piston Assembly	05132253	11-12	11-17	Dump Valve Kit, Option	05142518	11-36
11-6	High Pressure Piping	05142500	11-14	11-18	Pneumatic Control Dump Valve, Option	10184760	11-38
11-7	Hydraulic Power Package	05141981	11-16	11-19	Booster Pump/LP Water Filter Assembly, Option	49833866	11-40
11-8	Motor/Pump Assembly	80076441	11-18	11-20	Low Pressure Water Filter Assembly, Option	49833858	11-42
11-9	Hydraulic Manifold Assembly	05142187	11-20	11-21	Proportional Pressure Control, Option	80075732	11-44
11-10	Hydraulic Hose Connections	05141585	11-22				
11-11	Reservoir Assembly	05143599	11-24				
11-12	Bulkhead Pipe Assembly	80080047	11-26				



Parts List Index
Redundant Intensifier Models

Table	Description	Part Number	Page	Table	Description	Part Number	Page
11-22	S30 Redundant Intensifier Unit		11-46	11-30	Electrical Assembly	05086806	11-62
11-23	Intensifier Assembly	80072333	11-48	11-31	Control Box Configuration	05086889	11-64
11-3	Hydraulic Cartridge Seal	05130091	11-9	11-32	Redundant Kit	80080062	11-66
11-4	Sealing Head Assembly	80072349	11-10				
11-5	Hydraulic Piston Assembly	05132253	11-11				
11-24	High Pressure Piping	80080039	11-50				
11-25	Hydraulic Power Package	05110614	11-52				
11-26	Motor/Pump Assembly	80082407	11-54				
11-27	Hydraulic Manifold Assembly	05071766	11-56				
11-28	Hydraulic Hose Connections	05086228	11-58				
11-29	Reservoir Assembly	05041660	11-60				
11-12	Bulkhead Pipe Assembly	80080047	11-24				



Parts List Index
Accessories

Table	Description	Part Number	Page	Table	Description	Part Number	Page
11-33	High Pressure Tube Coning Tools		11-69	11-42	High Pressure Swivel Joints		11-81
11-34	High Pressure Tube Threading Tools		11-70	11-43	Nozzle Tubes		11-88
11-35	Maintenance Tools and Lubricants		11-71	11-44	Autoline™ Abrasive Nozzle Assembly	05078530	11-90
11-36	Focusing Tubes		11-73	11-45	Autoline™ Diamond Orifice		11-91
11-37	Standard Orifice Assemblies		11-75	11-46	Autoline™ Sapphire Orifice		11-91
11-38	Diamond Orifice Mounts		11-75	11-47	Pneumatic Control Valve, NC	10138824	11-92
11-39	High Pressure Fittings		11-76	11-48	Pneumatic Cylinder Assembly, NC	10177855	11-93
11-40	Bulk High Pressure Tubing		11-78	11-49	Pneumatic Control Valve, NO	10184760	11-94
11-41	High Pressure Filter Assemblies		11-79	11-50	Pneumatic Cylinder Assembly, NO	10189553	11-95



Table 11-1
Streamline S30 Single Intensifier Unit

Item	Part Number	Description	Quantity
1	80080047	Bulkhead Pipe Assembly	1
2	05143797	Electrical Assembly	1
3	05142559	Frame Assembly	1
4	05143599	Reservoir Assembly	1
5	05142500	High Pressure Piping	1
6	05141981	Hydraulic Power Package	1
7	05141585	Hydraulic Hose Connections	1
8	05143862	Attenuator Installation	1
9	10150464	Decal, Cutting Water In	1
10	10150472	Decal, Cooling Water In	1
11	10150480	Decal, Cooling Water Out	1
12	05041009	Socket Head Screw, 1/2-13 x 1.00	4
13	95688750	Lock Washer, 0.50 x 0.172	4
14	10150456	Decal, Cutting Water Out	1
15	05128087	Startup Tag	1
16	10082071	Pipe Plug, 0.38	1
17	49838253	Install Breather Tag	1

Figure 11-1: Streamline S30 Single Intensifier Unit

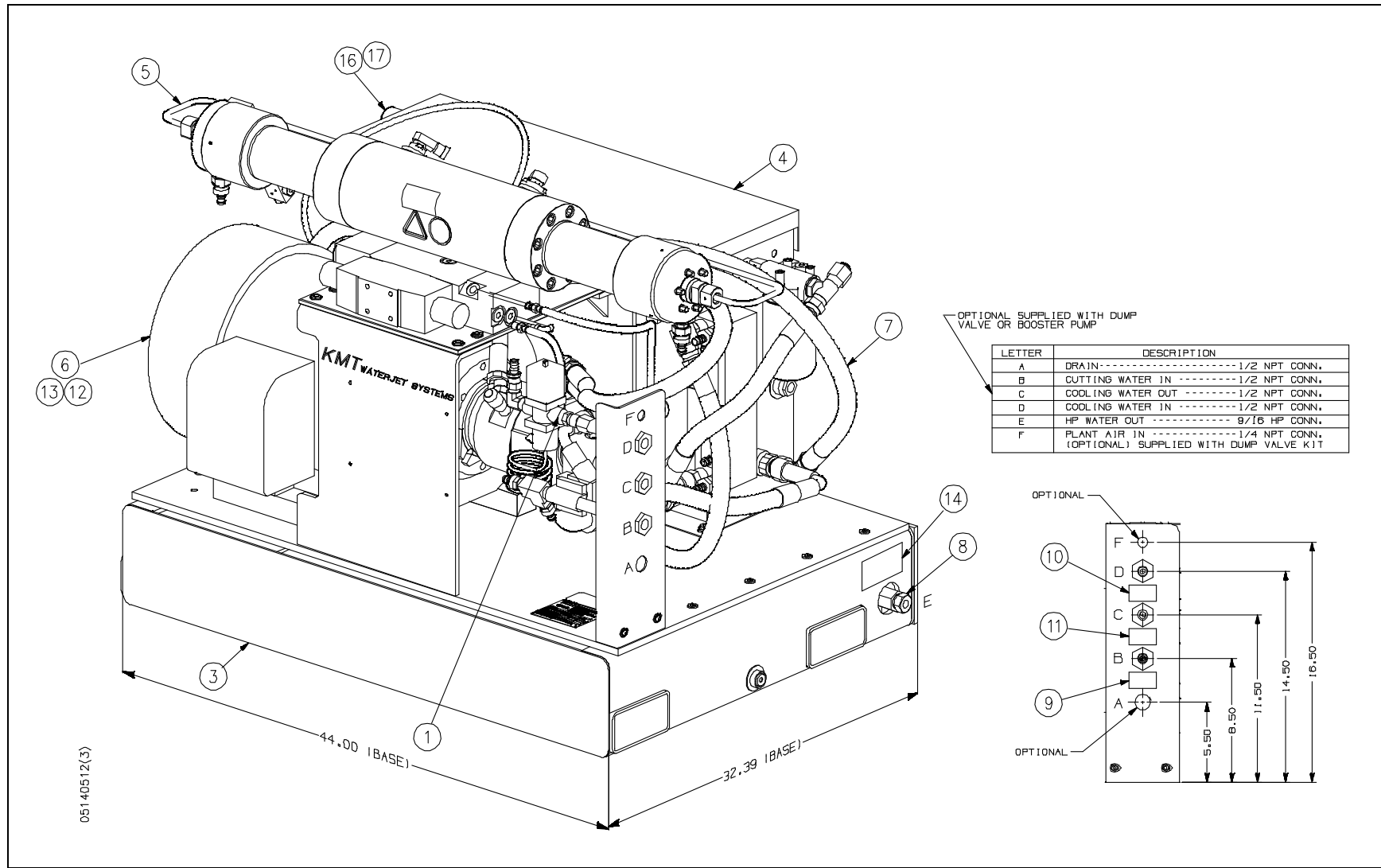




Table 11-2
Intensifier Assembly
80079999

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	05144647	HP Cylinder Body, 1.125 x 8	2	14	05034764	Hydraulic Cylinder, 6.22 x 4.03 x 14.96	1
2	05119151	Ceramic Plunger, 0.875	2	15	10075000	O-Ring, 3-3/4 x 4 x 1/8	2
3	80072349	Sealing Head Assembly	2	16	05034855	Backup Ring, 3-3/4 x 4	2
4	05034772	Hydraulic Cylinder Head	2	17	05141106	Socket Head Screw, M14 x 60	16
5	05149703	HP Seal Assembly, 0.875	2	18	05127584	Proximity Switch, 20-250V AC/DC	2
6	05144696	Spacer, Sealing Head	2	19	10183572	Socket Head Screw, M6 x 1.00 x 22 MM	4
7	80073646	HP Cylinder Nut, HSEC	2	20	05132253	Piston Assembly, 4.03 Diameter	1
8	05130091	Hydraulic Cartridge Seal Assembly	2	21	10074409	O-Ring, 1 x 1-1/4 x 1/8	2
9	05007786	Bushing Retainer Flange	2	22	05144183	Spacer, Proximity Switch	2
10	20418805	Liner, HP Cylinder	2				
11	10074920	O-Ring, 1-3/4 x 1-15/16 x 3/32	4				
12	80070352	Jackbolt, 7/16-20 x 2.31, 3/8 Hex Head	12				
13	05034798	Retaining Ring	2				

Figure 11-2: Intensifier Assembly

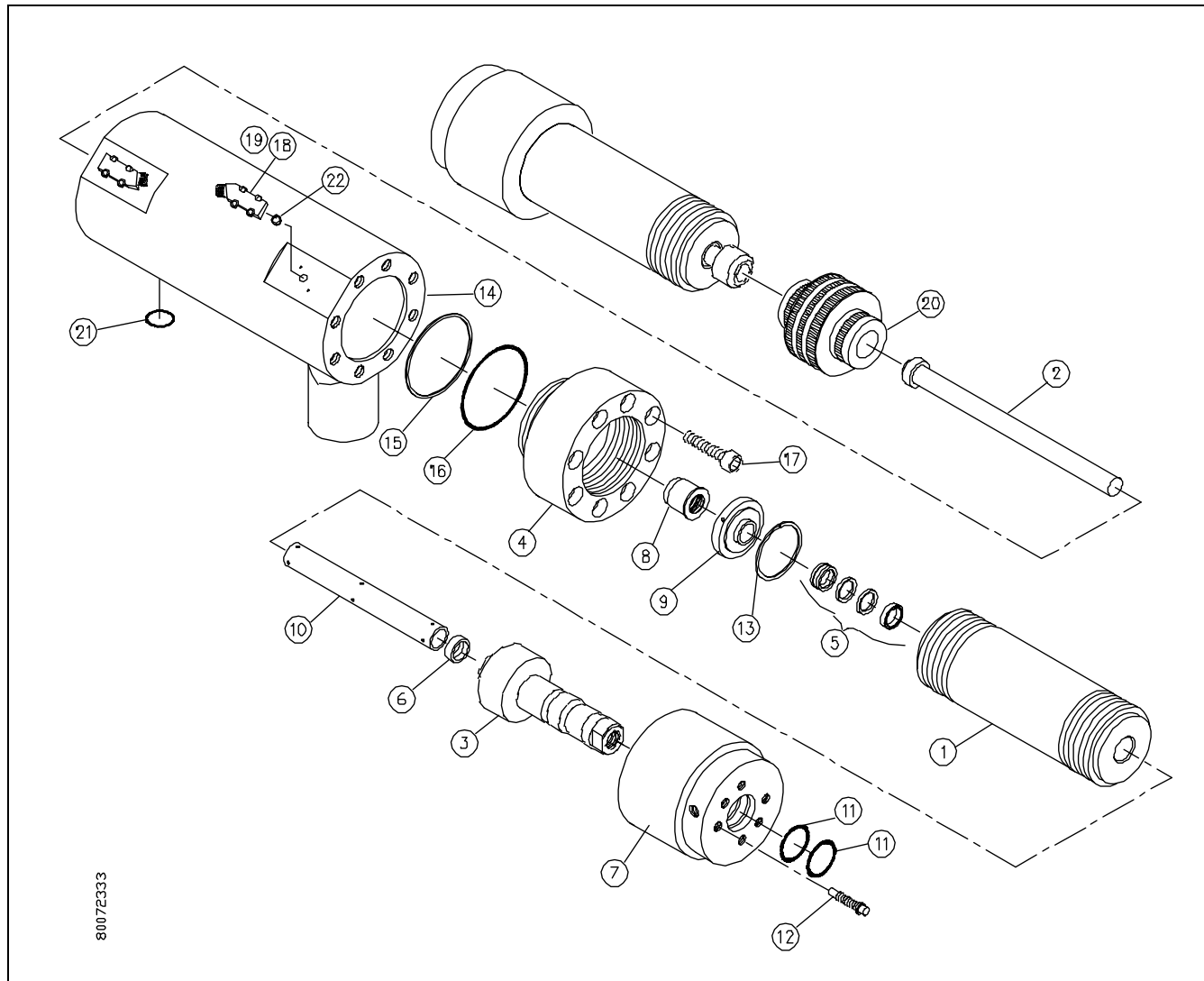


Table 11-3
Hydraulic Cartridge Seal
05130091

Item	Part Number	Description	Quantity
1	05130109	Seal Bushing, 1.36 x 0.89	1
2	05015060	Packing Ring W/O-Ring, 1.125 x 0.875	2
3	10193522	O-Ring, 1-3/16 x 1-3/8 x 3/32	1
4	05050760	Backup Ring, 1.188 x 1.375	1
5	05129481	O-Ring, 1 x 1-1/8 x 1/16	1
6	05013024	O-Ring, 1-1/4 x 1-3/8 x 1/16	1
7	05129515	Backup Ring, 1.127 x 0.891	1
8	05027255	Packing Seal, U-Cup W/O-Ring	1
80084759		Rebuild Kit	
		Includes Items 2-8	

Figure 11-3: Hydraulic Cartridge Seal

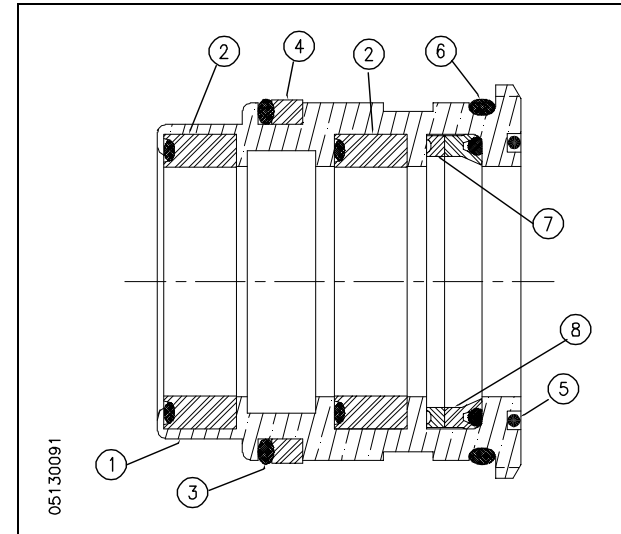


Table 11-4
Sealing Head Assembly
80072349

Item	Part Number	Description	Quantity
1	49834039	Sealing Head Body	1
2	05144662	Inlet Poppet Valve	1
	10107894	Alternate Inlet Poppet Valve	
3	05116777	Gland Nut	1
4	05112768	Seat	1
5	05116561	Discharge Poppet Valve	1
6	05144670	Poppet Retainer	1
7	05147863	Compression Spring	1
8	49884562	Compression Spring	1
9	05116751	Poppet Pin	1
05133335		Rebuild Kit	
		Includes Items 4, 5, 7 and 9	

Figure 11-4: Sealing Head Assembly

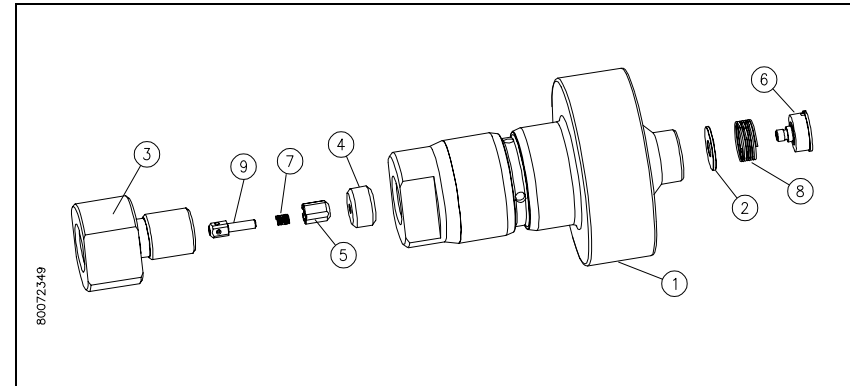




Table 11-5
Hydraulic Piston Assembly
05132253

Item	Part Number	Description	Quantity
1	05132261	Hydraulic Ram Piston, 4.03	1
2	05074380	Plunger Retainer Pin, Clevis, 0.25 x 0.43	12
3	05049887	Set Screw, Socket, 3/8-16 x 3/8	2
4	10148757	Check Valve Cartridge W/O-Ring	2
5	49877509	Adhesive, Thread Locker	--
6	05088364	Flat Snap Ring, 0.032 x 0.375 x 2.010	2
7	05049994	Backup Ring, 1.50 x 1.25	2
8	05087713	O-Ring, 1-1/4 x 1-1/2 x 1/8	2
9	05117965	Seal Assembly, Hydraulic Piston	1
10	05117940	Bearing Ring, Hydraulic Piston	2
	05115951	Rebuild Kit	
		Includes Items 4, 6, 7, 8,9 and 10	

Figure 11-5: Hydraulic Piston Assembly

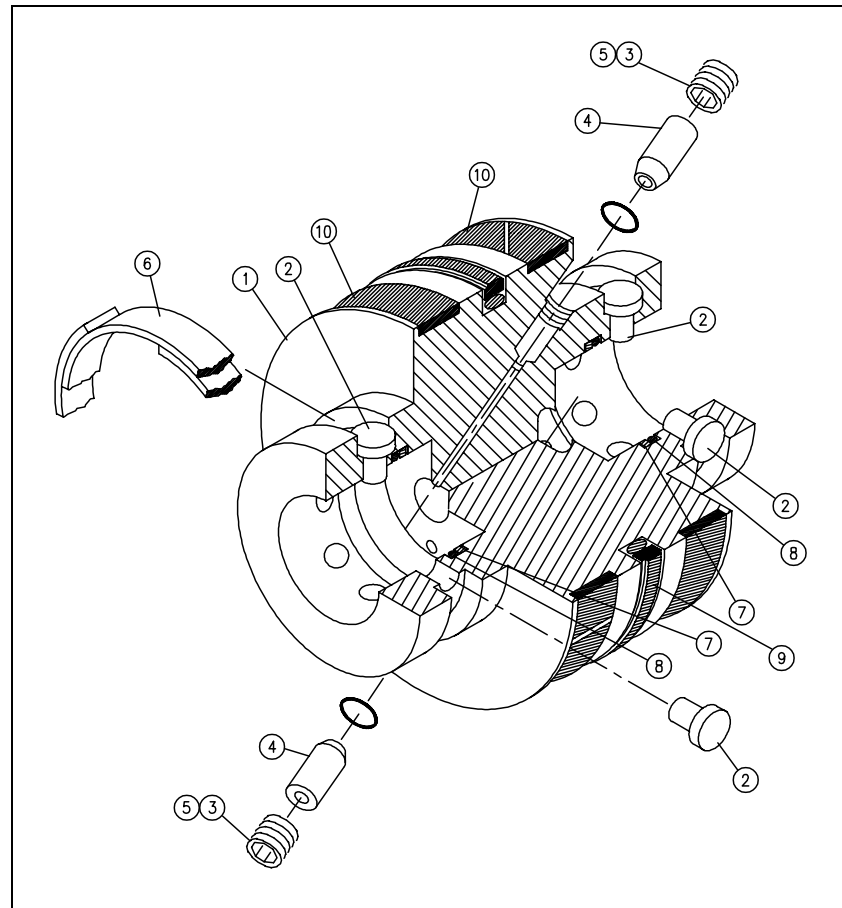




Table 11-6
High Pressure Piping
05142500

Item	Part Number	Description	Quantity
1	05127519	HP Tube, Bent, 0.38 x 0.125	1
2	05127501	HP Tube, Bent, 0.38 x 0.125	1
3	10078590	HP Tee, 0.38	2
4	05142187	Manifold Assembly	1
5	05141882	HP Tube, Bent, 0.38 x 0.125, Cone/Thread	1
6	10078129	HP Gland, 0.38	2
7	10078715	HP Collar, 0.38	2
8	80079999	Intensifier Assembly	1
9	10079523	HP Plug, 0.38, 17-4	1
10	10083897	Ferrule, 0.25 Hose	8
11	05028030	HP Tube, 0.38 x 0.125 x 6.75, Cone/Thread	1
12	95413696	Lock Washer, 0.50 x 0.125	5
13	10186153	Conduit, Extra Flexible, 0.38 ID	70.0"
14	95738514	Hex Head Screw, 1/2-13 x 1	5

Figure 11-6: High Pressure Piping

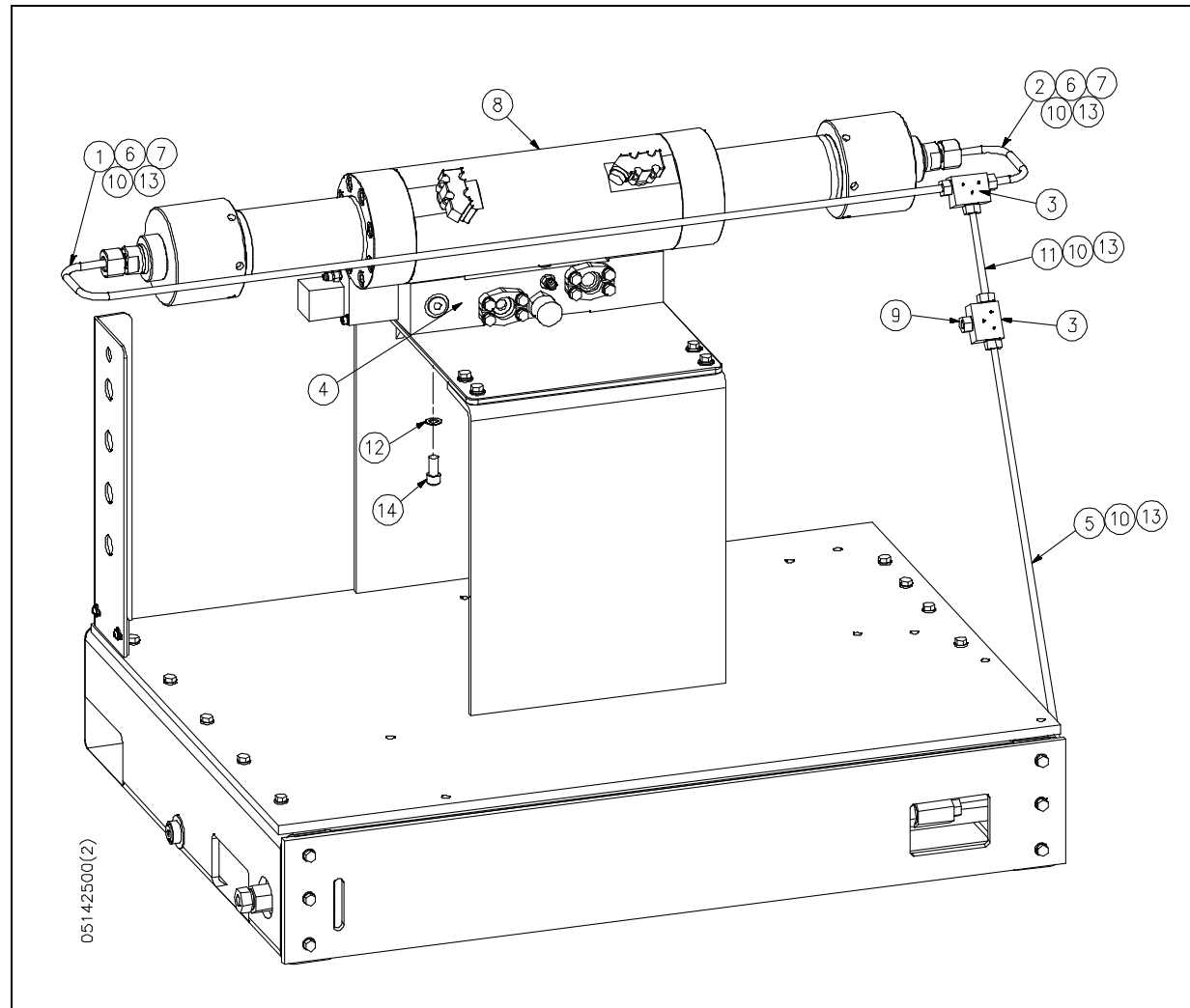




Table 11-7
Hydraulic Power Package
05141981

Item	Part Number	Description	Quantity
1	05086202	Split Flange Kit, 1.50	1
2	05086210	Elbow, Split Flange/Hose Barb, 4.50 x 2.00	1
3	80076441	Motor/Pump Assembly, S30	1
4	10118065	Split Flange Kit, 1.00	1
5	10151470	Adapter, JIC-O-Ring, 90D, 12-16	1
6	05047451	Adapter, JIC/O-Ring, 90D, 12-12	1
7	05050331	Elbow, JIC/O-Ring, 90D, 12-10	1
8	05092697	Hose Clamp	1
9	05050687	Cap, Recirculation Pump Shaft	1
10	10142644	Adapter, JIC/O-Ring, 90D, 4-4	1
Ref 1	05149166	Hose Assembly, Hydraulic	--

Figure 11-7: Hydraulic Power Package

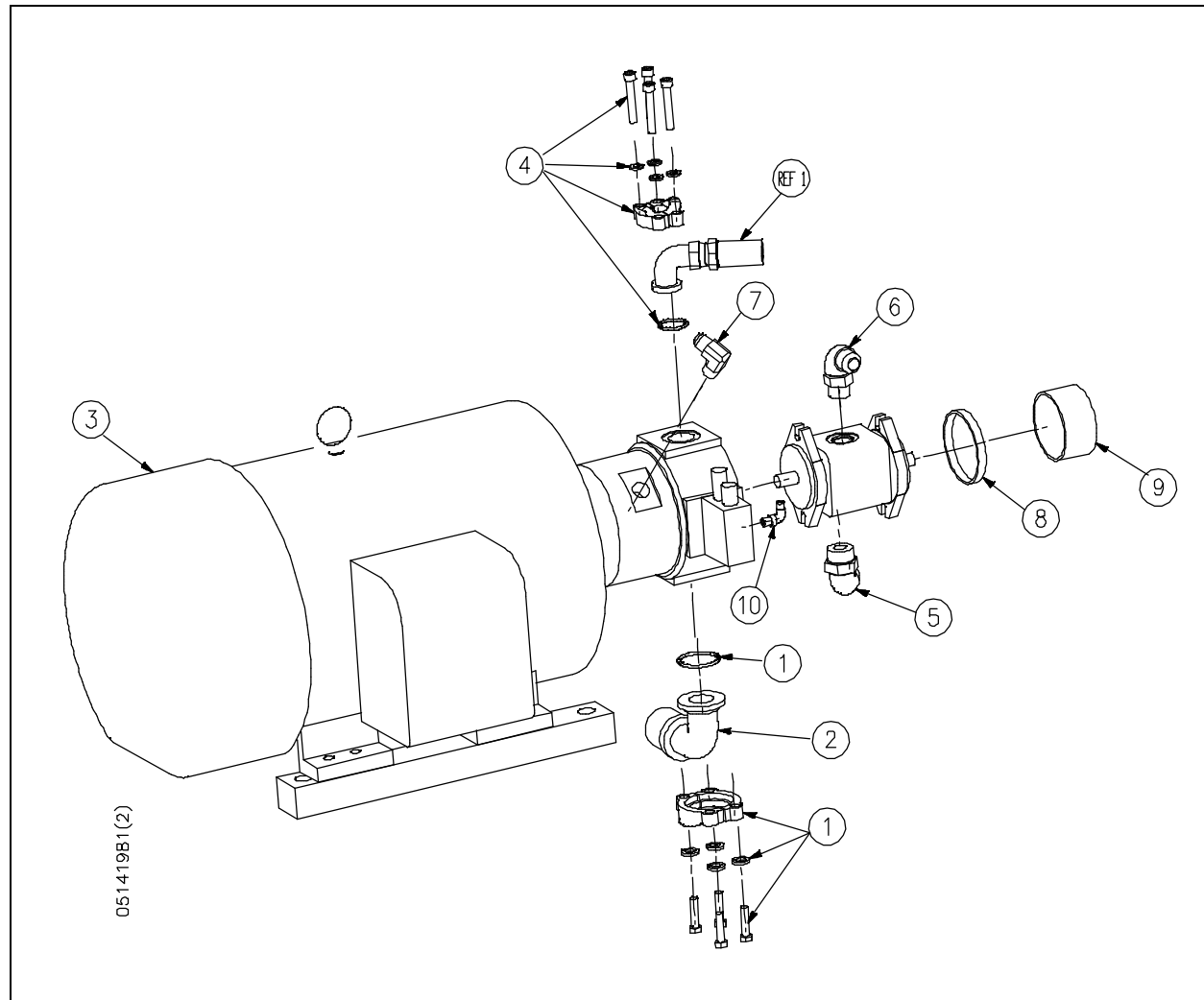




Table 11-8
Motor/Pump Assembly
80076441

Item	Part Number	Description	Quantity
1	80076995	Coupling, Flexible Drive, Motor Shaft	1
2	80077001	Flexible Drive Coupling Insert	1
3	05101605	Vibration Isolation Mount	2
4	80076599	Electric Motor, 30 HP	1
5	80077019	Flange, Motor/Pump Adapter	1
6	95716882	Hex Head Screw, 1/2-13 x 1-1/4	2
7	05083258	Piston Pump, 3100 psi, 45 cc	1
8	05037593	Socket Head Screw, M10 x 1.50 x 25 MM	2
9	10069714	Flat Washer, 0.38 x 0.078	2
10	10069763	Flat Washer, 0.50 x 0.109	2
11	05073168	Elbow, JIC/O-Ring, 45D	1
12	05045364	Gear Pump, Double Shaft	1
13	80077027	Coupling, Flexible Drive, Spline	1
14	05114087	Socket Head Screw, 3/8-16 x 1.38	3
15	95070132	Hex Head Screw, 5/8-11 x 1-1/2	4
16	10134989	Flat Washer, 0.63	4

Figure 11-8: Motor/Pump Assembly

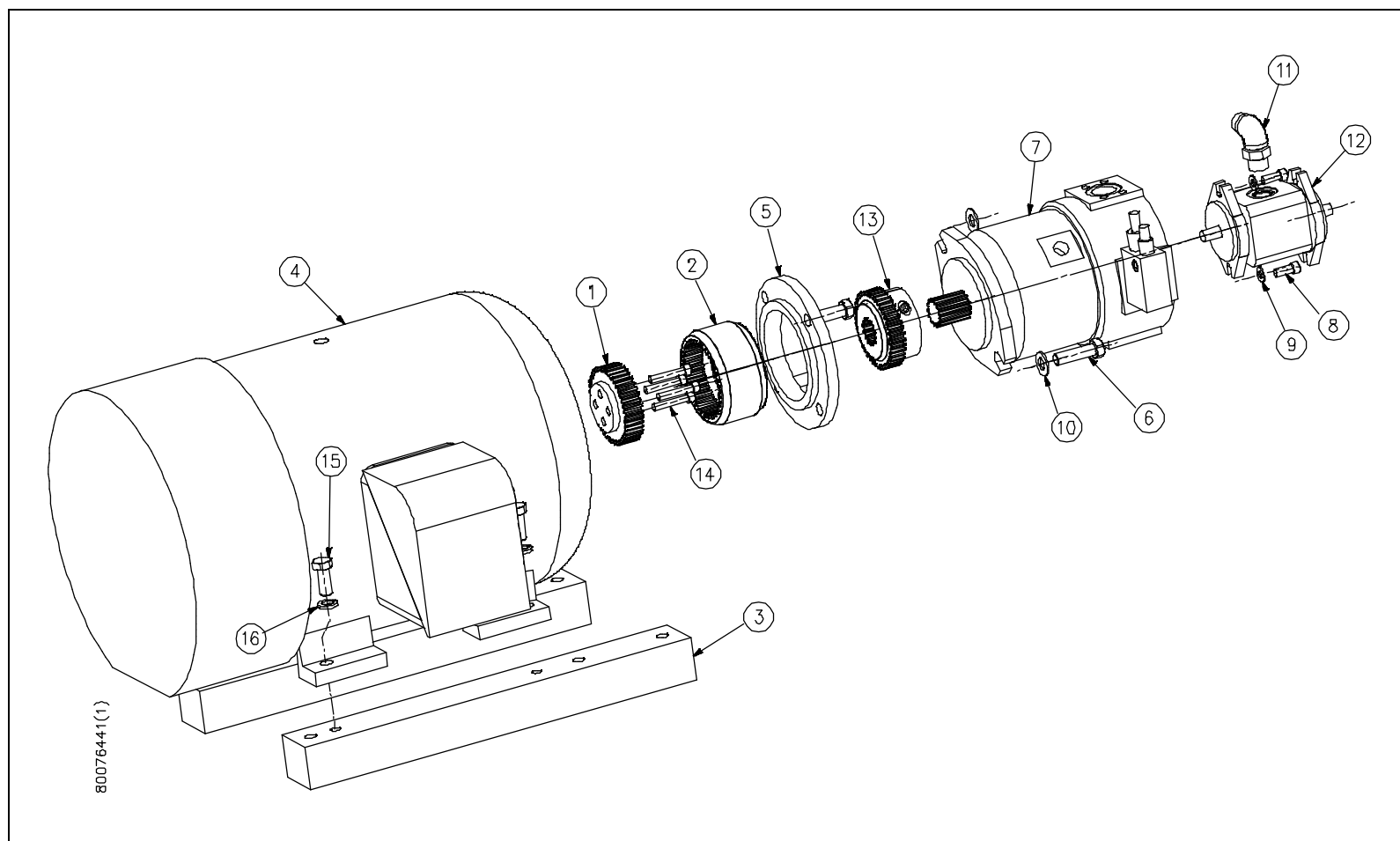




Table 11-9
Hydraulic Manifold Assembly
05142187

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	05142179	Manifold	1	12	95391322	Flat Washer, 0.25 x 0.063	2
2	05139936	Directional Control Valve	1	13	05142294	Pressure Gauge, 0-5000	1
3	05140785	Bolt Kit, Directional Control Valve	1	14	05129689	Plug, O-Ring, Hex Socket, 0.50	1
4	05071717	Relief Valve Cartridge	1	15	95838314	Lock Washer, 0.25 x 0.063	2
5	05122650	Plug, Hex Socket, 0.63, O-Ring	6	16	05140942	Socket Head Screw, 1/4-20 x 3-1/4	2
6	10192813	Plug, O-Ring, 0.25	1	17	05142302	Adapter, O-Ring/Pipe, 6-4	1
7	05140397	Hydraulic Check Valve Cartridge	1	18	05142393	Socket Head Screw, M10 x 1.50 x 75 MM	8
8	05140819	Flat Washer, M14 x 5	1	19	05061486	Lock Washer, M10	8
9	05140520	Hi/Lo Solenoid Valve	1	20	10087294	Split Flange Kit, 0.75, 5000 psi	2
10	10187052	Relief Valve Knob, 100/3000 psi	1	21	49876089	Adapter, JIC/O-Ring	2
11	05141072	Adapter, JIC/Split Flange, 12-12, 45D	1	22	10144749	Adapter, JIC/O-Ring, 45D, 4-4	1

Figure 11-9: Hydraulic Manifold Assembly

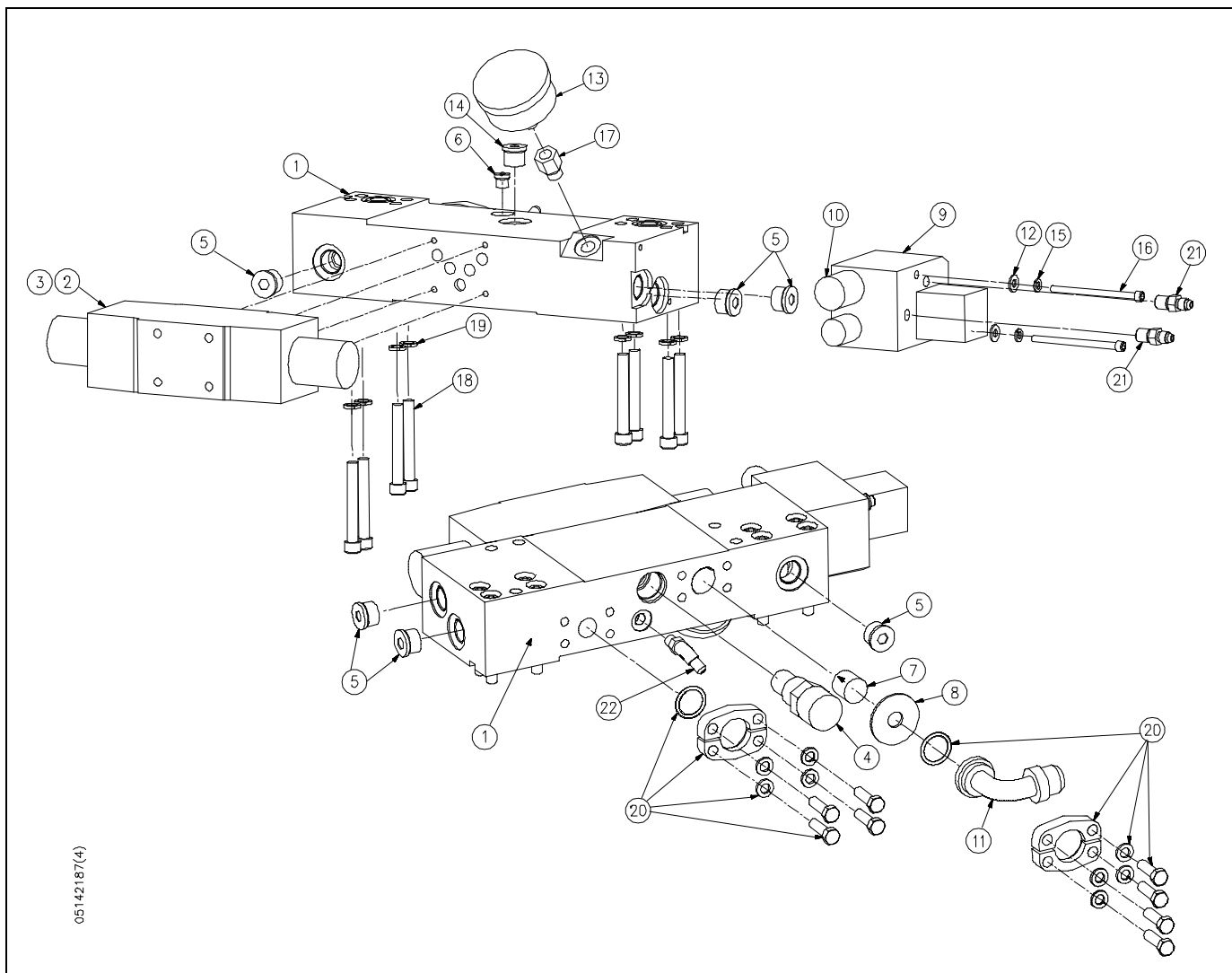




Table 11-10
Hydraulic Hose Connections
05141585

Item	Part Number	Description	Quantity
1	05141445	Hydraulic Hose Assembly, LP, 0.75, 0.75F JIC	1
2	05141411	Hydraulic Hose Assembly, LP, 0.25, -4, JIC	1
3	05141395	Hydraulic Hose Assembly, LP, 0.75, 0.75 JIC	1
4	05149166	Hydraulic Hose Assembly, MP, 0.75, -12 JIC	1
5	05141387	Hydraulic Hose Assembly, LP, 0.75, 0.75, JIC	1
6	05141361	Hydraulic Hose Assembly, LP, 0.75, 0.75, JIC	1
7	10179018	Radiator Hose, 2.0"	9.0"
8	10083517	Hose Clamp, 1.81-2.75	2
9	10117083	Hydraulic Hose Assembly, LP, 0.75, 0.75F, JIC	1
10	05060751	Hydraulic Hose Assembly, MP, 0.25, 0.25F, JIC	2

Figure 11-10: Hydraulic Hose Connections

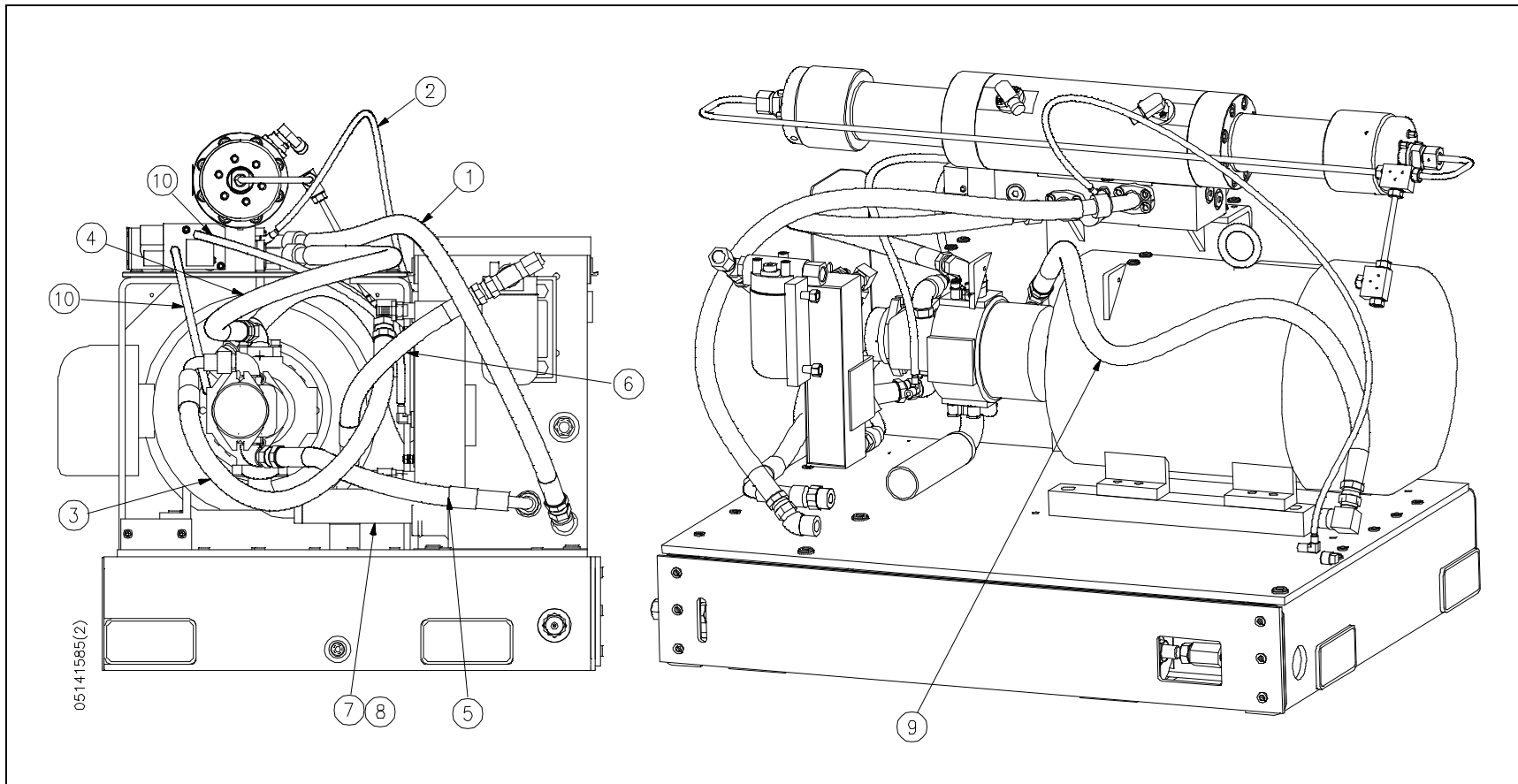




Table 11-11
Reservoir Assembly
05143599

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	10154979	Adapter, Pipe/JIC, 90D, 6-4	2	13	05069976	Hex Pipe Cap, 0.75	1
2	05049655	Pipe Elbow, JIC, 90D, 16 x 12	1	14	05079371	Adapter, Straight Swivel, JIC/BSPP	1
3	10080901	Ball Valve	1	15	10091858	Bulb, Well	1
4	95033619	Plug, Square Head, 0.50	1	16	49868524	Pipe Bushing, M/F, 1.25 x 1.00	1
5	05145958	Heat Exchanger, Water/Oil	1	17	05006291	Diffuser, Return Line, 1.25 NPT	1
6	10168862	Level/Temperature Gauge, Dual Scale	1	18	10100188	Adapter, Pipe/JIC, 16-12	1
7	05049697	Hydraulic Filter Head W/Gauge	1	19	10079713	Hose Barb, 0.50 x 0.50 NPT	2
	05103817	Pressure Gauge, only		20	95830766	Lock Washer, 0.31 x 0.078	2
8	05071063	Tee, Straight Thread Branch, O-Ring/JIC	1	21	10070191	Hex Nut, M8 x 1.25 MM	4
9	05057559	Adapter, O-Ring/Pipe, 12	1	22	10142727	Elbow, Pipe/JIC, 45D, 16-12	1
10	05049689	Oil Filter Element, 6 Micron Absolute	1	23	05073150	Adapter, JIC/O-Ring, 12-10	1
11	05139969	Temperature/Level Switch	1	24	05050331	Elbow, JIC/O-Ring, 90D, 12-10	1
12	05092739	Air Breather	1				

Figure 11-11: Reservoir Assembly

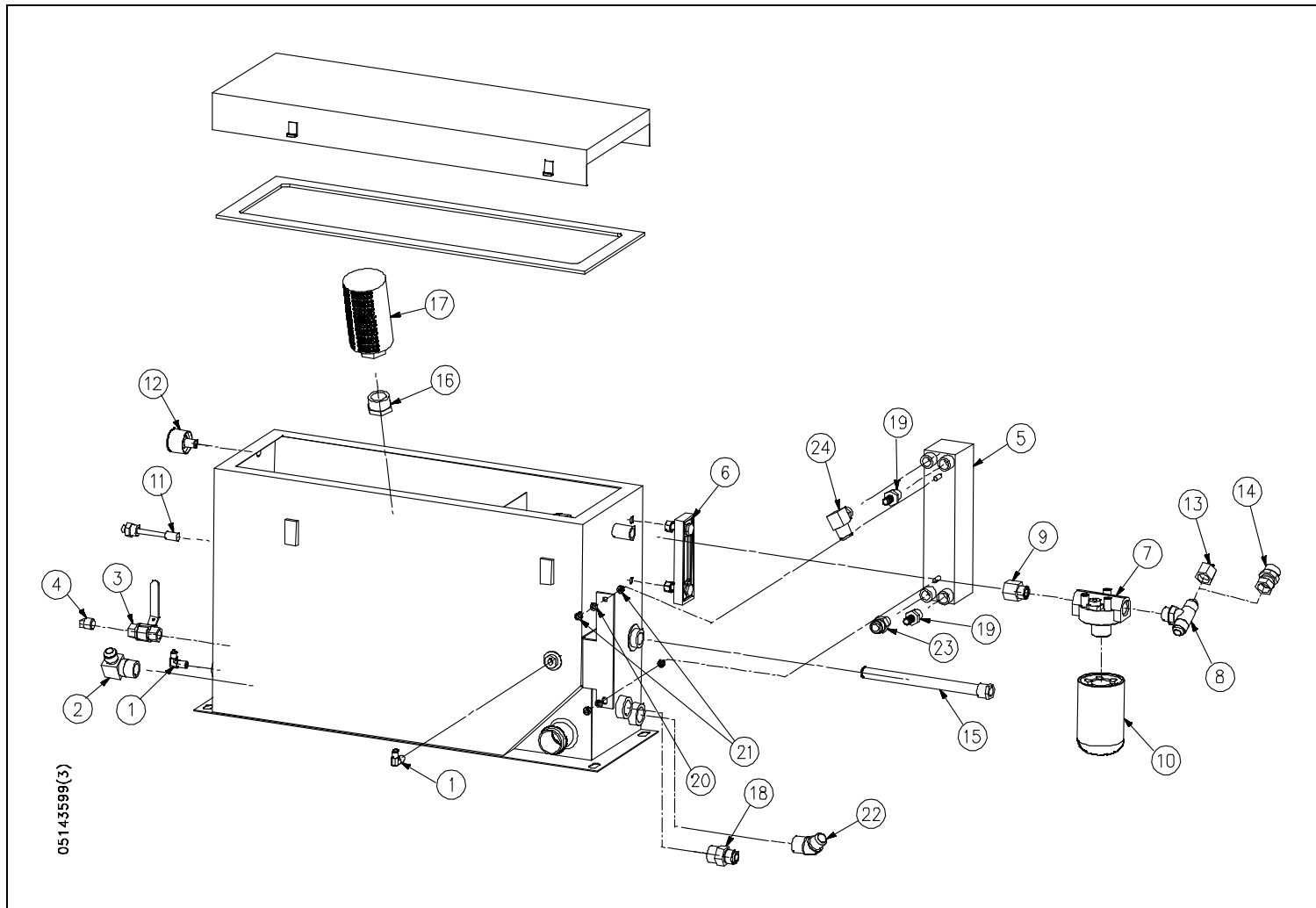




Table 11-12
Bulkhead Pipe Assembly
80080047

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	95680922	Adapter, Pipe/JIC, 90D, 8-8	2	11	49896749	Tee, M Run, 0.50	1
2	10091866	Water Modulating Valve	1	12	10189025	Adapter, Hose/JIC, 0.50 x 0.50	2
3	05060207	Pipe Nipple, 0.50 x 5.00	1	13	05111406	Adapter, 0.25 NPT x 0.50 JIC	2
4	10079713	Hose Barb, 0.50 x 0.50 NPT	2	14	49834302	Adapter, Tube/Pipe, 0.50 x 0.50	1
5	49890239	Solenoid Valve, 24V DC, 2-Way	1	15	49834310	Adapter, Tube/Pipe, 0.50 x 0.50	1
6	49886922	Adapter, Bulkhead, 8-24	3	16	10069763	Flat Washer, 0.50 x 0.109	8
7	10127348	Hose, Push On, 0.50, 250 psi	120.0"	17	10066199	Hex Head Screw, 1/2-13 x 3/4	4
8	10144368	Socket Head Screw, 1/2-13 x 1-1/4	4	18	10173805	Adapter, Hose/JIC Swivel	2
9	10070092	Jam Nut, 1-14	3	19	10192425	Barbed Insert, 0.50 x 0.50	2
10	95688750	Lock Washer, 0.50 x 0.172	4	20	10084523	Pipe Nipple, 3000 psi, 0.50 x 4.0	1

Figure 11-12: Bulkhead Pipe Assembly

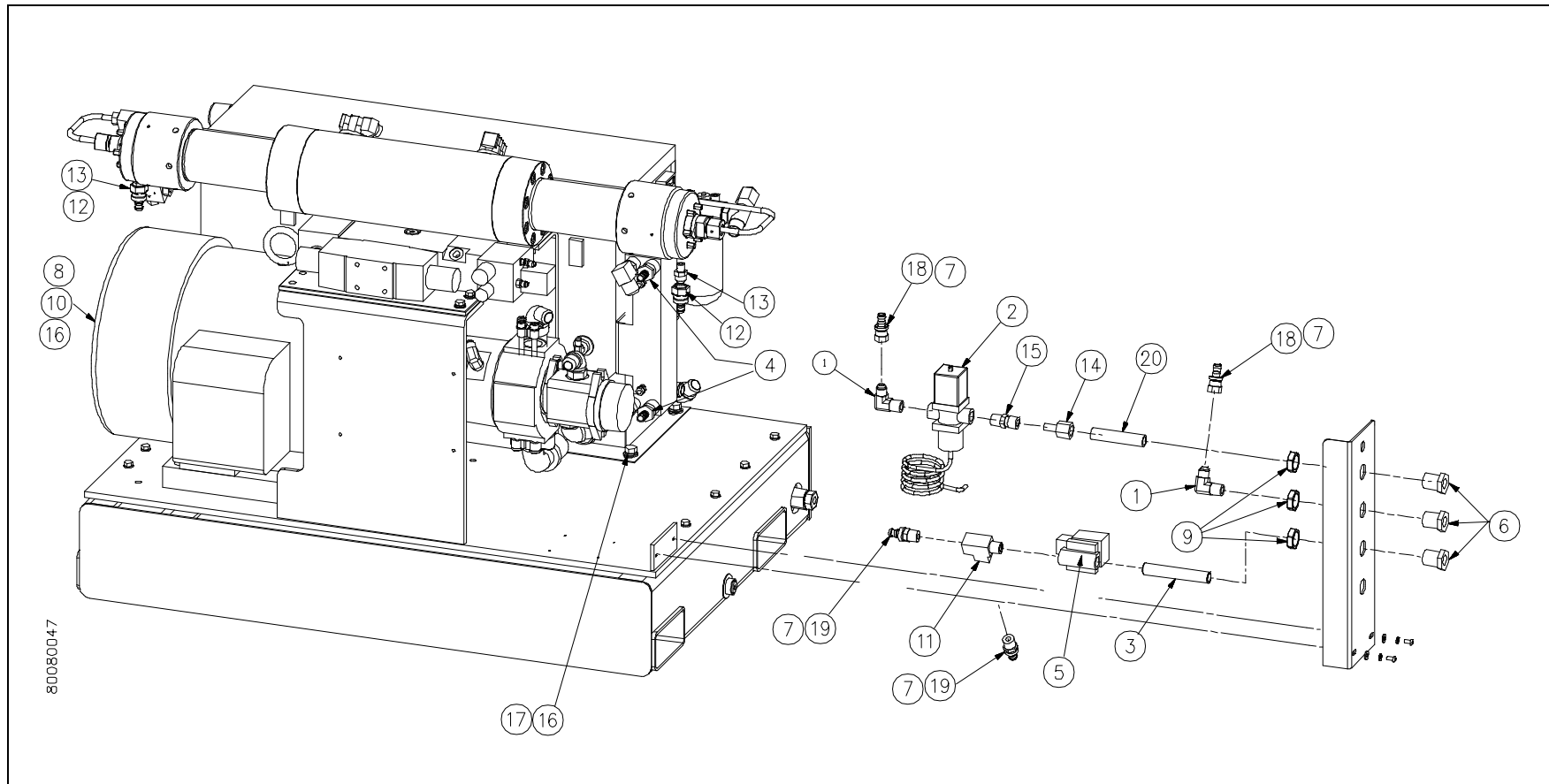




Table 11-13
Electrical Assembly
05143797

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	05141718	Harness, Sensor/Solenoid Cable	1	8	05043161	Terminal Block, 9-Post	1
2	10125912	Cable Tie, 0.87	5	9	95077012	Hex Head Screw, 5/16-18 x 1-3/4	2
3	05044029	Adapter Block, Motor Junction Box	1	10	10094712	Terminal Ring, #14-10	12
4	05062344	Lock Nut, 1/4-20	2	11	05142542	Electrical Support Bracket	1
5	10069755	Flat Washer, 0.31 x 0.078	2	12	10066967	Socket Head Screw, 6-32 x 5/8	4
6	10120921	Cable Tie Mount, 1.00 x 1.00	5	13	10069888	Lock Washer, #6 x 0.031	4
7	95686721	Socket Head Screw, 1/4-20 x 1-3/4	2	14	95146411	Hex Nut, #6-32	4

Figure 11-13: Electrical Assembly

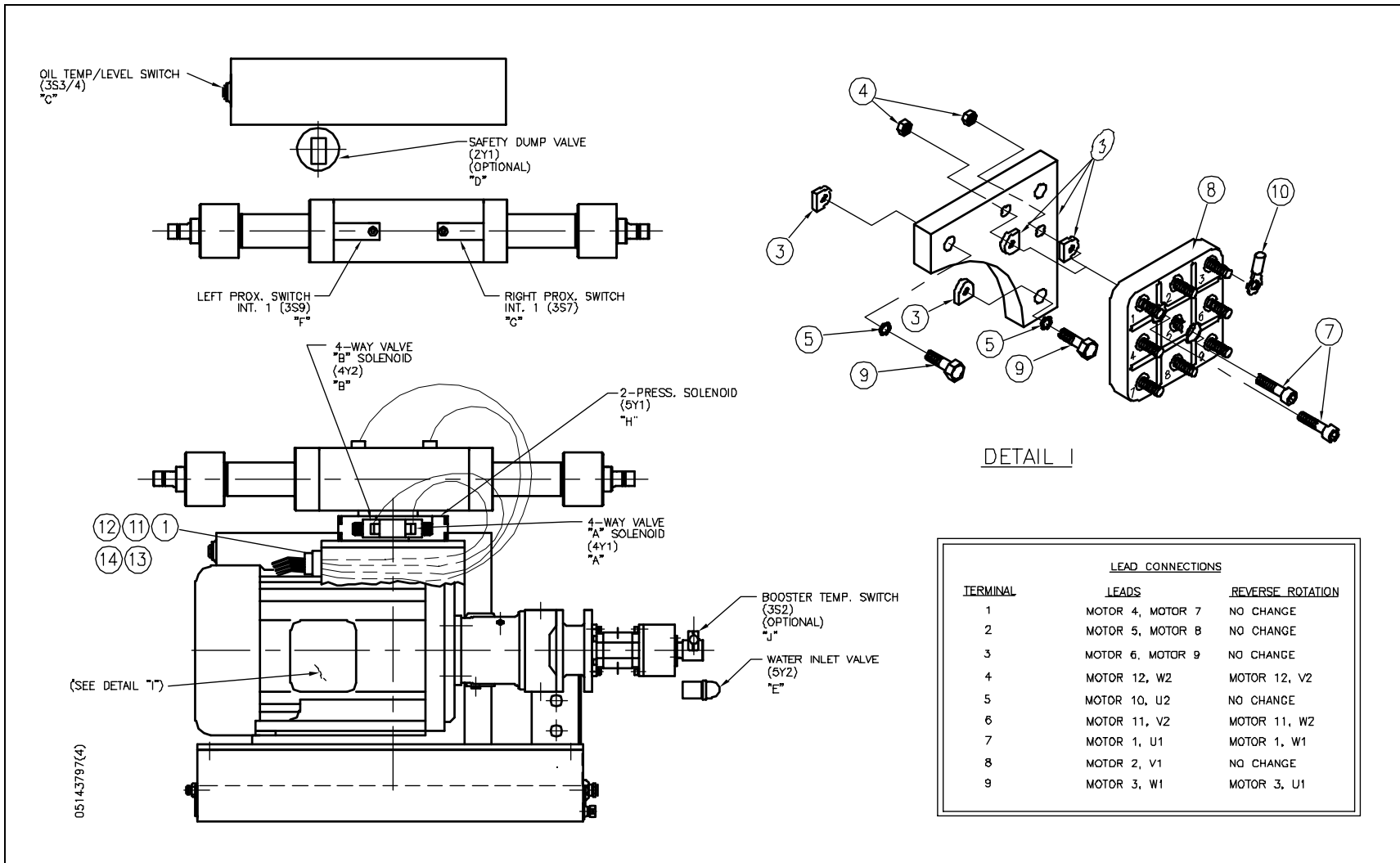




Table 11-14
Electrical Assembly with Junction Box
49835499

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	49835911	Harness, Sensor/Solenoid Cable	1	8	05043161	Terminal Block, 9-Post	1
2	10125912	Cable Tie, 0.87	5	9	95077012	Hex Head Screw, 5/16-18 x 1-3/4	2
3	05044029	Adapter Block, Motor Junction Box	1	10	10094712	Terminal Ring, #14-10	12
4	05062344	Lock Nut, 1/4-20	2	11	49839277	Configuration, Junction Box	1
5	10069755	Flat Washer, 0.31 x 0.078	2	12	10097657	Button Head Screw, 1/4-20 x 3/4	4
6	10120921	Cable Tie Mount, 1.00 x 1.00	5	13	95838314	Lock Washer, 0.25 x 0.063	4
7	95686721	Socket Head Screw, 1/4-20 x 1-3/4	2	14	95391322	Flat Washer, 0.25 x 0.063	4

Figure 11-14: Electrical Assembly with Junction Box

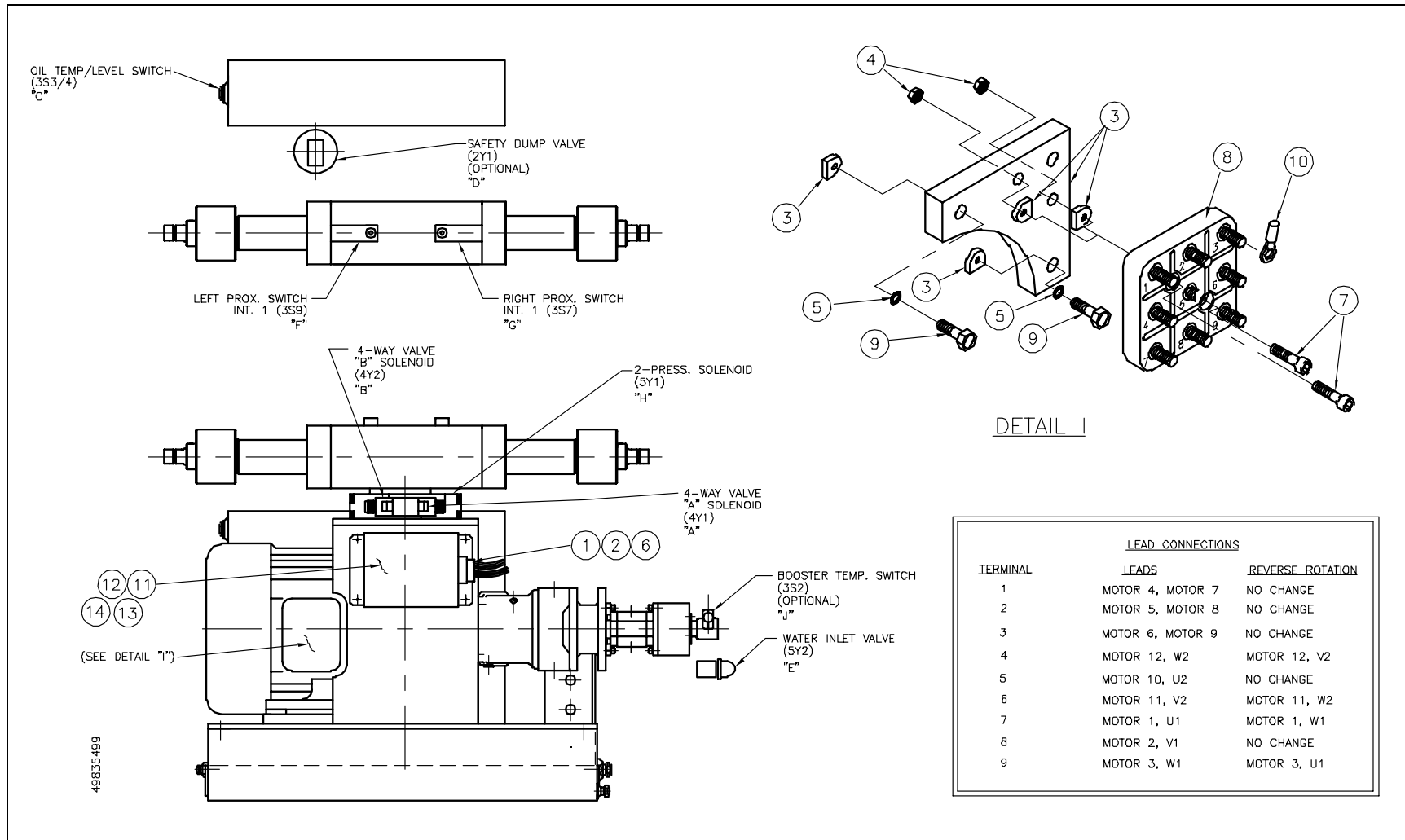




Table 11-15
Junction Box Configuration
49839277

Item	Part Number	Description	Quantity
1	80070485	Junction Box Enclosure	1
2	05091426	Panel Insert	1
3	10103034	DIN Rail	5.0"
4	10073492	Pan Head Screw, 8-32 x 1/2	3
5	05032362	End Anchor, Terminal Block	2
6	05115704	Terminal Block, Ground	1
7	05113634	Terminal Block, 3-Level	10
8	05112826	Terminal Block Jumper, 10-Pole	1.4
9	05112818	Terminal Block Marker	0.5
10	05117601	End Barrier, 3-Level Terminal Block	1
13	10170165	Wire, #16, Green/Yellow	6.0"
14	10181873	Ring Terminal, #16-#14	1



Table 11-16
Electrical Interface
49833874

Item	Part Number	Description	Quantity
1	49833171	Plug Connector, 37-Pin	1
2	05141973	Environmental Adapter Kit	1
3	49832983	Shrink Tube	0.125

Figure 11-16: Electrical Interface

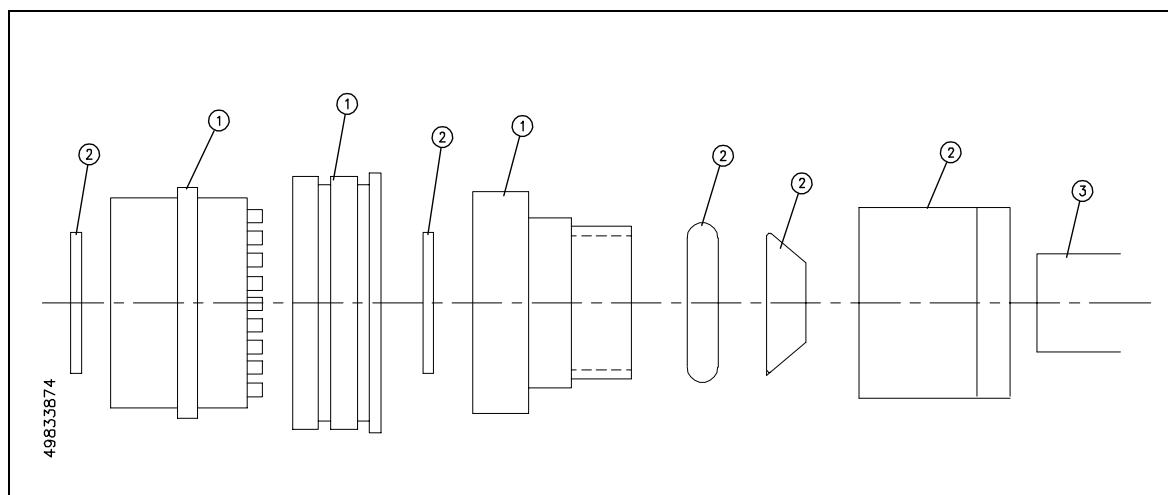




Table 11-17
Dump Valve Kit
05142518

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	10184760	Pneumatic Control Valve, NO	1	14	05071808	Decal, Plant Air	1
2	10083897	Ferrule, 0.25 Hose	2	15	10073823	Tee, M Run, 0.50	1
3	95895769	Hex Head Screw, 1/4-28 x 7/8	2	16	05142690	Tube, Bent, 0.25 x 0.083	1
4	95838314	Lock Washer, 0.25 x 0.063	2	17	49886922	Bulkhead Adapter, 8-24	1
5	05141874	HP Tube, 0.38 x 0.125 x 12.93, Cone/Thread	1	18	10086999	Plug, Hex Socket, 1/2-14	1
6	10078715	HP Collar, 0.38	2	19	10150449	Decal, Drain	1
7	95391322	Flat Washer, 0.25 x 0.063	2	20	10070092	Jam Nut, 1-14	1
8	05142534	Bracket, Valve Assembly	1	21	10078335	Reducing Nipple, 0.25 x 0.125	1
9	10186153	Flexible Conduit, 0.38 ID	30.0"	22	49888035	Solenoid Valve	1
10	10077055	Bulkhead Adapter	1	23	10077030	Elbow, 90D, M, 0.25 x 0.13	1
11	10078095	Coupling, Poly, M, 0.25 x 0.125	1	24	10079580	Adapter, HP, M/F	1
12	10079903	Tube, Poly, 0.25	60.0"	25	10078913	HP Gland, Anti-Vibration, 0.38	1
13	49834328	Adapter, Tube/Pipe, M, 0.25 x 0.50	1	26	05112271	Muffler, 0.125 NPT	1

Figure 11-17: Dump Valve Kit

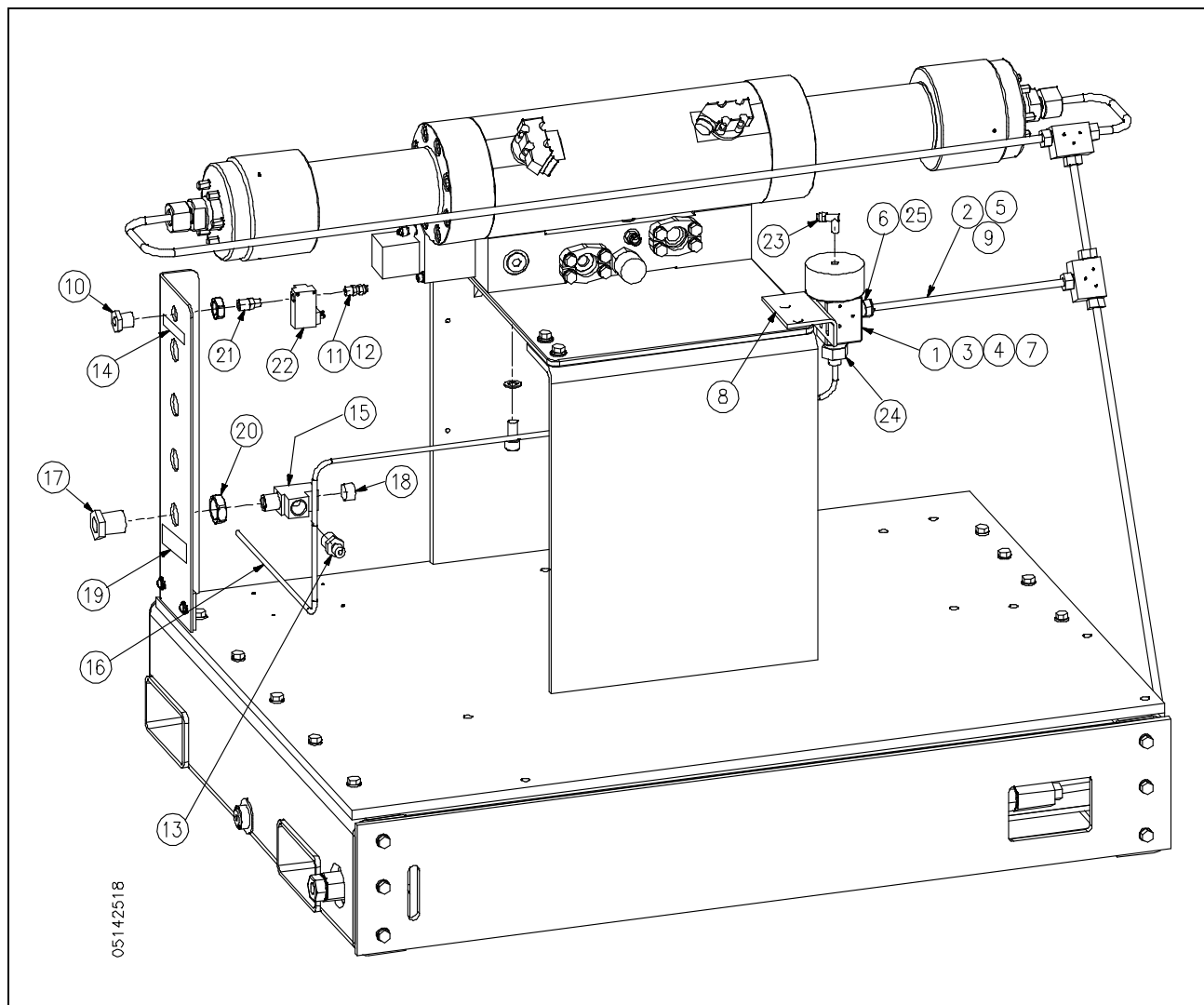




Table 11-18
Pneumatic Control Dump Valve, Normally Open
10184760

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	10189181	Pneumatic Valve Body	1	8	BV401184	Pneumatic Cylinder, 2.375 ID	1
2	10178697	Valve Seat, 0.50 x 0.040	1	9	BV601184	Pneumatic Cylinder Head, 2.425	1
3	BV701184	HP Gland Fitting	1	10	BV501184	Piston, Pneumatic Control Valve, 2.374	1
4	BV901184	Valve Stem, 0.080	1	11	10187250	Backup Ring, SST, 0.475 x 0.125 x 0.105	1
5	10188233	Brass Backup Ring, 0.480 x 0.082 x 0.170	1	12	10074714	O-Ring, 2-7/16 x 2-5/8 x 3/32	1
6	10178978	Seal Assembly, 0.25	1	13	10074565	O-Ring, 2-1/4 x 2-3/8 x 1/16	2
7	10189553	Cylinder Assembly, NO	1				

05116017 Rebuild Kit

Includes Items 4, 5, 6, 12 and 13

Figure 11-18: Pneumatic Control Dump Valve, Normally Open

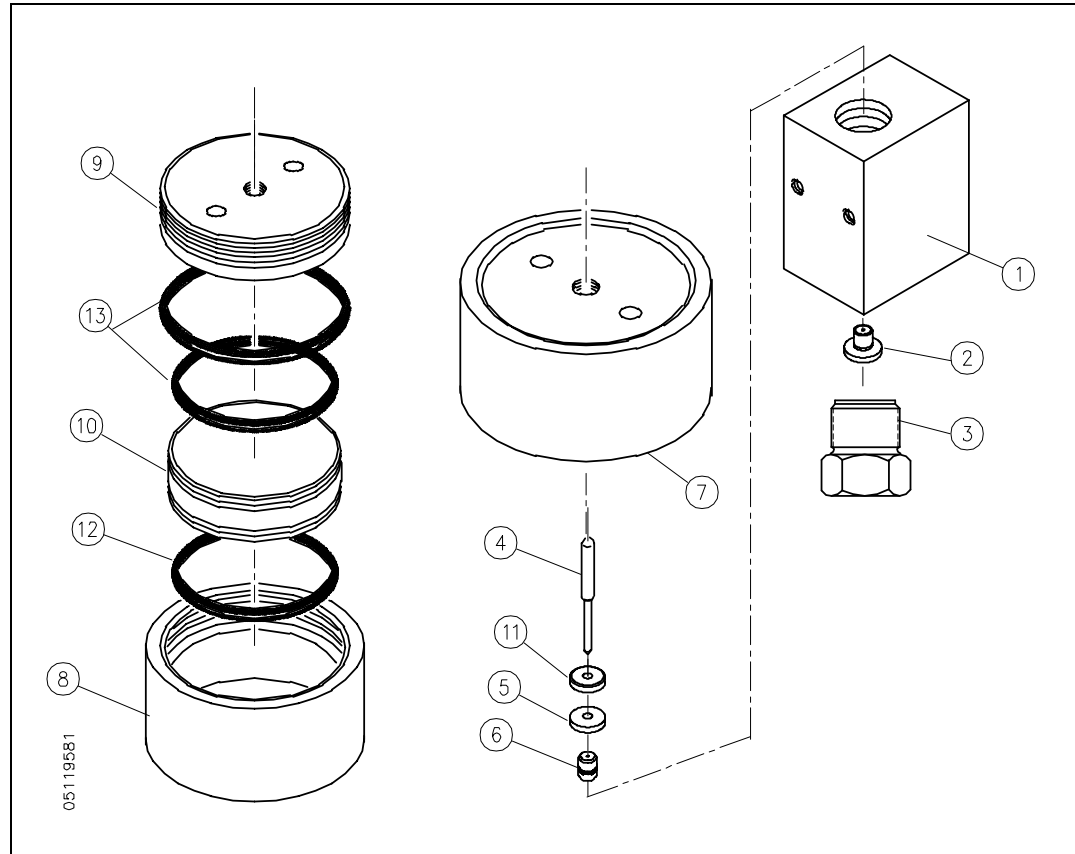




Table 11-19
Booster Pump/Low Pressure Water Filter Kit
49833866

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	49833858	Low Pressure Water Filter Assembly	1	11	05049168	Adapter, Water Pump	1
2	10127348	Hose, Push-On, 0.50	180.0"	12	10192425	Barbed Insert, 0.50 x 0.50	1
3	49833841	Bracket, Filter Mount	1	13	10198190	Plug, Hex Socket, 1/2-14	1
4	95572897	Hex Head Screw, 1/4-20 x 5/8	3	14	10189025	Adapter, Hose/JIC, 0.50 x 0.50	2
5	95838314	Lock Washer, 0.25 x 0.063	3	15	95750394	Lock Washer, 0.38 x 0.094	2
6	49887094	Water Pump, Vane	1	16	10069714	Flat Washer, 0.38 x 0.078	2
7	10150449	Decal, Drain	1	17	95416319	Hex Head Screw, 3/8-16 x 1.00	2
8	49886989	Adapter, Pipe/JIC	2	18	49886922	Adapter, Bulkhead	1
9	10092302	Shaft Coupling, 0.63	1	19	10070092	Jam Nut, 1-14	1
10	10116952	Cap Plug, 1.04 x 0.855	2				

Figure 11-19: Booster Pump/Low Pressure Water Filter Kit

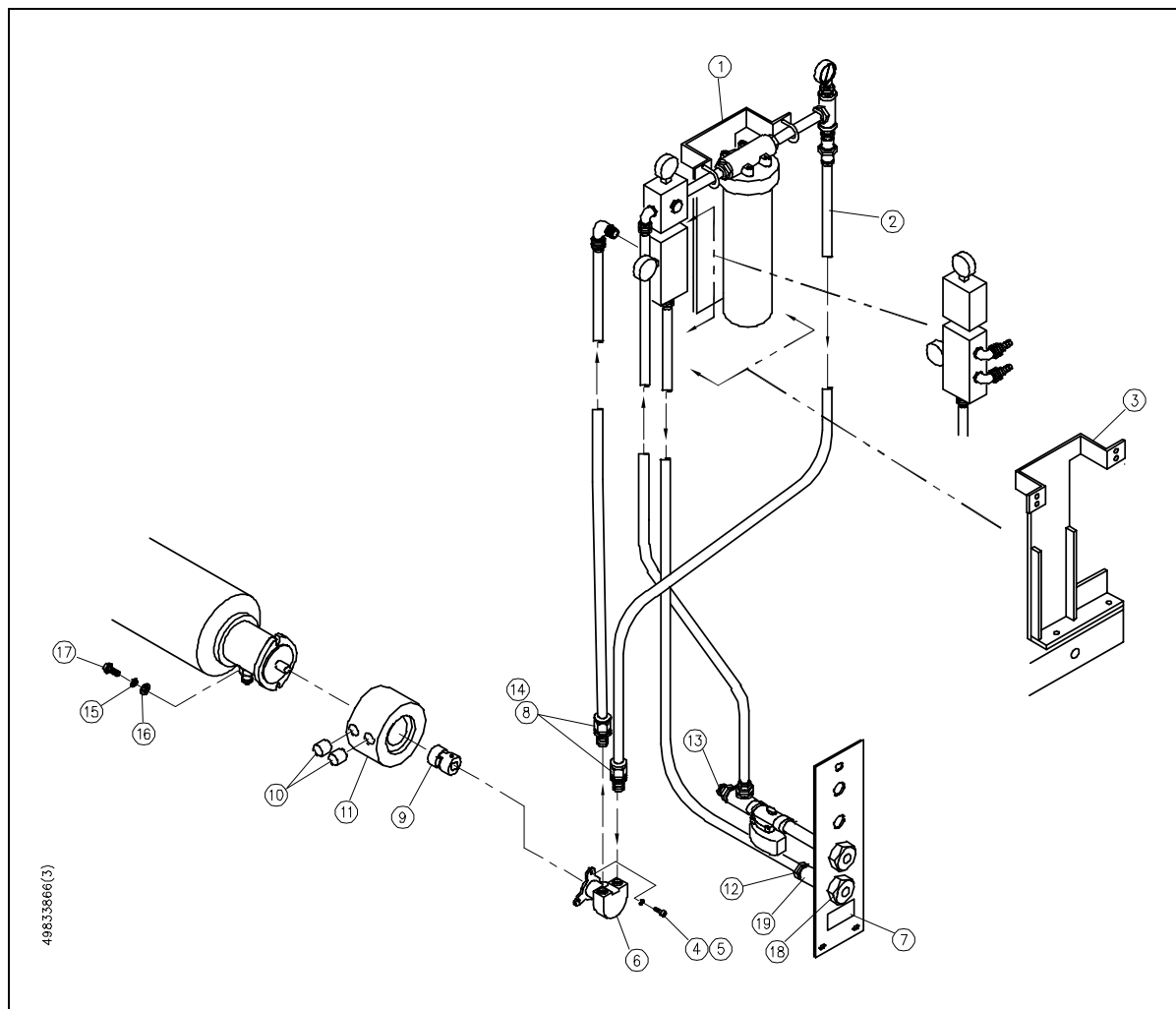




Table 11-20
Low Pressure Water Filter Assembly
49833858

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	05044052	Pressure Gauge, 0-200 psi	1	13	05105440	Pressure Gauge, 0-100 psi, Dual Scale	2
2	10100428	Pipe Bushing, M/F, 0.50 x 0.25	1	14	10106722	Filter Element	1
3	05070982	Relief Valve, 0.50, 50-150 psi	1	15	10189025	Adapter, Hose/JIC, 0.50 x 0.50	4
4	05074067	Pipe Nipple, 0.50 x 3.00	2	16	10114023	U-Bolt, 0.50	2
5	10078111	Pipe Bushing, M/F, 0.75 x 0.50	2	17	10113983	Tee, F	1
6	49836729	Low Pressure Manifold	1	18	05135637	Square Head Plug, 0.25, NPTM	2
7	05135629	Low Pressure Manifold	1	19	95416335	Hex Nut, 1/4-20	4
8	05135660	Elbow, JIC/O-Ring, 90D, W/Jamb Nut	4	20	95838314	Lock Washer, 0.25 x 0.063	4
9	49835804	Adapter, Pipe/Hose Barb	1	21	95391322	Flat Washer, 0.25 x 0.063	4
10	05016381	Water Filter Body	1	22	49868813	Temperature Sensor, 128F	1
11	05135652	Check Valve	1	Ref 1	49833841	Bracket, Filter Mount	--
12	10192425	Barbed Insert, 0.50 x 0.50	1				

Figure 11-20: Low Pressure Water Filter

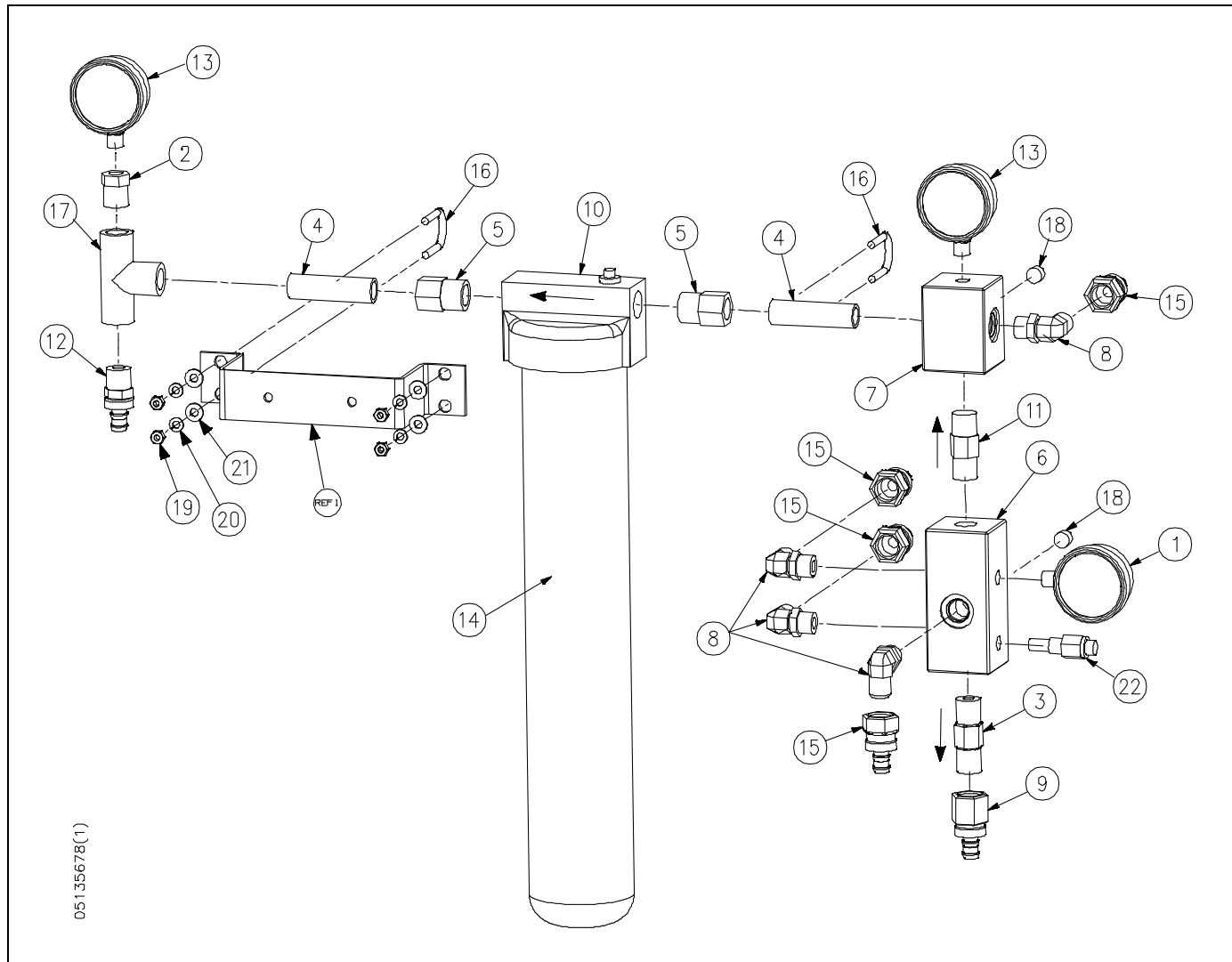




Table 11-21
Proportional Pressure Control
80075732

Item	Part Number	Description	Quantity
1	80071087	Hydraulic Solenoid Valve, 24V, Cartridge	1
2	49867104	Cable, #18, 4 Conductor	96.0"
3	10067205	Cable Connector, 0.50	1
4	10176410	Wire, #16, Blue	100.0"
5	10185395	Connector, Crimp Ferrule, #16	10
6	80088560	End Cap, 4-Way Valve	1

Figure 11-21: Proportional Pressure Control

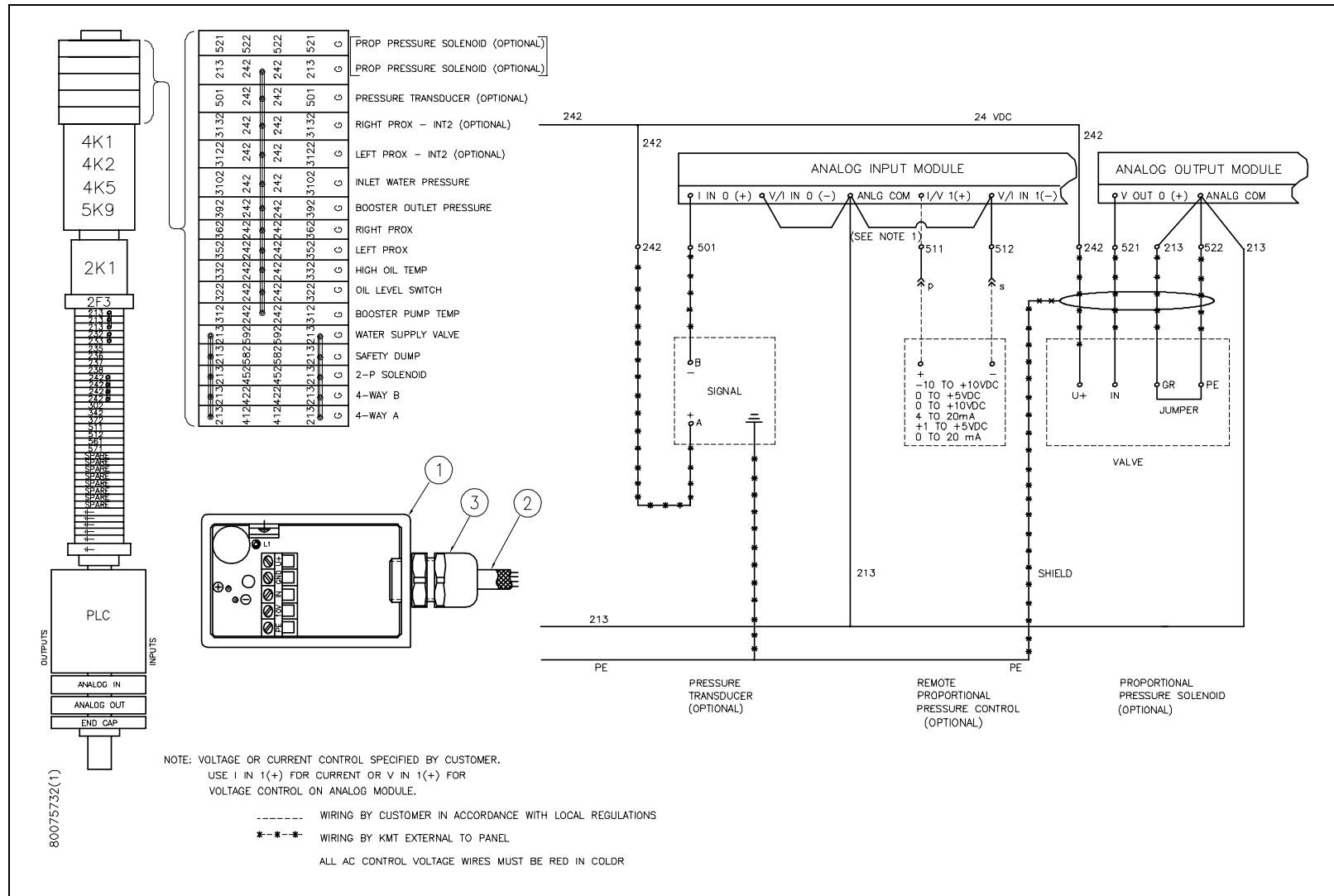




Table 11-22
Streamline S30 Redundant Intensifier Unit

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	80080047	Bulkhead Pipe Assembly	1	12	95391322	Flat Washer, 0.25 x 0.063	4
2	05086889	Control Box Configuration	1	13	95838314	Lock Washer, 0.25 x 0.063	4
3	05086806	Electrical Assembly	1	14	10150464	Decal, Cutting Water In	1
4	05086038	Base Assembly	1	15	10150472	Decal, Cooling Water In	1
5	05041660	Reservoir Assembly	1	16	10150480	Decal, Cooling Water Out	1
6	80080039	High Pressure Piping	1	17	05041009	Socket Head Screw, 1/2-13 x 1.00	4
7	05110614	Hydraulic Power Package	1	18	95688750	Lock Washer, 0.50 x 0.172	4
8	05141585	Hydraulic Hose Connections	1	19	10150456	Decal, Cutting Water Out	1
9	05091400	Attenuator Installation	1	20	80080062	Redundant Kit	1
10	20419318	Decal, U.S. Patent	1	21	05128087	Startup Tag	1
11	10097624	Button Head Screw, 1/4-20 x 1/2	4				

Figure 11-22: Streamline S30 Redundant Intensifier Unit

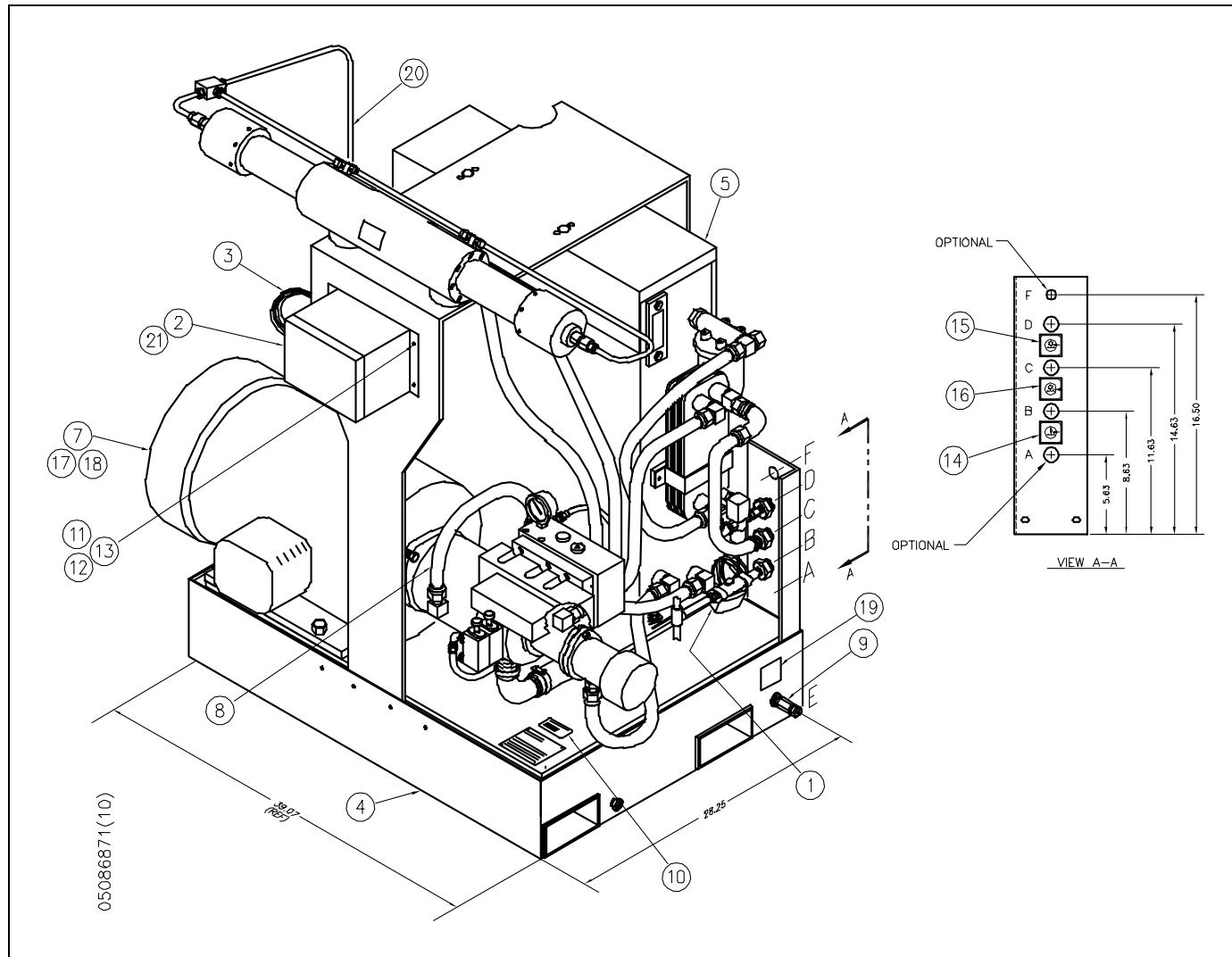
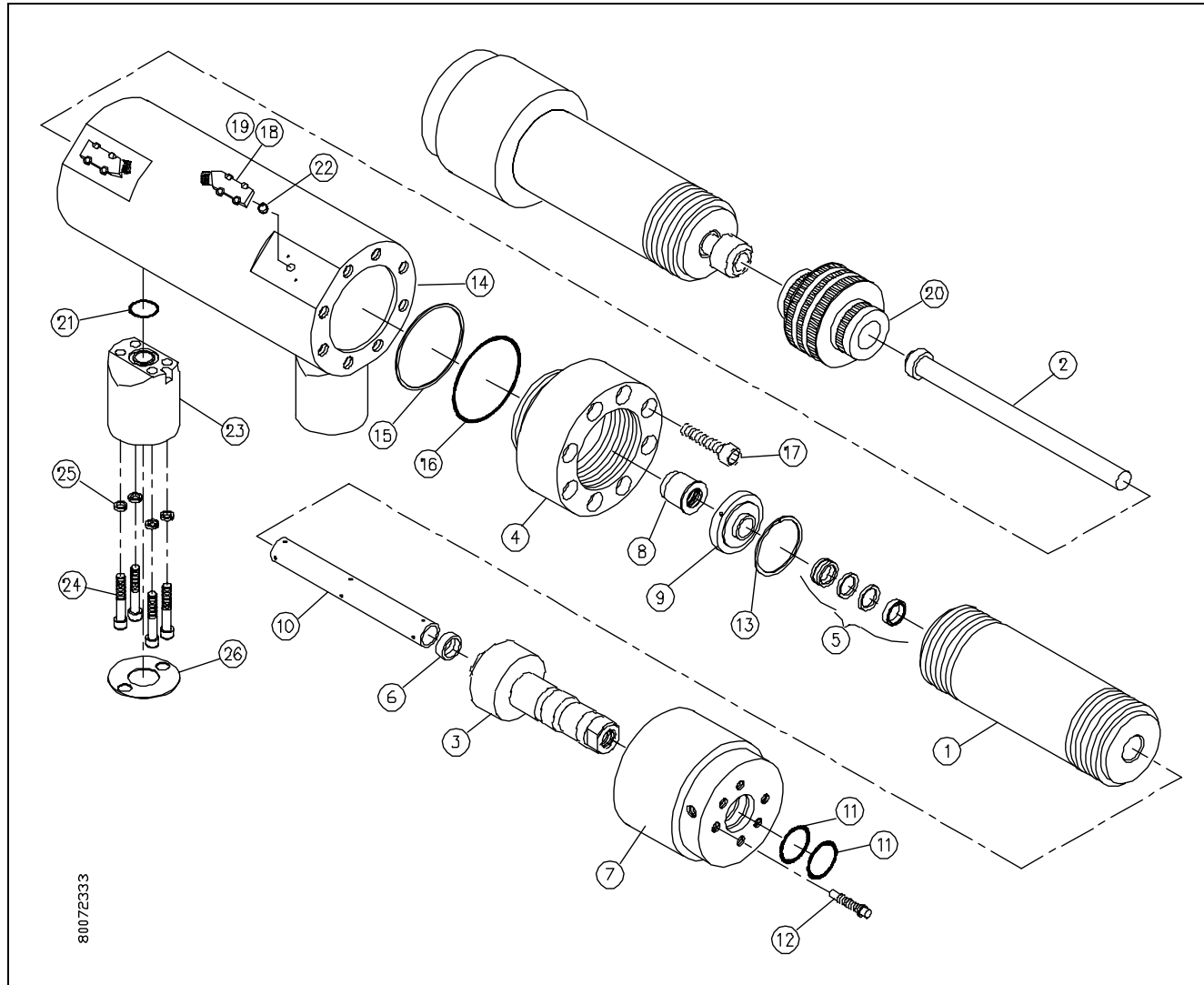




Table 11-23
Intensifier Assembly
80072333

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	05144647	HP Cylinder Body, 1.125 x 8	2	14	05034764	Hydraulic Cylinder, 6.22 x 4.03 x 14.96	1
2	05119151	Ceramic Plunger, 0.875	2	15	10075000	O-Ring, 3-3/4 x 4 x 1/8	2
3	80072349	Sealing Head Assembly	2	16	05034855	Backup Ring, 3-3/4 x 4	2
4	05034772	Hydraulic Cylinder Head	2	17	05141106	Socket Head Screw, M14 x 60	16
5	05149703	HP Seal Assembly, 0.875	2	18	05127584	Proximity Switch, 20-250V AC/DC	2
6	05144696	Spacer, Sealing Head	2	19	10183572	Socket Head Screw, M6 x 1.00 x 22 MM	4
7	80073646	HP Cylinder Nut, HSEC	2	20	05132253	Piston Assembly, 4.03 Diameter	1
8	05130091	Hydraulic Cartridge Seal Assembly	2	21	10074409	O-Ring, 1 x 1-1/4 x 1/8	2
9	05007786	Bushing Retainer Flange	2	22	05144183	Spacer, Proximity Switch	2
10	20418805	Liner, HP Cylinder	2	23	05049812	Stem, 3.00 x 4.00	2
11	10074920	O-Ring, 1-3/4 x 1-15/16 x 3/32	4	24	05079652	Socket Head Screw, M10 x 1.5 x 85 MM	8
12	80070352	Jackbolt, 7/16-20 x 2.31, 3/8 Hex Head	12	25	05061486	Lock Washer, M10	8
13	05034798	Retaining Ring	2	26	05081872	Gasket, Stem/Upper Drip Pan	2

Figure 11-23: Intensifier Assembly



80072333



Table 11-24
High Pressure Piping
80080039

Item	Part Number	Description	Quantity
1	05070628	HP Tube, Bent, 0.38 x 0.125	1
2	05070644	HP Tube, Bent, 0.38 x 0.125	1
3	10078590	HP Tee, 0.38	1
4	10186153	Conduit, Extra Flexible, 0.38 ID	120.0"
5	05089735	HP Tube, Bent, 0.38 x 0.125	1
6	10078129	HP Gland, 0.38	2
7	10078715	HP Collar, 0.38	2
8	80072333	Intensifier Assembly	1
9	95383790	Socket Head Screw, 1/2-13 x 1	4
10	95413696	Lock Washer, 0.50 x 0.125	4
11	10083897	Ferrule, 0.25 Hose	6

Figure 11-24: High Pressure Piping

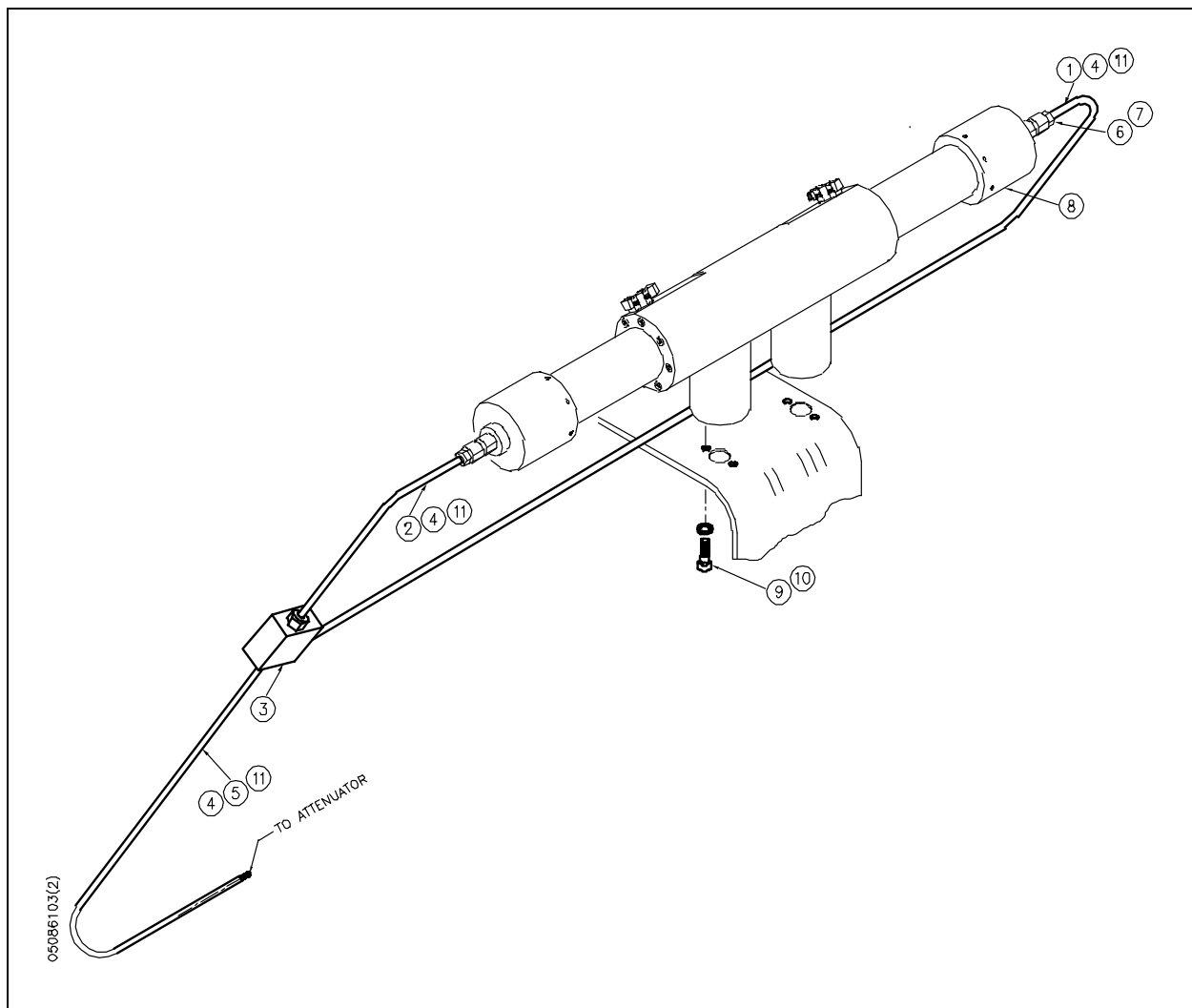




Table 11-25
Hydraulic Power Package
05110614

Item	Part Number	Description	Quantity
1	80082407	Motor/Pump Assembly	1
2	05050687	Cap, Recirculation Pump Shaft	1
3	10091510	Decal, Arrow	2
4	95688750	Lock Washer, 0.50 x 0.172	6
5	95055026	Socket Head Screw, 1/2-13 x 1-3/4	6
6	05092523	Directional Control Valve, 24V DC	1
7	05092697	Hose Clamp	1

Figure 11-25: Hydraulic Power Package

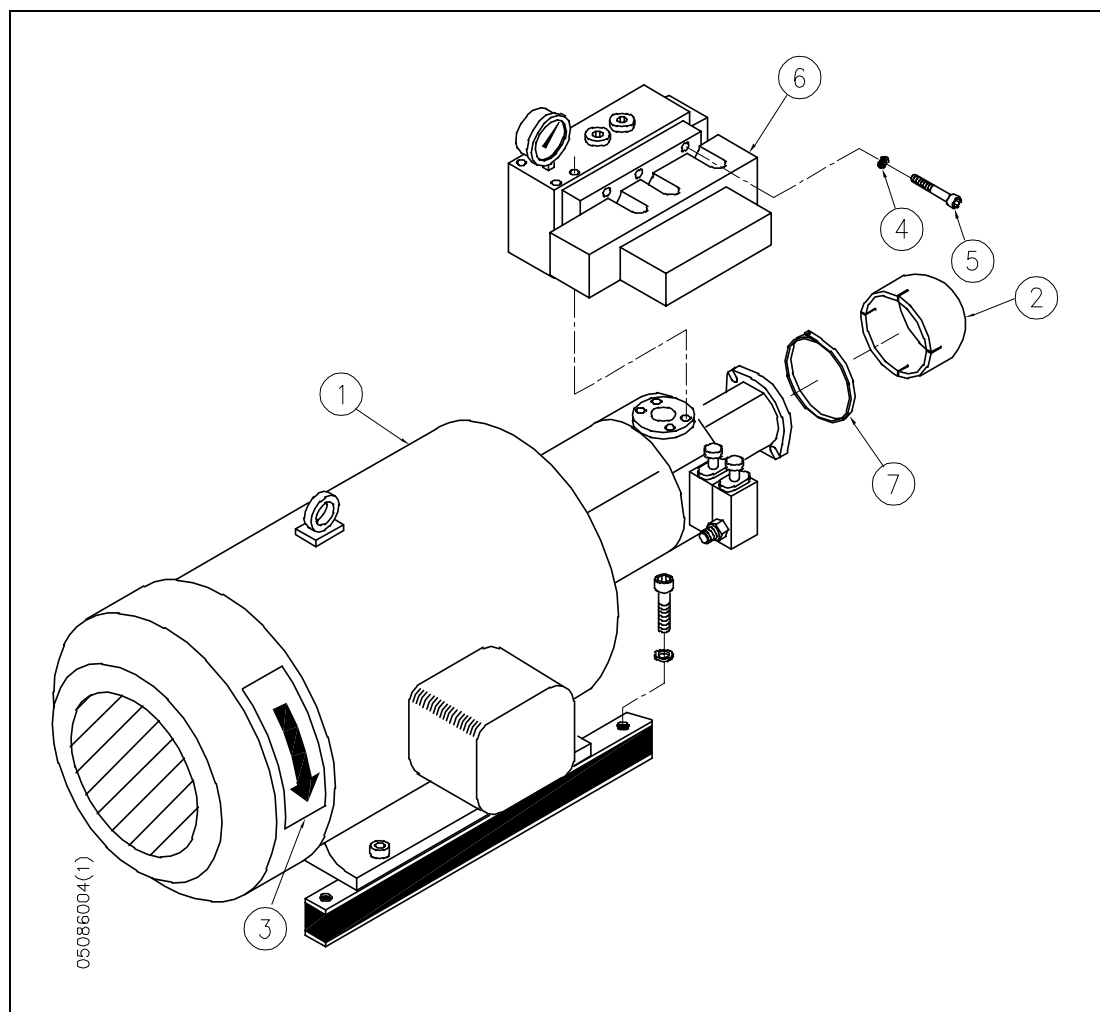




Table 11-26
Motor/Pump Assembly
80082407

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	80076995	Coupling, Flexible Drive, Motor Shaft	1	12	05045364	Gear Pump, Double Shaft	1
2	80077001	Flexible Drive Coupling Insert	1	13	80077027	Coupling, Flexible Drive, Spline	1
3	05101605	Vibration Isolation Mount	2	14	05114087	Socket Head Screw, 3/8-16 x 1.38	3
4	80076599	Electric Motor, 30 HP	1	15	05085063	Socket Head Screw, 3/8-16 x 6	4
5	80077019	Flange, Motor/Pump Adapter	1	16	05050356	Lock Washer, 0.43 x 0.140	4
6	95716882	Hex Head Screw, 1/2-13 x 1-1/4	2	17	10074953	O-Ring, 1-1/2 x 1-3/4 x 1/8	1
7	05083258	Piston Pump, 3100 psi, 45 cc	1	18	10069763	Flat Washer, 0.50 x 0.109	2
8	05037593	Socket Head Screw, M10 x 1.50 x 25 MM	2	19	10134989	Flat Washer, 0.63	12
9	10069714	Flat Washer, 0.38 x 0.078	2	20	95070132	Hex Head Screw, 5/8-11 x 1-1/2	4
10	05071766	Manifold Assembly	1	21	10134989	Flat Washer, 0.63	4
11	05073168	Elbow, JIC/O-Ring, 45D	1				

Figure 11-26: Motor/Pump Assembly

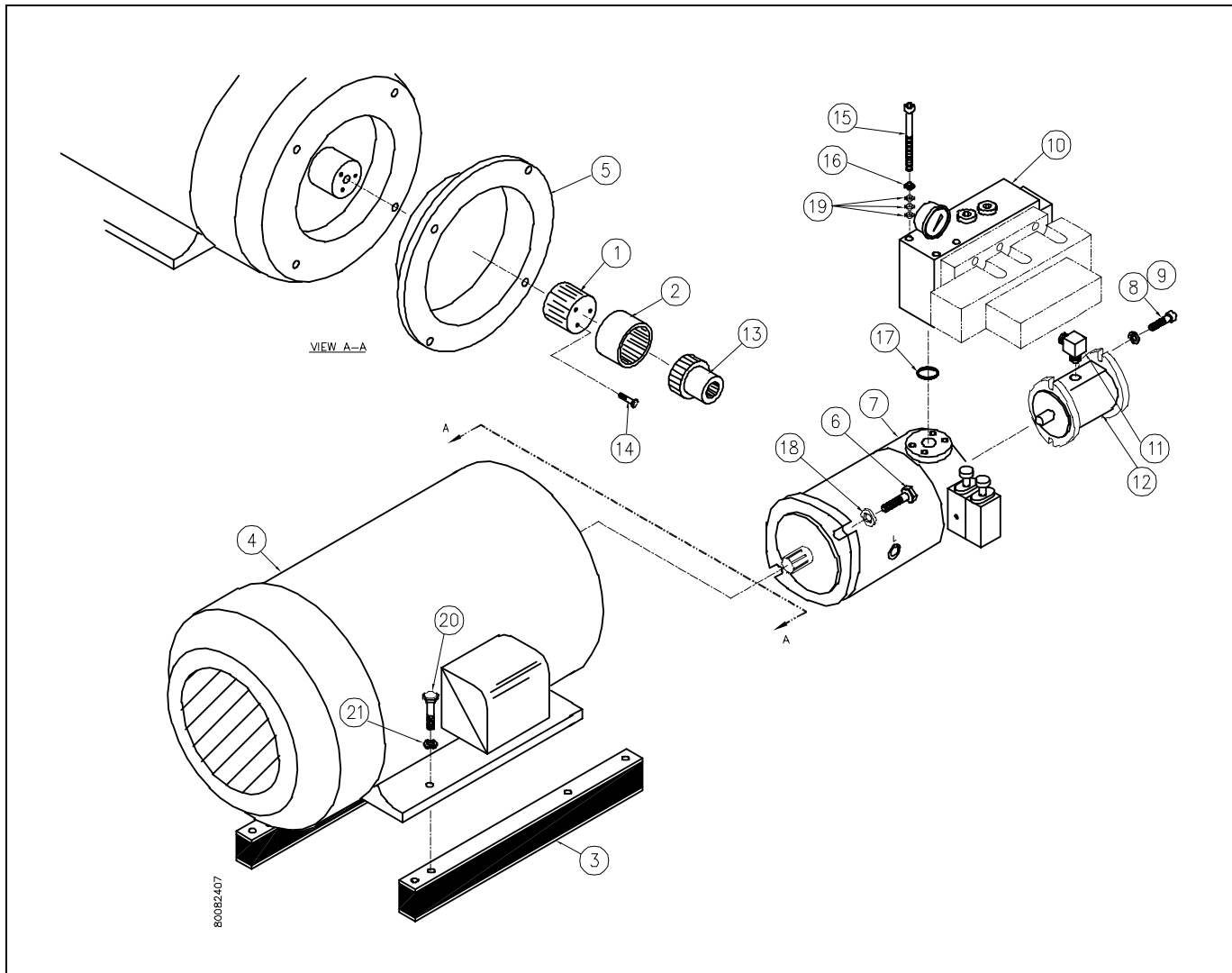




Table 11-27
Hydraulic Manifold Assembly
05071766

Item	Part Number	Description	Quantity
1	05044144	Manifold	1
2	05071055	Plug, O-Ring, Hex Socket, 0.75	3
3	05071717	Relief Valve Cartridge	1
4	05055017	Plug, O-Ring, 0.125	2
5	10185585	Solenoid Valve, 24V DC, NC, 2-Way/2-Position	1
6	05045497	Pressure Gauge, 0-5000 psi	1
7	10187052	Relief Valve Knob, 100/3000 psi	1
8	10187060	Relief Valve, 25/800 psi	1
9	49889744	Retainer, Valve Cartridge	1
10	49889736	Hydraulic Check Valve Cartridge	1
11	49889769	Plug, O-Ring, 0.25	1
Ref 1	05092523	Directional Control Valve	--

Figure 11-27: Hydraulic Manifold Assembly

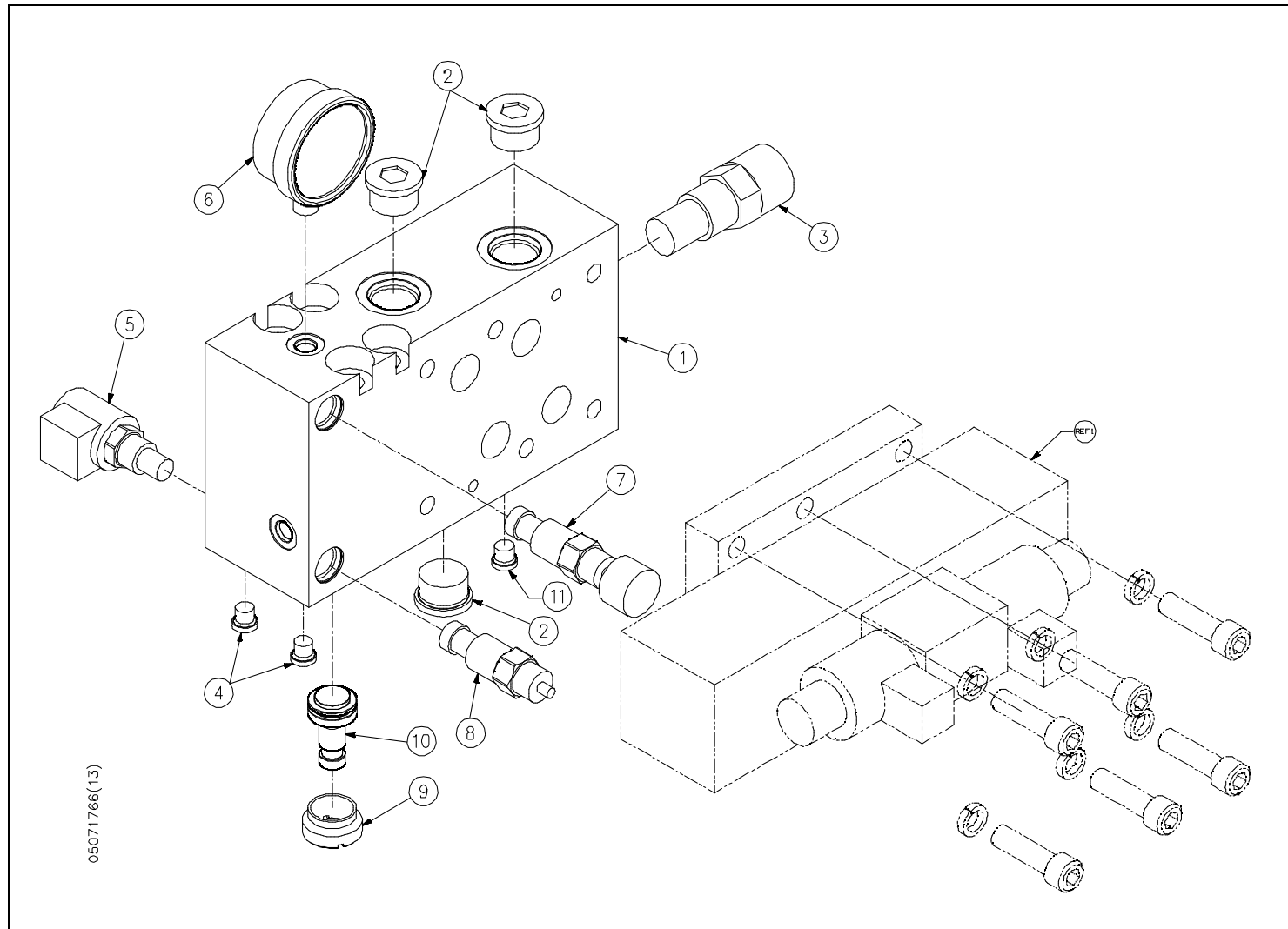




Table 11-28
Hydraulic Hose Connections
05086228

Item	Part Number	Description	Quantity
1	05060744	Hydraulic Hose Assembly, LP, 0.75, 0.75F JIC, Swivel	1
2	05089883	Hydraulic Hose Assembly, LP, 0.50, 0.50, JIC, Swivel	1
3	05090931	Hydraulic Hose Assembly, HP, 0.75, 0.75F JIC	1
4	10083517	Hose Clamp, 1.81-2.75	2
5	10179018	Radiator Hose, 2.0"	7.31"
6	05086202	Split Flange Kit, 1.50	1
7	05086210	Elbow, Split Flange/Hose Barb	1
8	05051214	Hydraulic Hose Assembly, MP, 0.25, 0.25F, JIC, Swivel	1
9	05060751	Hydraulic Hose Assembly, MP, 0.25, 0.25F, JIC, Swivel	1
10	05049713	Hydraulic Hose Assembly, LP, 0.75, 0.75F JIC, Swivel	1
11	05089875	Hydraulic Hose Assembly, HP, 0.50, 0.50, JIC	2
12	05071121	Hydraulic Hose Assembly, MP, 0.25, 0.25F, JIC, Swivel	1
13	05052493	Elbow, JIC/O-Ring, 45D	2
14	05089867	Adapter, JIC/O-Ring, Straight	3
15	10142644	Adapter, JIC/O-Ring, 90D	3
16	10144749	Adapter, JIC/O-Ring, 45D	1
17	05089891	Tube End Reducer	3
18	05050331	Elbow, JIC/O-Ring, 90D	1
19	10142594	Adapter, JIC/O-Ring, Straight	1

Figure 11-28: Hydraulic Hose Connections

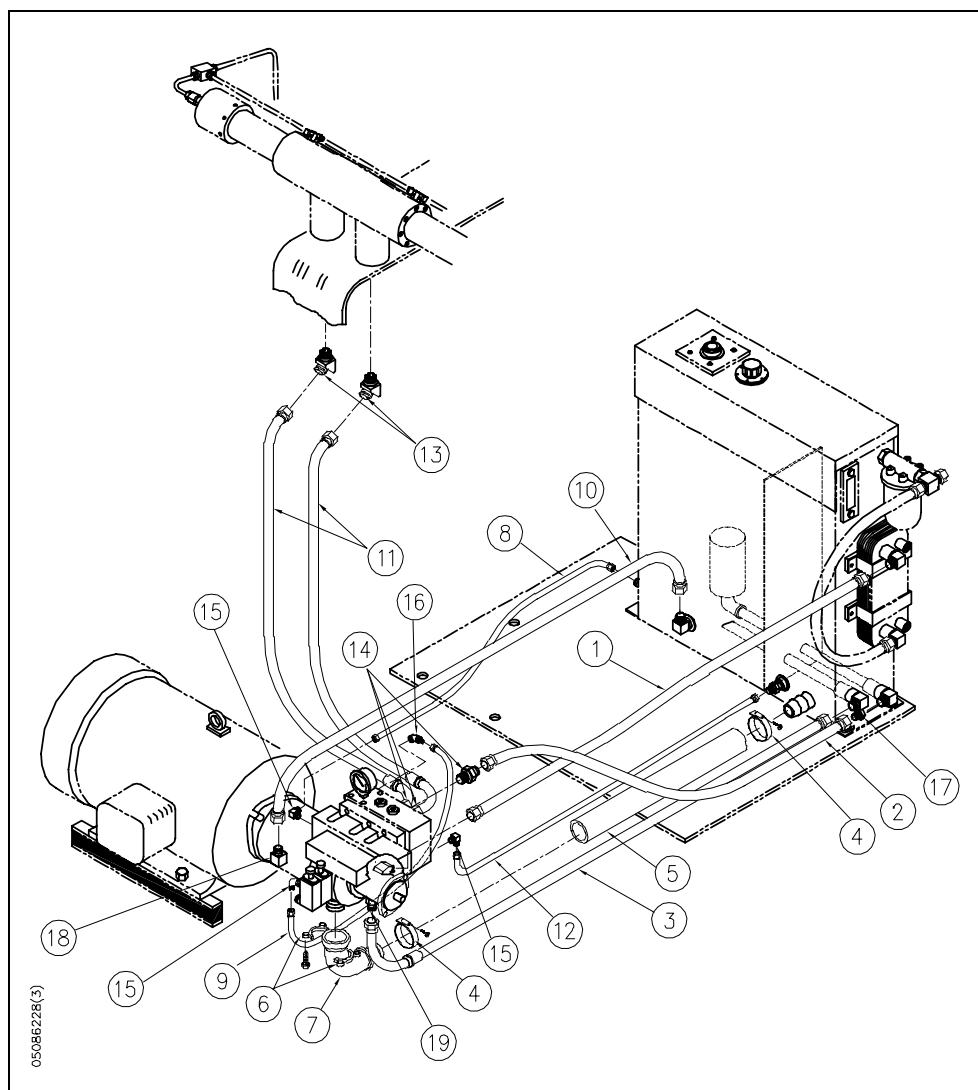




Table 11-29
Reservoir Assembly
05041660

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	05041686	Reservoir Weldment	1	17	95716890	Lock Washer, 0.50 x 0.031	4
2	05049861	Gasket, Reservoir	1	18	10069763	Flat Washer, 0.50 x 0.109	4
3	05050026	Temperature Switch	1	19	05057559	Adapter, O-Ring/Pipe, 12	1
4	05092739	Air Breather	1	20	49868524	Pipe Bushing, M/F, 1.25 x 1.00	1
5	10168862	Level/Temperature Gauge, Dual Scale	1	21	05006291	Diffuser, Return Line, 1.25 NPT	1
6	05049697	Hydraulic Filter Head W/Gauge	1	22	10142644	Adapter, JIC/O-Ring, 90D	1
	05103817	Pressure Gauge, only		23	10080901	Ball Valve	1
7	05049689	Oil Filter Element, 6 Micron Absolute	1	24	95033619	Plug, Square Head, 0.50	1
8	20421954	Elbow, JIC/O-Ring, 90D	3	25	95897948	Button Head Screw, 10-24 x 1/2	4
9	05069976	Hex Pipe Cap, 0.75	1	26	95367728	Lock Washer, #10 x 0.047	4
10	05071063	Tee, Straight Thread Branch, O-Ring/JIC	1	27	20423993	Adapter, JIC/O-Ring, Straight	1
11	05145958	Heat Exchanger, Water/Oil	1	28	05050331	Elbow, JIC/O-Ring, 90D, 12-10	2
12	95830766	Lock Washer, 0.31 x 0.078	4	29	05079371	Adapter, Straight Swivel, JIC/BSPP	1
13	10103232	Neoprene/Nitrile, 0.125 x 1.00	12.0"	30	05079967	Gasket, Oil Sensor	1
14	10091858	Bulb, Well	1	31	95716882	Hex Head Screw, 1/2-13 x 1-1/4	4
15	95119897	Hex Head Screw, 5/16-18 x 1/2	4	32	95367207	Flat Washer, #10 x 0.047	4
16	05145974	Bracket, Heat Exchanger	2				

Figure 11-29: Reservoir Assembly

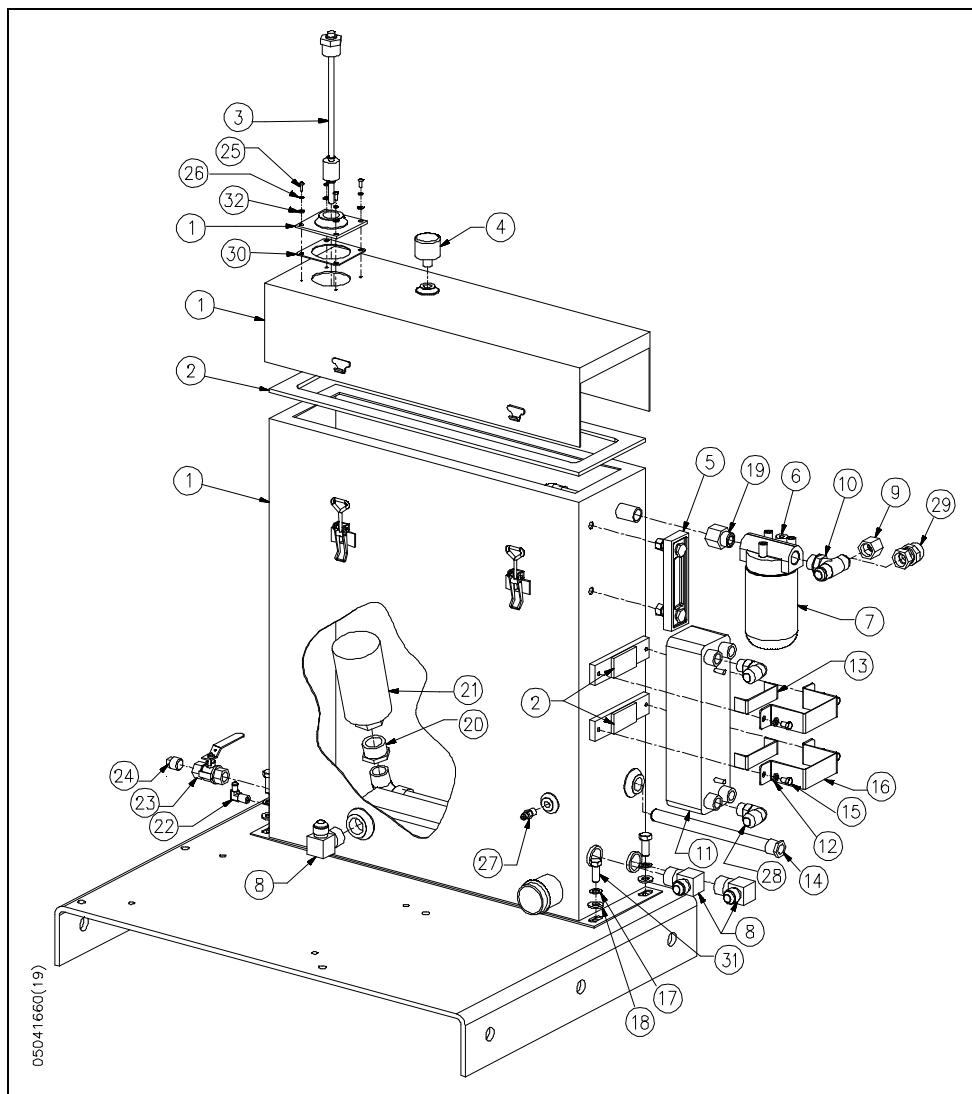




Table 11-30
Electrical Assembly
05086806

Item	Part Number	Description	Quantity
1	05049762	Harness, Sensor/Solenoid Cable	1
2	10125912	Cable Tie, 0.87	5
3	05044029	Adapter Block, Motor Junction Box	1
4	05062344	Lock Nut, 1/4-20	2
5	10069755	Flat Washer, 0.31 x 0.078	2
6	10120921	Cable Tie Mount, 1.00 x 1.00	5
7	95686721	Socket Head Screw, 1/4-20 x 1-3/4	2
8	05043161	Terminal Block, 9-Post	1
9	95077012	Hex Head Screw, 5/16-18 x 1-3/4	2
10	10094712	Terminal Ring, #14-10	12

Figure 11-30: Electrical Assembly

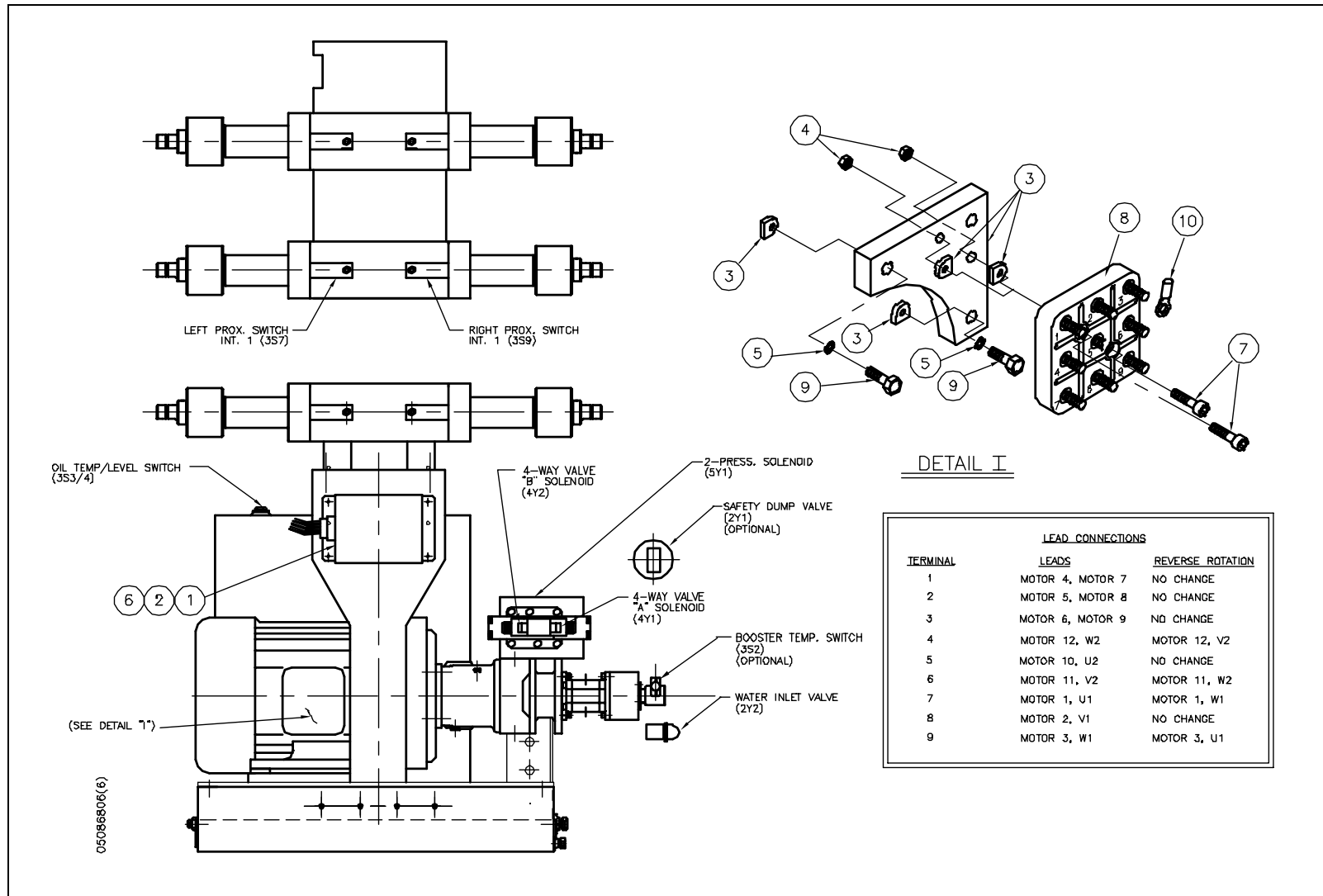




Table 11-31
Control Box Configuration
05086889

Item	Part Number	Description	Quantity
1	05086897	Enclosure	1
2	10066736	Panel Insert	1
3	10103034	DIN Rail	7.0"
4	10073492	Pan Head Screw, 8-32 x 1/2	3
5	05032362	End Anchor, Terminal Block	2
6	05046214	Terminal Block, IEC	3
7	05113634	Terminal Block, 3-Level	10
8	05112826	Terminal Block Jumper, 10-Pole	1.4
9	05112818	Terminal Block Marker	0.5
10	05117601	End Barrier, 3-Level Terminal Block	1
11	05032370	End Barrier, IEC	1
12	05032396	Terminal Block Marker	0.6
13	10170165	Wire, #16, Green/Yellow	6.0"
14	10181873	Ring Terminal, #16-#14	1



Figure 11-31: Control Box Configuration

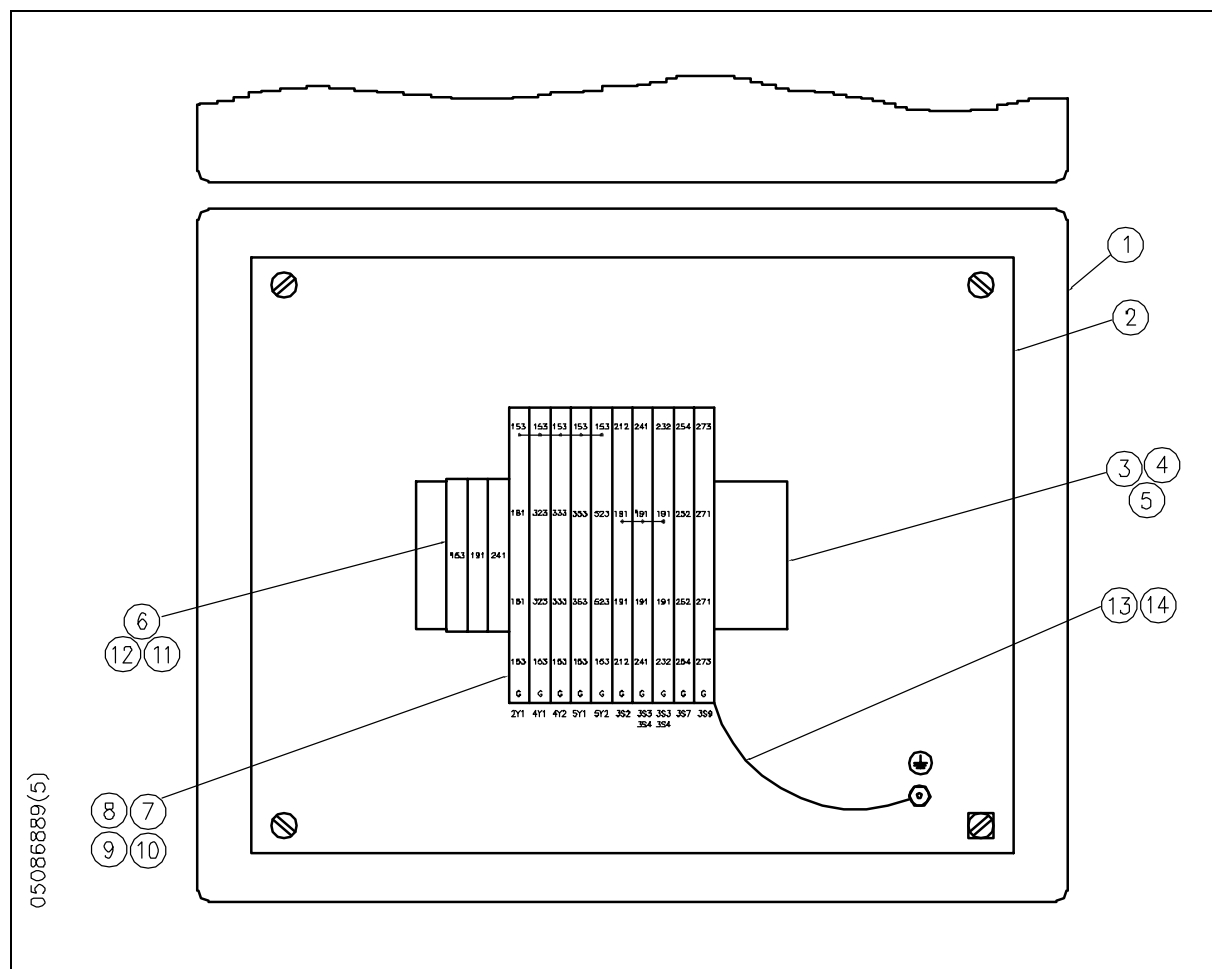




Table 11-32
Redundant Kit with Optional Dump Valve
80080062

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
1	5070628	Tube, Bent, 0.38 x 0.125	2	18	5091871	Adapter, O-Ring/O-Ring	4
2	5137807	Tube, Bent, 0.38 x 0.125, 90D	2	19	5091905	Elbow, JIC/O-Ring, 45D, 8-8	4
3	10078590	Tee, HP, 0.38	2	20	5091863	Adapter, O-Ring/O-Ring, Straight, M/F	2
4	10062289	SST Welded Tube	0.56"	21	10083897	Ferrule, 0.25 Hose	16
5	5137724	3-Way Valve, HP, 0.38	2	22	5137815	Tube, Straight, 0.38 x 0.125 x 7.04	1
6	10078129	HP Gland, 0.38	2	23	5137823	Tube, Bent, 0.38 x 0.125, 90D	1
7	10078715	HP Collar, 0.38	2	24	5069703	Valve Assembly, Pneumatic	1
8	80072333	Intensifier Assembly	1	25	10077055	Adapter, Bulkhead	1
9	95413696	Lock Washer, 0.50 x 0.125	4	26	10176766	Elbow, 90D, 0.25 x 0.25	1
10	95383790	Socket Head Screw, 1/2-13 x 1.00	4	27	10079903	Tube, 0.25, Clear	60.0"
11	10186153	Conduit, Extra Flexible, 0.38 ID	120.0"	28	49834328	Adapter, Tube/Pipe, M, 0.25 x 0.50	1
12	5137781	Tube, Bent, 0.38 x 0.25, 90D	1	29	95895777	Hex Head Screw, 1/4-28 x 1.00	2
13	5137799	Tube, Straight, 0.38 x 0.125 x 3.13	1	30	95838314	Lock Washer, 0.25 x 0.063	2
14	5089875	Hydraulic Hose Assembly, 0.50, JIC, F, 90D	2	31	5071808	Decal, Plant Air	1
15	5091889	Adapter, JIC/O-Ring, 8-10	2	32	49896749	Tee, M Run, 0.50	1
16	5091897	Adapter, O-Ring/O-Ring, M/F	2	33	49886922	Adapter, Bulkhead	1
17	5090949	2-Way Ball Valve, 0.50 O-Ring	4	34	10086999	Plug, Hex socket, 1/2-14	1



Table 11-32
Redundant Kit with Optional Dump Valve
80080062

Item	Part Number	Description	Quantity	Item	Part Number	Description	Quantity
35	10150449	Decal, Drain	1	38	5112271	Muffler, 0.125 NPT	1
36	10070092	Jam Nut, 1-14	1	39	5092390	Tube, Bent, 0.25 x 0.083	1
37	5137831	Tube, Bent, 0.38 x 0.125, 90D	1				

Figure 11-32: Redundant Kit with Optional Dump Valve

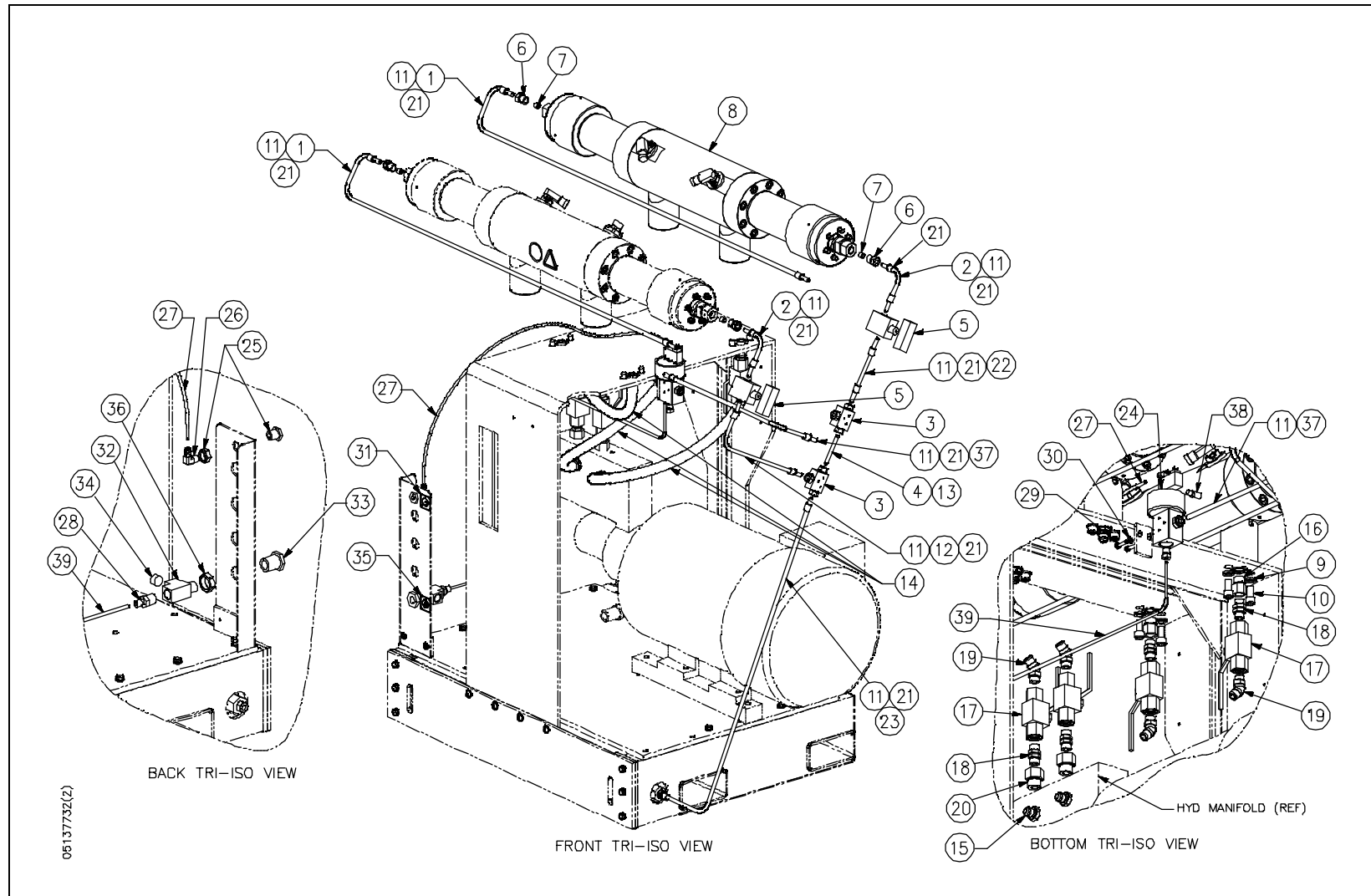


Table 11-33
High Pressure Tube Coning Tools

Item	Part Number	Description
	05108832	1/4" Hand Coning Tool Assembly
	05108857	3/8" Hand Coning Tool Assembly
	05108840	9/16" Hand Coning Tool Assembly
1	05108972	1/4" Coning Tool Collet
	05108964	3/8" Coning Tool Collet
	05108956	9/16" Coning Tool Collet
2	05108808	1/4" Coning Tool Blade
	05108824	3/8" Coning Tool Blade
	05108816	9/16" Coning Tool Blade
	05109897	1/4" Power Coning Tool Assembly
	05109889	3/8" Power Coning Tool Assembly
	05109871	9/16" Power Coning Tool Assembly
	05120472	Cone and Thread Lubricant, 4 oz.

Figure 11-33: Hand Coning Tool Assembly

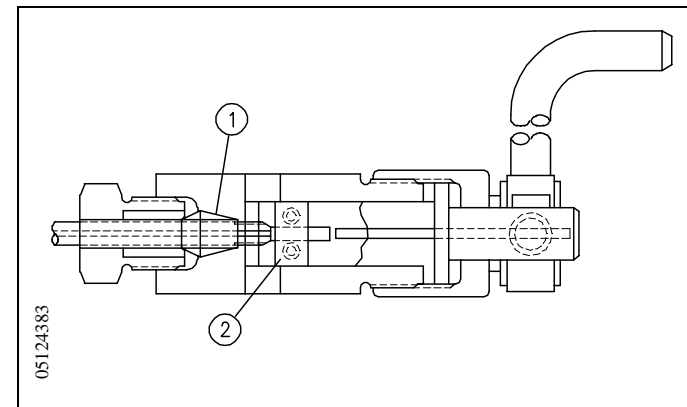


Table 11-34
High Pressure Tube Threading Tools

Item	Part Number	Description
1	05108865	1/4" Hand Threading Tool Assembly
	05108873	3/8" Hand Threading Tool Assembly
	05108881	9/16" Hand Threading Tool Assembly
	05108899	1/4-28 HP Threading Die, LH
	05108915	3/8-24 HP Threading Die, LH
	10078301	9/16-18 HP Threading Die, LH
	05108741	1/4" Guide Bushing
2	05108758	3/8" Guide Bushing
	05108766	9/16" Guide Bushing
	05122742	1/4" Power Threading Tool Assembly
	05120258	3/8" Power Threading Tool Assembly
	05122759	9/16" Power Threading Tool Assembly
	05108782	1/4" Tube Vise
	05108790	3/8" Tube Vise
	05108774	9/16" Tube Vise

Figure 11-34: Hand Threading Tool Assembly

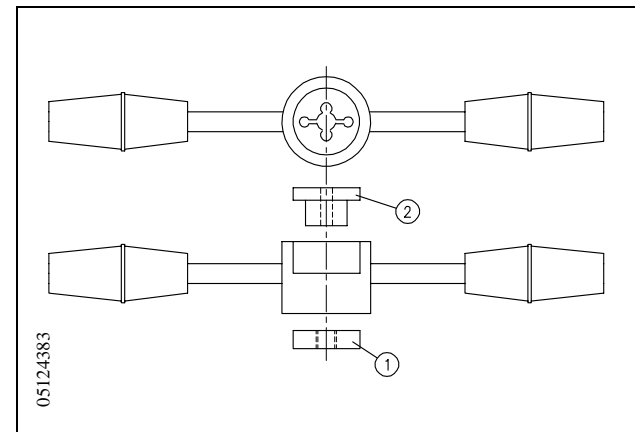


Table 11-35
Maintenance Tools and Lubricants

Item	Part Number	Description
1	05004924	Plunger Removal Tool, 7/8" Plunger
	49830391	Plunger Removal Tool, 1-1/8" Plunger
2	05149877	Vee Block Cradle, 7/8" Plunger
	49830946	Vee Block Cradle, 1-1/8" Plunger
3	05066139	Cylinder Wrench
4	80079239	End Cap Wrench, HSEC, 6x/8x
5	80079247	End Cap Wrench, HSEC, 8x
6	80078330	Seal Removal Tool Stand
7	10079523	HP Plug, 3/8"
	10078772	HP Plug, 9/16"
8	10078129	HP Gland Fitting, 3/8"
	10078608	HP Gland Fitting, 9/16"
9	10148674	Seal Removal Tool, 7/8" Plunger
	05146618	Seal Removal Tool, 1-1/8" Plunger

Figure 11-35A: Maintenance Tools

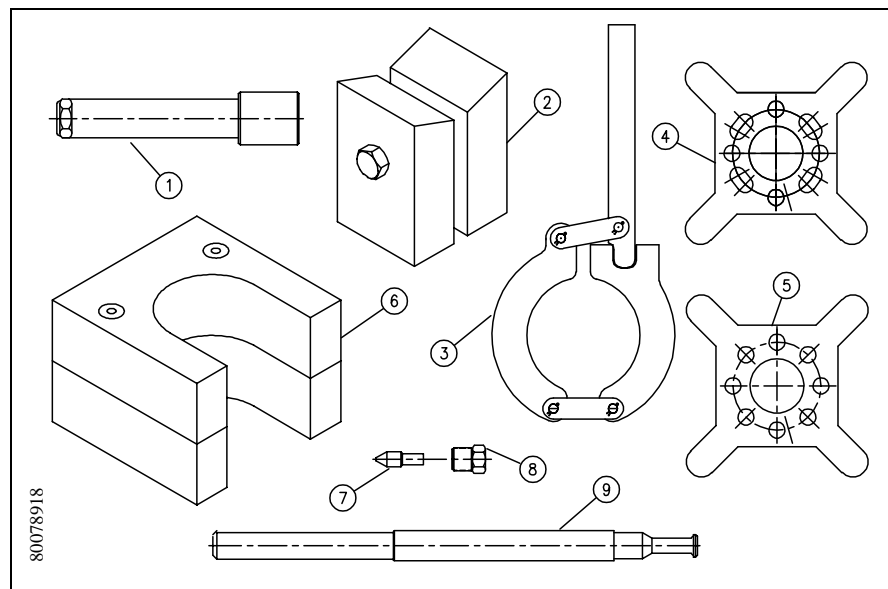


Table 11-35
Maintenance Tools and Lubricants

Item	Part Number	Description
	05141759	Seal Tool Kit
1	05103882	Seal Installation Tool
2	05067350	Seal Positioning Tool
3	05103890	Seal Push Tool

	Lubricants
10084440	Pure Goop
10087385	FML-2 Grease, 14.5 oz.
49832199	JL-M Grease, 16 oz.
80082191	JL-M Grease, 15 ML
49877509	Threadlocker Adhesive
10184802	Optimol, Anti-Seize Grease

Figure 11-35B: Seal Tools

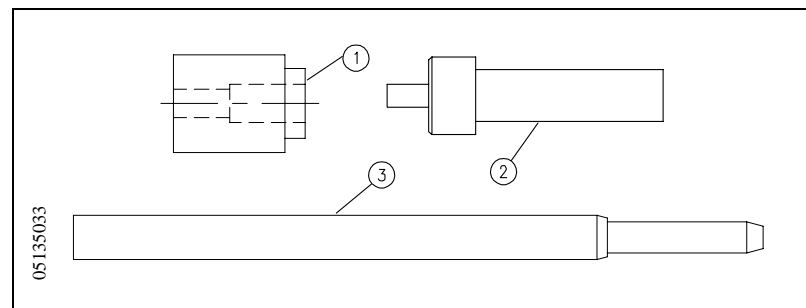


Table 11-36
Focusing Tubes

Part Number	Description	
05147889	R-100	0.018" (0.457 mm) x 2.00" (50.8 mm)
10139426	R-100	0.021" (0.533 mm) x 2.00" (50.8 mm)
10126969	R-100	0.030" (0.762 mm) x 3.13" (79.4 mm)
80075252	R-100	0.036" (0.914 mm) x 3.13" (79.4 mm)
49833593	R-100	0.039" (0.991 mm) x 3.13" (79.4 mm)
49835390	R-100	0.040" (1.016 mm) x 3.13" (79.4 mm)
10126928	R-100	0.043" (1.092 mm) x 3.13" (79.4 mm)
10186799	R-100	0.050" (1.321 mm) x 3.13" (79.4 mm)
05117528	R-100	0.052" (1.321 mm) x 3.13" (79.4 mm)
05051891	R-100	0.058" (1.473 mm) x 3.13" (79.4 mm)
10126936	R-100	0.063" (1.600 mm) x 3.13" (79.4 mm)
10139418	R-100	0.093" (2.632 mm) x 3.13" (79.4 mm)

Figure 11-36A: R-100 Focusing Tube

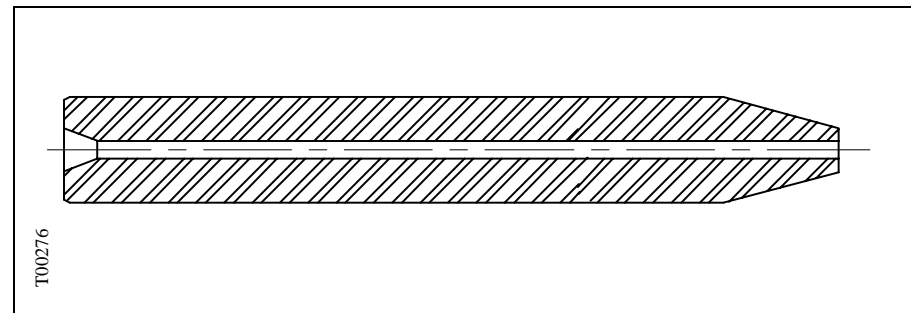


Table 11-36
Focusing Tubes

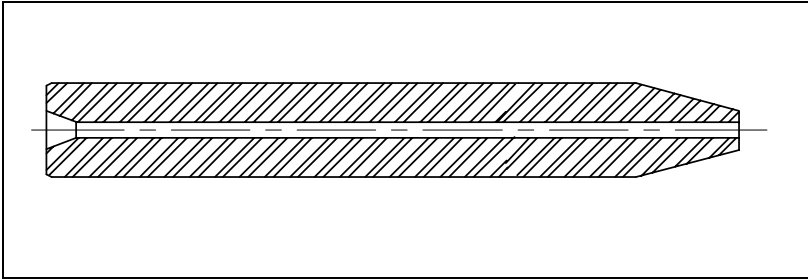
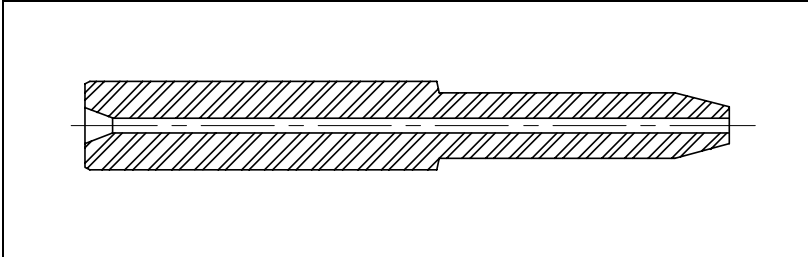
Part Number	Description		
05097928	R-500	0.021" (0.533 mm) x 2.00" (50.8 mm)	<p><i>Figure 11-36B: R-500 Focusing Tube</i></p> 
05105366	R-500	0.043" (1.092 mm) x 2.75" (69.9 mm)	
05097944	R-500	0.030" (0.762 mm) x 3.13" (79.4 mm)	
05116652	R-500	0.036" (0.914 mm) x 3.13" (79.4 mm)	
05097936	R-500	0.043" (1.092 mm) x 3.13" (79.4 mm)	
05130919	R-500	0.063" (1.600 mm) x 3.13" (79.4 mm)	
05130927	R-500	0.093" (2.632 mm) x 3.13" (79.4 mm)	
05105366	R-500 Special	0.043" (1.092 mm)x 2.75" (69.9 mm)	<p><i>Figure 11-36C: R-500 Special Focusing Tube</i></p> 

Table 11-37
Standard Orifice Assemblies

Part Number	Description	Part Number	Description	Part Number	Description
A2260003	0.003" (0.076 mm)	A2260011	0.011" (0.279 mm)	A2260019	0.019" (0.483 mm)
A2260004	0.004" (0.102 mm)	A2260012	0.012" (0.305 mm)	A2260020	0.020" (0.508 mm)
A2260005	0.005" (0.127 mm)	A2260013	0.013" (0.330 mm)	A2260021	0.021" (0.533 mm)
A2260006	0.006" (0.152 mm)	A2260014	0.014" (0.356 mm)	A2260022	0.022" (0.559 mm)
A2260007	0.007" (0.178 mm)	A2260015	0.015" (0.381 mm)	A2260023	0.023" (0.584 mm)
A2260008	0.008" (0.203 mm)	A2260016	0.016" (0.406 mm)	A2260024	0.024" (0.610 mm)
A2260009	0.009" (0.229 mm)	A2260017	0.017" (0.432 mm)		
A2260010	0.010" (0.254 mm)	A2260018	0.018" (0.457 mm)		

Figure 11-37: Standard Orifice

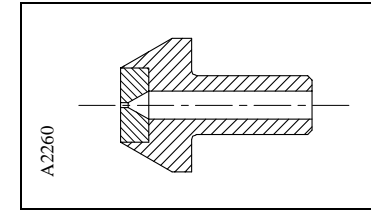


Table 11-38
Long Life Diamond Orifice Mounts

Part Number	Description	Part Number	Description	Part Number	Description
49888852	0.003" (0.076 mm)	49888910	0.009" (0.229 mm)	49888969	0.016" (0.406 mm)
49888860	0.004" (0.102 mm)	49888928	0.010" (0.254 mm)	49888977	0.018" (0.457 mm)
49888878	0.005" (0.127 mm)	49888936	0.012" (0.305 mm)	49888993	0.022" (0.559 mm)
49888886	0.006" (0.152 mm)	49836786	0.013" (0.330 mm)		
49888894	0.007" (0.178 mm)	49888944	0.014" (0.356 mm)		
49888902	0.008" (0.203 mm)	49888951	0.015" (0.381 mm)		

Figure 11-38: Diamond Orifice Mounts

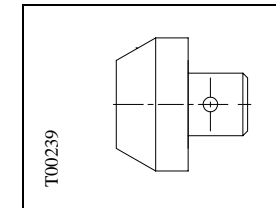


Table 11-39
High Pressure Fittings

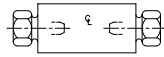
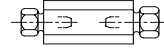

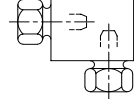
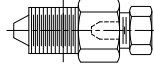
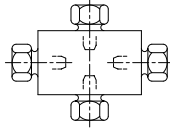

Part Number	Description		Part Number	Description	
10079028	Coupling, Straight, 1/4"	<i>HP Straight Coupling</i> 	10079614	Reducing Coupling, 1/4" x 3/8"	<i>HP Reducing Coupling</i> 
10078905	Coupling, Straight, 3/8"		10078145	Reducing Coupling, 1/4" x 9/16"	
10078640	Coupling, Straight, 9/16"		10079531	Reducing Coupling, 3/8" x 9/16"	
10078426	Collar, 1/4"	<i>HP Collar</i> 	10079051	Coupling, 90 Degree Elbow, 1/4"	<i>HP Elbow Coupling</i> 
10078715	Collar, 3/8"		10078780	Coupling, 90 Degree Elbow, 3/8"	
10079119	Collar, 9/16"		10078525	Coupling, 90 Degree Elbow, 9/16"	
10079473	Adapter, 1/4" M x 3/8" F	<i>HP M/F Adapter</i> 	10097228	Cross, 1/4"	<i>HP Cross</i> 
10079424	Adapter, 1/4" M x 9/16" F		10078038	Cross, 3/8"	
10079432	Adapter, 3/8" M x 1/4" F		10079168	Cross, 9/16"	
10079655	Adapter, 3/8" M x 9/16" F				
10079580	Adapter, 9/16" M x 1/4" F				
10079457	Adapter, 9/16" M x 3/8" F				
		<i>HP Cone Plug</i> 			
10116333	Cone Plug, 1/4"				
10078509	Cone Plug, 3/8"				
10079291	Cone Plug, 9/16"				

Table 11-39
High Pressure Fittings

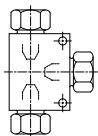
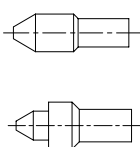

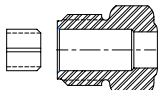
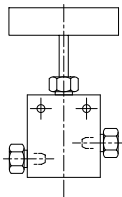
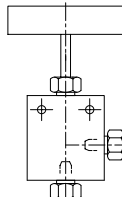
Part Number	Description		Part Number	Description	
10079481	HP Tee, 1/4"	HP Tee 	10078244	Plug, 1/4"	HP Plug 
10078590	HP Tee, 3/8"		10079523	Plug, 3/8"	
10079465	HP Tee, 9/16"		10078772	Plug, 9/16"	
10078459	HP Gland Nut, 1/4"	HP Gland Nut 	10078699	Anti-Vibration Collet, 1/4"	HP Anti-Vibration Collet 
10078129	HP Gland Nut, 3/8"		10078913	Anti-Vibration Collet, 3/8"	
10078608	HP Gland Nut, 9/16"		10093573	Anti-Vibration Collet, 9/16"	
10079259	Hand Valve, Straight, 1/4"	2-Way Straight Valve 	10079002	Hand Valve, 90 Degree, 1/4"	2-Way Angle Valve 
10078863	Hand Valve, Straight, 3/8"		10078749	Hand Valve, 90 Degree, 3/8"	
10078889	Hand Valve, Straight, 9/16"		10079275	Hand Valve, 90 Degree, 9/16"	



Table 11-40
Bulk High Pressure Tubing

Part Number	Description
10064376	20 ft (6.10 m), 1/4"
10184810	Up to 40 ft (12.19 m), 1/4"
10064665	20 ft (6.10 m), 3/8"
10061190	20 ft (6.10 m), 9/16"

High Pressure Tubing also available coned, threaded and/or autofrettaged

Figure 11-40: Bulk High Pressure Tubing Coned/Threaded Both Ends

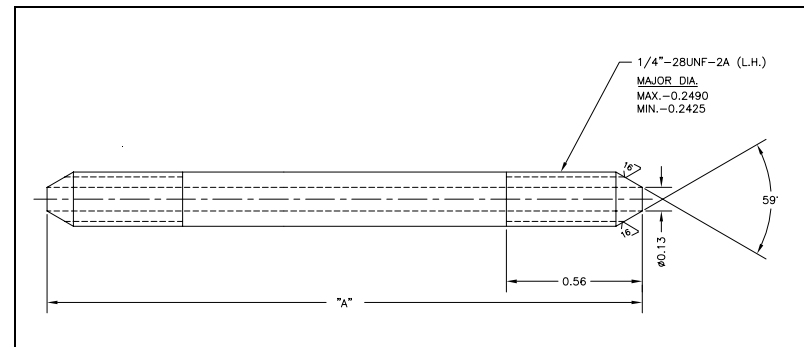


Table 1141
High Pressure Filter Assemblies

Item	Part Number	Description	Quantity
	05114137	HP Line Filter, 0.25	
1	05114129	Filter Body	1
2	05114145	HP Gland	1
3	05114152	Filter Cover	1
4	05110531	Filter Element, 0.25	1
	CJ200988	HP Line Filter, 0.38	
1	10078715	HP Collar, 0.38	2
2	10078129	HP Gland, 0.38	2
3	CJ300988	Filter Body, 0.38	1
4	CJ400988	HP Gland, Filter, 0.38	1
5	SKJA266	Filter Element, 20 Micron	1
6	SKJA286	Bayonet Filter	1
7	SKJA287	Bayonet Nipple	1

Figure 11-41A: 1/4" High Pressure Line Filter

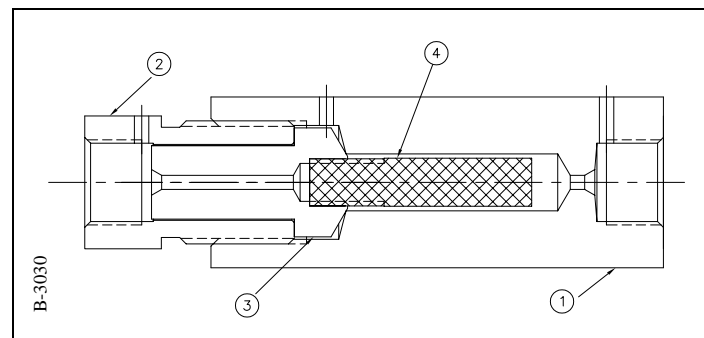


Figure 11-41B: 3/8" High Pressure Line Filter

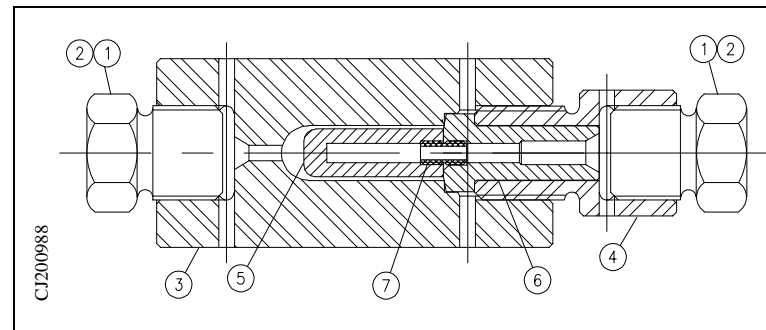


Table 11-41
High Pressure Filter Assemblies

Item	Part Number	Description	Quantity
	BF103473	HP Line Filter, 0.56	
1	AF413972	HP Gland, 0.562	1
2	AF303473	Seal Head, 0.56, Outlet	1
3	AF503473	Filter Element, 20 Micron	1
4	BF203473	Filter Body, 0.5625 Connection	1
5	AF913972	HP Gland, 0.656	1
6	10074599	O-Ring, 3/8 x 1/2 x 1/16	1
7	AF403473	Seal Head, 0.56, Inlet	1

Figure 11-41C: 9/16" High Pressure Line Filter

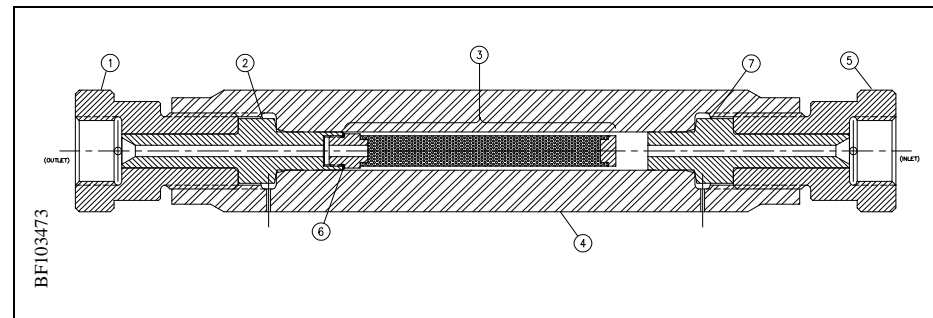


Table 11-42
High Pressure Swivel Joints

Item	Part Number	Description	Quantity
	CJ211388	HP Swivel Joint, Straight, 0.25, M/F	
1	10084713	Thrust Needle Bearing, 0.812 x 0.375	1
2	10094647	Thrust Washer, 0.81 x 0.38 x 0.095	2
3	10103505	Set Screw, 6-32 x 1/8	1
4	CJ311388	Swivel Body, Straight, 0.56	1
5	CJ401288	Swivel Bushing	1
6	CJ501288	Spindle, 0.25	1
7	BJ701288	Cap Assembly	1
8	BJ201388	Seal Assembly, Swivel	1
	BJ701288	Cap Assembly	
1	CJ801288	Cap	1
2	10144442	Swivel Bushing, 0.502 x 0.344	1

Figure 11-42A: 1/4" High Pressure Swivel Joint, Straight, M/F Connection

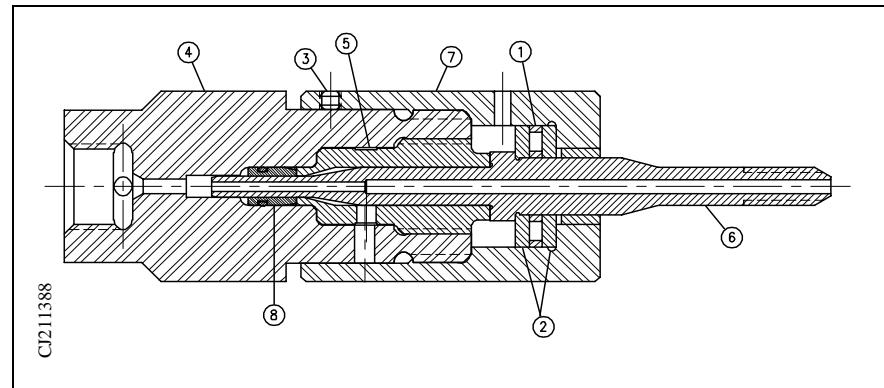


Table 11-42
High Pressure Swivel Joints

Item	Part Number	Description	Quantity
	CJ211388	HP Swivel Joint, Straight, 0.25, M/F	
1	10084713	Thrust Needle Bearing, 0.812 x 0.375	1
2	10094647	Thrust Washer, 0.81 x 0.38 x 0.095	2
3	10103505	Set Screw, 6-32 x 1/8	1
4	CJ311388	Swivel Body, Straight, 0.56	1
5	CJ401288	Swivel Bushing, 90D	1
6	CJ501288	Spindle, 0.25	1
7	BJ701288	Cap Assembly	1
8	BJ201388	Seal Assembly, Swivel	1

Figure 11-42B: 1/4" High Pressure Swivel Joint, Straight, M/F Connection

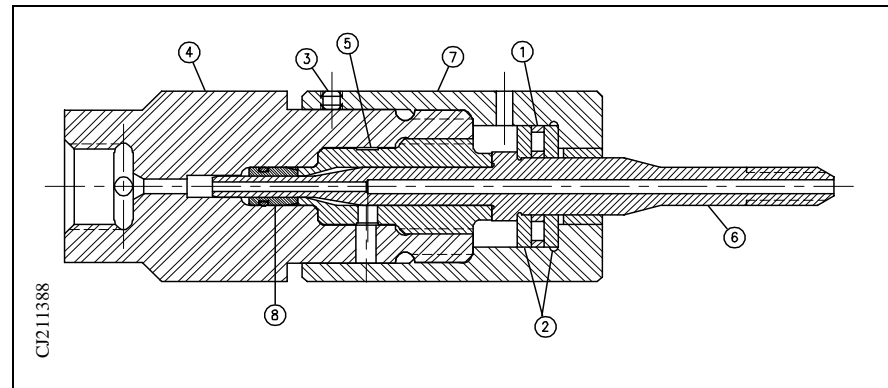


Table 11-42
High Pressure Swivel Joints

Item	Part Number	Description	Quantity
	10134708	HP Swivel Joint, Straight, 0.38, M/F	
1	10084713	Thrust Needle Bearing, 0.812 x 0.375	1
2	10094647	Thrust Washer, 0.81 x 0.38 x 0.095	2
3	10103505	Set Screw, 6-32 x 1/8	1
4	10134716	Swivel Body, Straight, 0.75	1
5	CJ401288	Swivel Bushing, 90D	1
6	49899602	Spindle, 0.38	1
7	BJ701288	Cap Assembly	1
8	BJ201388	Seal Assembly, Swivel	1
9	10078913	HP Gland, Anti-Vibration, 0.38	2
10	10078715	HP Collar, 0.38	2

Figure 11-42C: 3/8" High Pressure Swivel Joint, Straight, M/F Connection

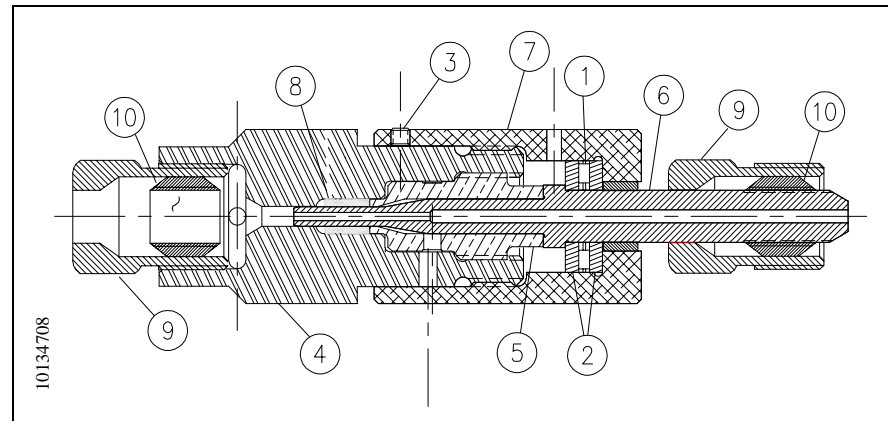


Table 11-42
High Pressure Swivel Joints

Item	Part Number	Description	Quantity
	CJ218088	HP Swivel Joint, Straight, 0.25, F/F	
1	10084713	Thrust Needle Bearing, 0.812 x 0.375	1
2	10094647	Thrust Washer, 0.81 x 0.38 x 0.095	2
3	10103505	Set Screw, 6-32 x 1/8	1
4	10154680	Clamp Collar, 0.688 x 0.313	1
5	CJ318088	Spindle, 0.56	1
6	CJ418088	Cap, 0.25	1
7	CJ311388	Swivel Body, Straight, 0.56	1
8	CJ401288	Swivel Bushing	1
9	BJ201388	Seal Assembly, Swivel	1

Figure 11-42D: 1/4" High Pressure Swivel Joint, Straight, F/F Connection

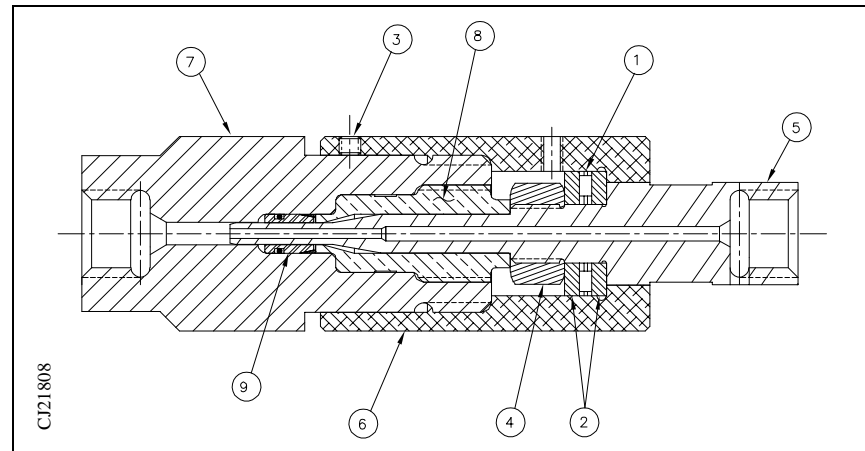


Table 11-42
High Pressure Swivel Joints

Item	Part Number	Description	Quantity
	CJ201288	HP Swivel Joint, 90D, 0.25, M/F	
1	10084713	Thrust Needle Bearing, 0.812 x 0.375	1
2	10094647	Thrust Washer, 0.81 x 0.38 x 0.095	2
3	10103505	Set Screw, 6-32 x 1/8	1
4	DJ301288	Swivel Body, 90D, 0.56	1
5	CJ401288	Swivel Bushing, 90D	1
6	CJ501288	Spindle, 0.25	1
7	BJ701288	Cap Assembly	1
8	BJ201388	Seal Assembly, Swivel	1

Figure 11-42E: 1/4" High Pressure Swivel Joint, 90D, M/F Connection

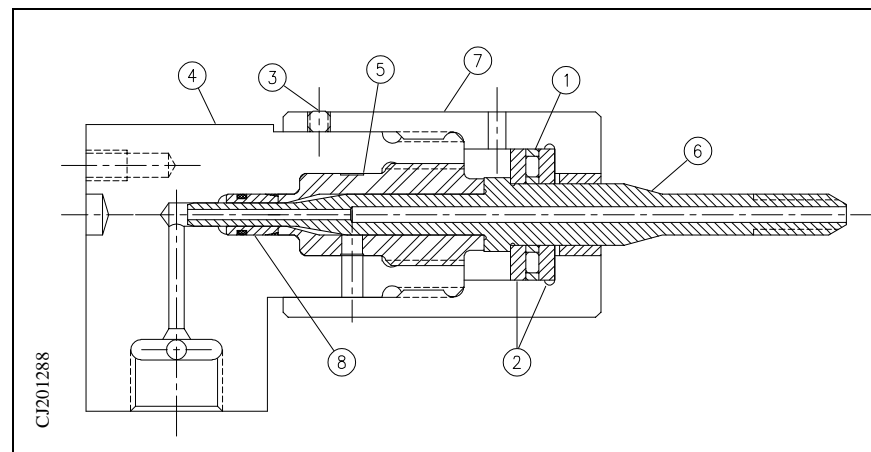


Table 11-42
High Pressure Swivel Joints

Item	Part Number	Description	Quantity
	10134682	HP Swivel Joint, 90D, 0.38, M/F	
1	10084713	Thrust Needle Bearing, 0.812 x 0.375	1
2	10094647	Thrust Washer, 0.81 x 0.38 x 0.095	2
3	10103505	Set Screw, 6-32 x 1/8	1
4	10134690	Swivel Body, 90D, 0.75	1
5	CJ401288	Swivel Bushing, 90D	1
6	49899602	Spindle, 0.38	1
7	BJ701288	Cap Assembly	1
8	BJ201388	Seal Assembly, Swivel	1
9	10078913	HP Gland, Anti-Vibration, 0.38	2
10	10078715	HP Collar, 0.38	2

Figure 11-42F: 3/8" High Pressure Swivel Joint, 90D, M/F Connection

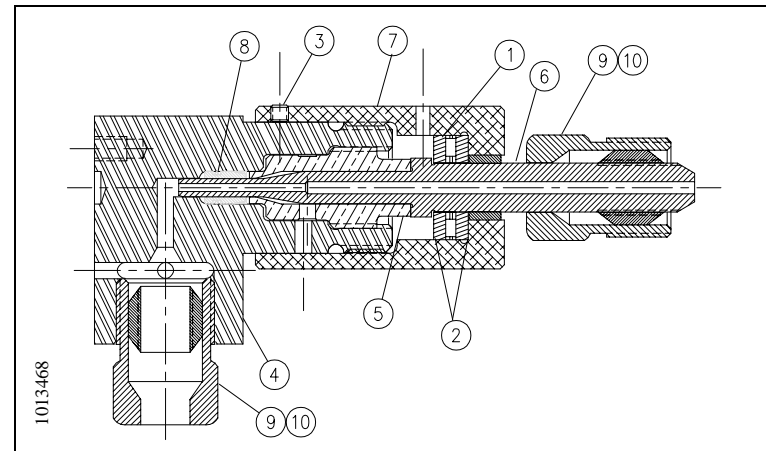


Table 11-42
High Pressure Swivel Joints

Item	Part Number	Description	Quantity
	10134682	HP Swivel Joint, 90D, 0.25, F/F	
1	10084713	Thrust Needle Bearing, 0.812 x 0.375	1
2	10094647	Thrust Washer, 0.81 x 0.38 x 0.095	2
3	10103505	Set Screw, 6-32 x 1/8	1
4	10154680	Clamp Collar, 0.688 x 0.313	1
5	CJ318088	Spindle, 0.56	1
6	CJ418088	Cap, 0.25	1
7	DJ301288	Swivel Body, 90D, 0.56	1
8	CJ401288	Swivel Bushing, 90D	1
9	BJ201388	Seal Assembly, Swivel	1

Figure 11-42G: 1/4" High Pressure Swivel Joint, 90D, F/F Connection

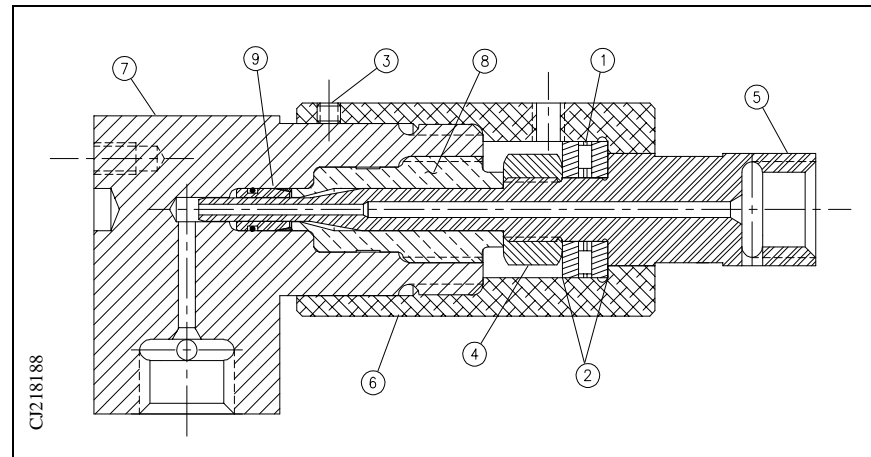




Table 11-43
3/8" Diameter Nozzle Tubes

Part Number	Description		Part Number	Description	
	Actual in (mm)	Nominal in (mm)		Actual in (mm)	Nominal in (mm)
10181113	2.65 (67.31)	3.00 (76.20)	10138444	7.65 (194..31)	8.00 (203.20)
10138402	3.65 (92.91)	4.00 (101.60)	10138451	8.65 (219.71)	9.00 (228.60)
10138410	4.65 (118.11)	5.00 (127.0)	10138469	9.65 (245.11)	10.00 (254.0)
10138428	5.65 (143.51)	6.00 (152.40)	05106224	10.65 (270.51)	11.00 (279.40)
05131784	5.91 (150.11)	6.25 (158.75)	05013735	11.65 (295.91)	12.00 (304.80)
10138436	6.65 (168.91)	7.00 (177.80)	05086913	14.65 (372.11)	15.00 (381.0)
10138584	3.64 (92.46)	4.00 (101.60)	10138618	6.64 (168.66)	7.00 (177.80)
10183051	4.53 (115.06)	4.875 (123.83)	10138634	7.64 (194.06)	8.00 (203.20)
10138592	4.64 (117.86)	5.00 (127.0)	10138642	8.64 (219.46)	9.00 (228.60)
10138600	5.64 (143.26)	6.00 (152.40)	10138659	9.64 (244.86)	10.00 (254.0)

Figure 11-43A: 3/8" Nozzle Tube, Nozzle Nut Connection

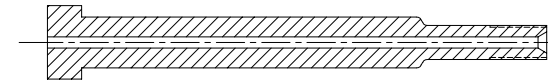


Figure 11-43B: 3/8" Nozzle Tube, HP Connection

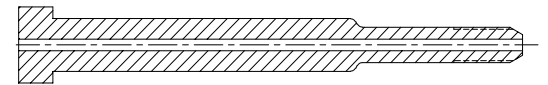


Table 11-43
9/16" Diameter Nozzle Tubes

Part Number	Description	
	Actual in (mm)	Nominal in (mm)
10138477	2.65 (67.31)	3.00 (76.20)
10138485	3.65 (92.91)	4.00 (101.60)
10138493	4.65 (118.11)	5.00 (127.0)
10138501	5.65 (143.51)	6.00 (152.40)
10138519	6.65 (168.91)	7.00 (177.80)
10138667	3.65 (92.91)	4.00 (101.60)
10138675	4.65 (118.11)	5.00 (127.0)
10138683	5.65 (143.51)	6.00 (152.40)
10138691	6.65 (168.91)	7.00 (177.80)

Part Number	Description	
	Actual in (mm)	Nominal in (mm)
10138527	7.65 (194.31)	8.00 (203.20)
10138535	8.65 (219.71)	9.00 (228.60)
10181105	9.65 (245.11)	10.00 (254.0)
10193100	11.65 (295.91)	12.00 (304.80)
10138709	7.65 (194.31)	8.00 (203.20)
10138717	8.65 (219.71)	9.00 (228.60)
10138725	9.65 (245.11)	10.00 (254.0)

Figure 11-43C: 9/16” Nozzle Tube, Nozzle Nut Connection

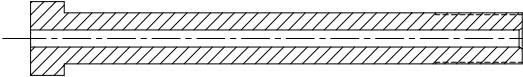


Figure 11-43D: 9/16” Nozzle Tube, HP Connection

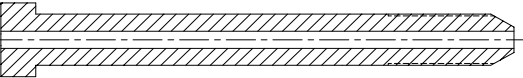


Figure 11-43C: 9/16" Nozzle Tube, Nozzle Nut Connection

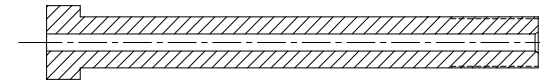
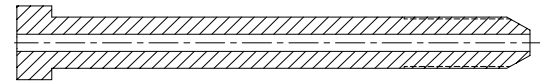


Figure 11-43D: 9/16" Nozzle Tube, HP Connection



Nozzle Tube Seat and Nut

10178697	Item 1, Nozzle Tube Seat
B2841	Item 2, Nozzle Tube Nut, 3/8"
B3393	Item 2, Nozzle Tube Nut, 9/16"

Figure 11-43E: Nozzle Tube Seat and Nut

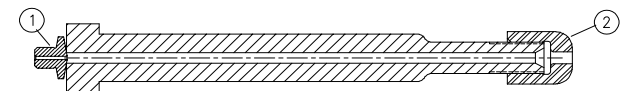


Table 11-44
Autoline™ Abrasive Nozzle

Item	Part Number	Description	Quantity
	05078530	Autoline™ Abrasive Nozzle Assembly	
1	05076971	Cap Assembly, Body	1
2	05073820	Body	1
3	05076955	Abrasive Insert, 0.370/0.372, 0.030 x 0.156	1
	05135827	Abrasive Insert, 0.370/0.372, 0.043 x 0.156	
4	05076989	Feed Tube Adapter	1
5	05077292	Set Screw, 1/4-28	1
6	05081518	O-Ring, 3/8 x 1/2 x 1/16	1
7	05104930	O-Ring, 1/2 x 5/8 x 1/16	2
8	05092887	O-Ring, 3/4 x 5/8 x 1/16	1
9	05078712	Retainer Knob	1
10	05087168	Guard	1
Ref 1	49885361	Poly Tube, 0.38	

Figure 11-44: Autoline™ Abrasive Nozzle Assembly

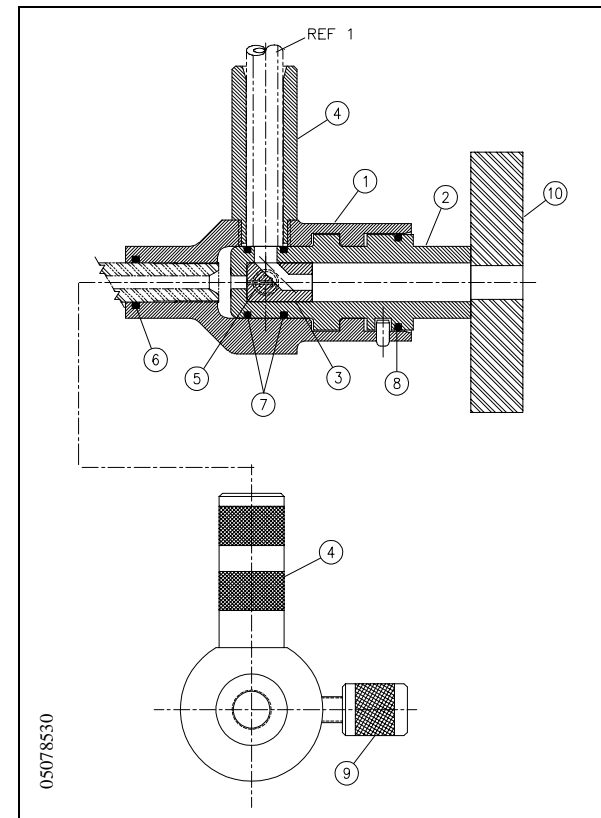


Table 11-45
Autoline™ Diamond Orifice

Part Number	Description	Part Number	Description
05063847	0.007" (0.178 mm)	05077037	0.014" (0.356 mm)
05112537	0.008" (0.203 mm)	80075781	0.015" (0.381 mm)
05084504	0.009" (0.229 mm)	05121512	0.016" (0.406 mm)
05077029	0.010" (0.254 mm)	05114905	0.018" (0.457 mm)
05101753	0.011" (0.279 mm)	80086663	0.019" (0.482 mm)
05077300	0.012" (0.305 mm)	05114897	0.020" (0.508 mm)
05136098	0.013" (0.330 mm)		

Figure 11-45: Autoline™ Diamond Orifice

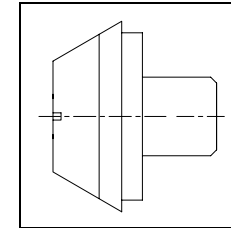


Table 11-46
Autoline™ Sapphire Orifice

Part Number	Description	Part Number	Description
05109079	0.007" (0.178 mm)	20412569	0.013" (0.330 mm)
05109087	0.008" (0.203 mm)	05109137	0.014" (0.356 mm)
05109095	0.009" (0.229 mm)	05114913	0.018" (0.457 mm)
05109103	0.010" (0.254 mm)	80086671	0.019" (0.482 mm)
05109111	0.011" (0.279 mm)	05114921	0.020" (0.508 mm)
05109129	0.012" (0.305 mm)		

Figure 11-46: Autoline™ Sapphire Orifice

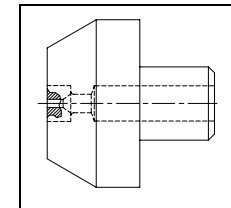


Table 11-47
Pneumatic Control Valve, Normally Closed
10138824

Item	Part Number	Description	Quantity
1	10177855	Cylinder Assembly, Pneumatic Control Valve	1
2	10189181	Valve Body	1
3	BV701184	HP Gland Fitting, 0.5938	1
4	10188233	Brass Backup Ring, 0.048 x 0.082 x 0.170	1
5	10178978	Seal Assembly, HP Valve, 0.25	1
6	BV901184	Valve Stem, 0.080	1
7	10178697	Valve Seat, 0.50 x 0.04	1

See Maintenance Tools, Table 11-35, Page 11-71

Figure 11-47: Pneumatic Control Valve, NC

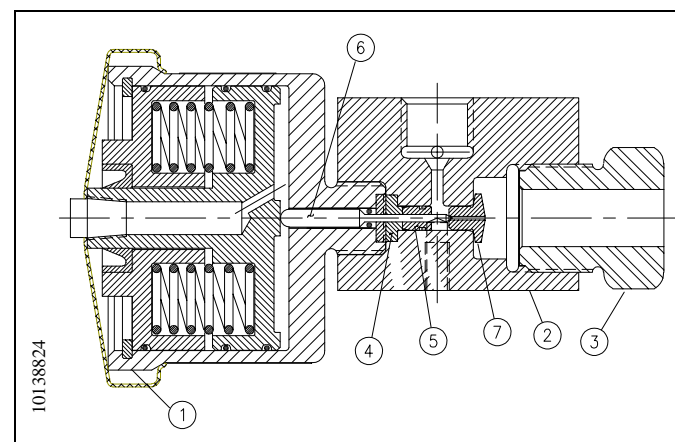


Table 11-48
Pneumatic Cylinder Assembly, Normally Closed
10177855

Item	Part Number	Description	Quantity
1	10176550	Piston, 2.746	1
2	20411554	Cylinder Cap	1
3	10177780	Wiper Seal, 0.625	1
4	10177772	Retaining Ring, 2.75	1
5	10176543	Pneumatic Cylinder, 2.750 ID	1
6	10177806	O-Ring, 2-5/8 x 2-3/4 x 1/16	3
7	05054119	Compression Spring, 0.72 x 0.105 x 1.50	6
8	49895584	O-Ring, 5/64 x 13/64 x 1/16	1
9	10187250	Backup Ring, 0.475 x 0.125 x 0.105	1
10	0080028	Cover	1

Figure 11-48: Pneumatic Cylinder Assembly, NC

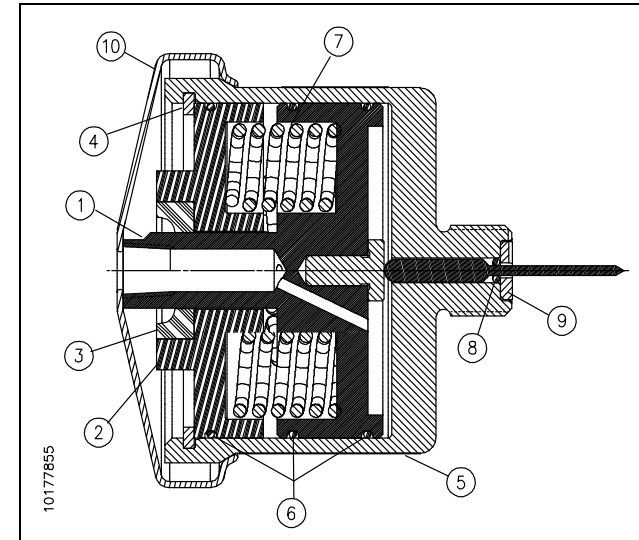


Table 11-49
Pneumatic Control Valve, Normally Open
10184760

Item	Part Number	Description	Quantity
1	10189553	Cylinder Assembly, Pneumatic Control Valve	1
2	10189181	Valve Body	1
3	BV701184	HP Gland Fitting, 0.5938	1
4	10188233	Brass Backup Ring, 0.048 x 0.082 x 0.170	1
5	10178978	Seal Assembly, HP Valve, 0.25	1
6	BV901184	Valve Stem, 0.080	1
7	10178697	Valve Seat, 0.50 x 0.04	1

See Maintenance Tools, Table 11-35, Page 11-71

Figure 11-49: Pneumatic Control Valve, NO

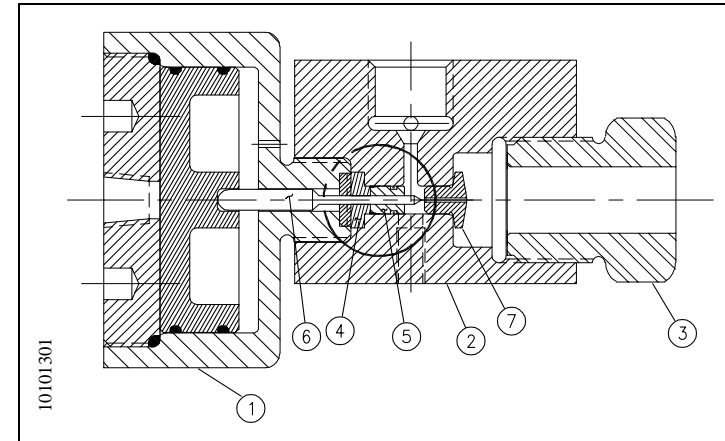
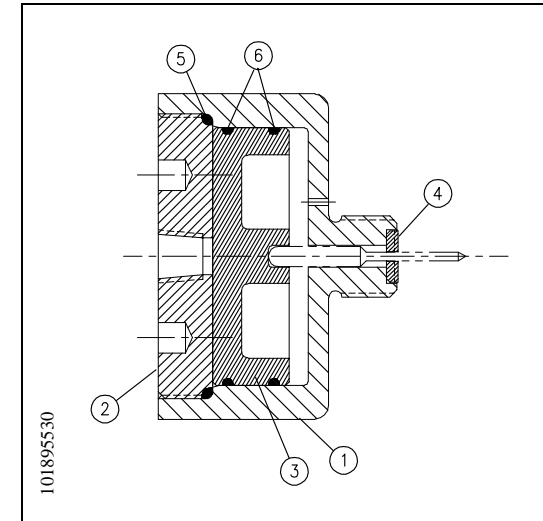


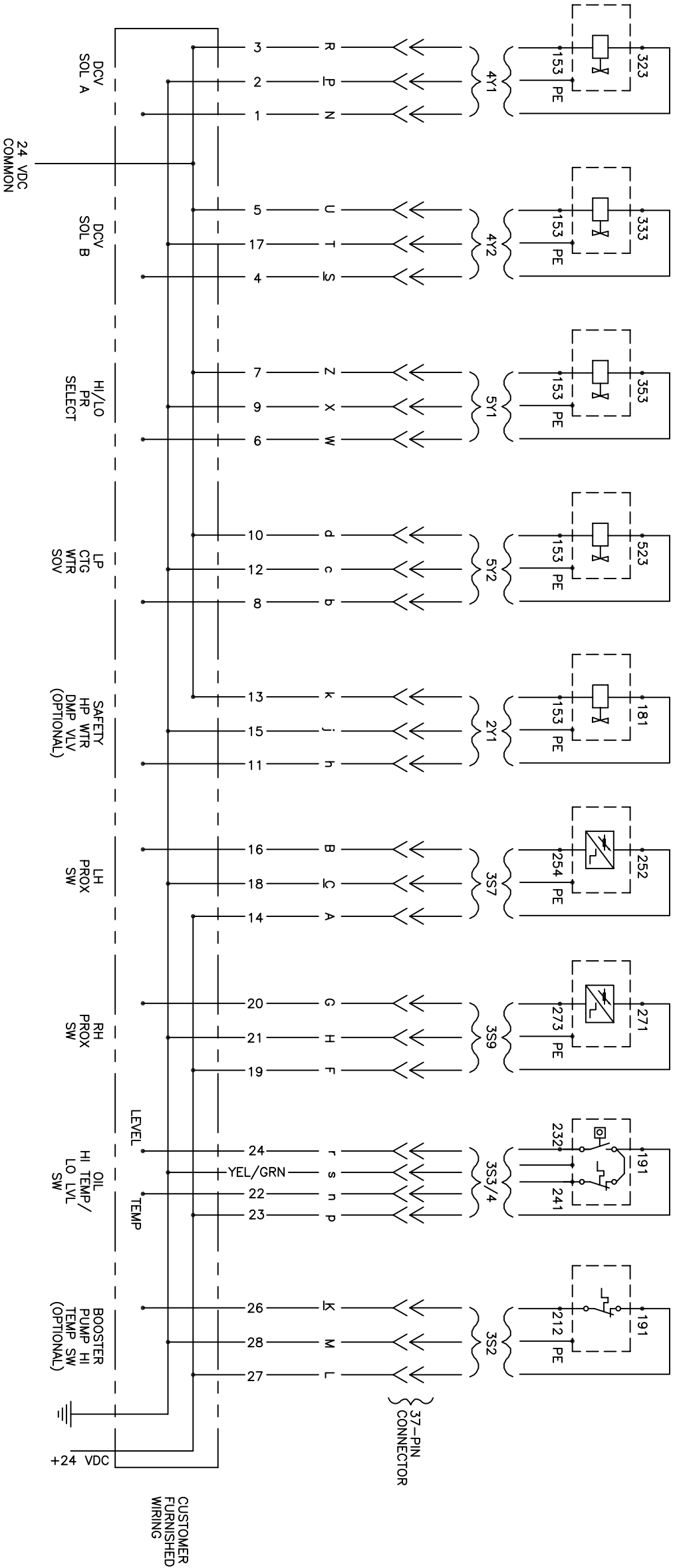
Table 11-50
Pneumatic Cylinder Assembly, Normally Open
10189553

Item	Part Number	Description	Quantity
1	BV401184	Pneumatic Cylinder, 2.375 ID	1
2	BV601184	Cylinder Head	1
3	BV501184	Piston, 2.374	1
4	10187250	Backup Ring, SST, 0.475 x 0.125 x 0.105	1
5	10074714	O-Ring, 2-7/16 x 2-5/8 x 3/32	1
6	10074565	O-Ring, 2-1/4 x 2-3/8 x 1/16	2

Figure 11-50: Pneumatic Cylinder Assembly, NO

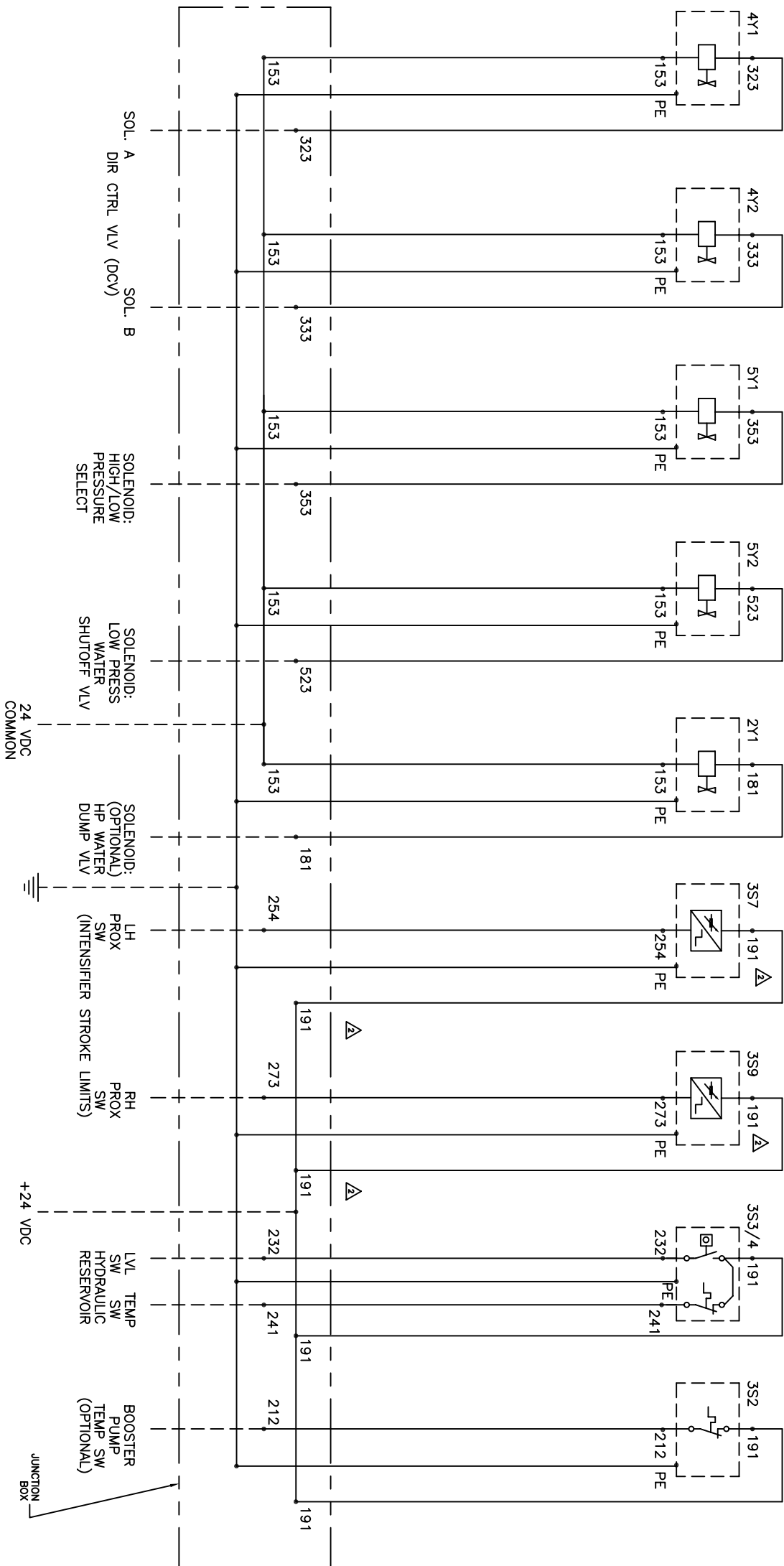


REV. NO. 05143946D					REV. 1	REV. 5
REVISIONS						
NO	DESCRIPTION	DATE	BY	APPROVED		
1	WIRE #17 WAS 6, REV01157.	8/21/01	BR	HS		
2	REVISED PER REV01287	9/28/01	BR	HS		
3	SWAPPED 357 & 359, REV01428.	1/10/02	BR	HS		
4	REVISED PER REV01633	8/7/02	BR	HS		
5	REVISED PER REV01703	6/7/02	BR	HS		

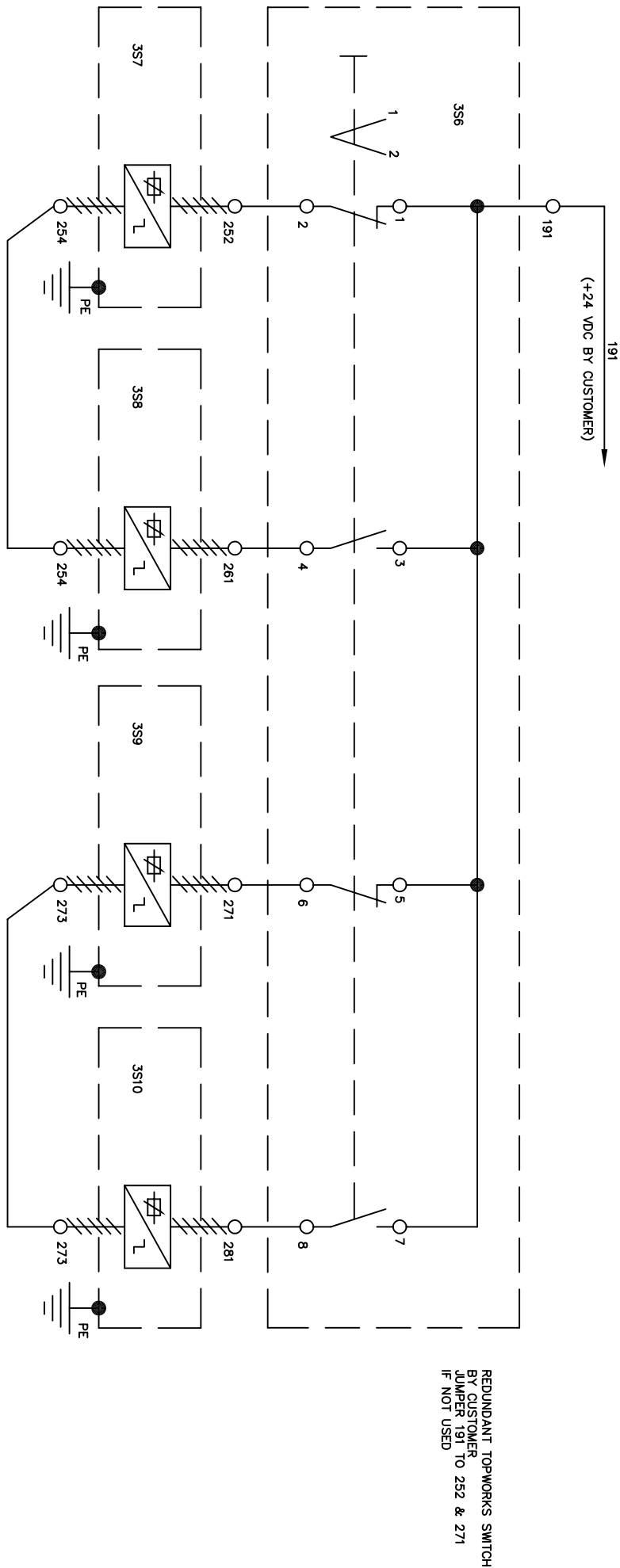


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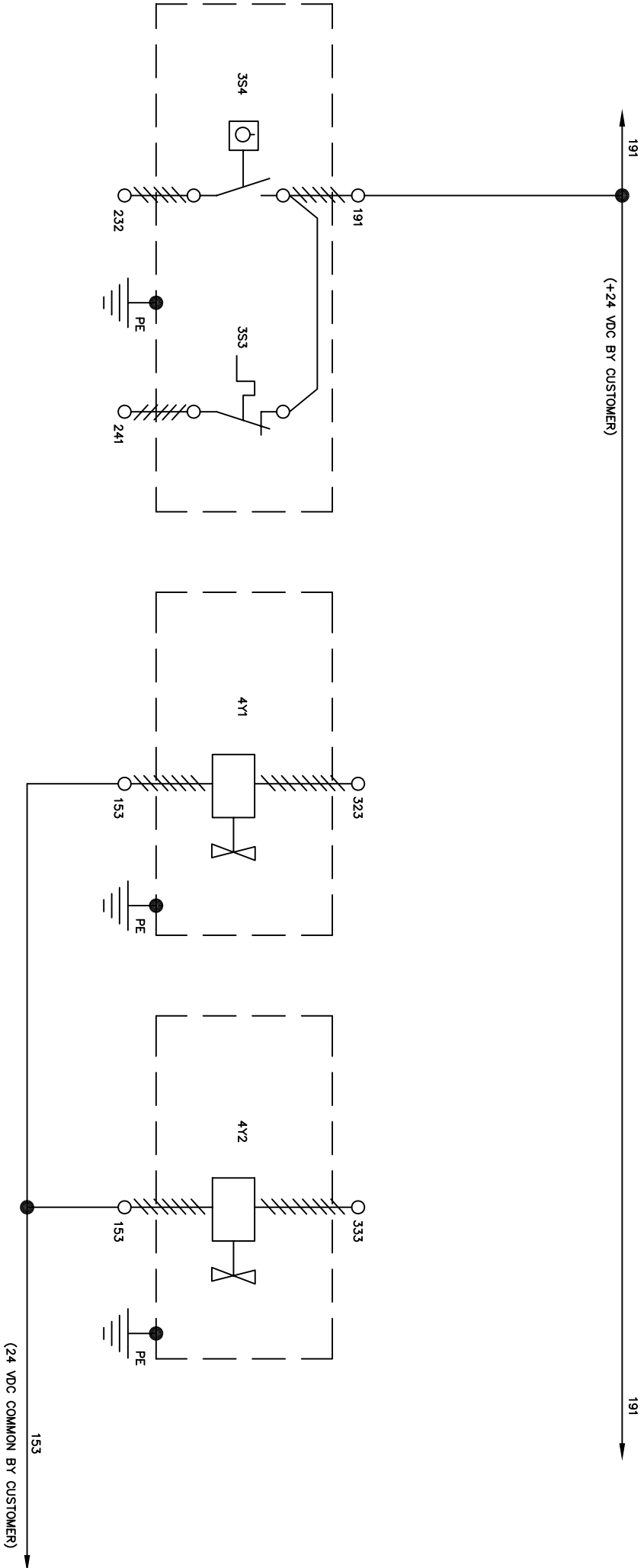
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		498354160	1	2
REVISIONS				
NO	DESCRIPTION	DATE	APPROVED	
1	REDRAWN PER REV01724	8/30/02 BR	8/30/02 HS	
2	191 WAS 252 & 271 REF EOR REV01763	10/2/02 WOL	10/2/02 HS	

[illegible]

REVISIONS			
NO	DESCRIPTION	DATE	APPROVED
1	ADDED NOTE 1 & +24VDC, CHANGED SWITCH NOTE, REF EGR #970191	8/28/97	JDS



DWG NO 05087044D				SHT	REV
REVISIONS				2	2
NO	DESCRIPTION	DATE	APPROVED		
1	ADDED +24 VDC & 24 VDC COMMON REF ECR #970191	8/28/97	JDS		



OIL LEVEL
SWITCH

OIL TEMP
SWITCH

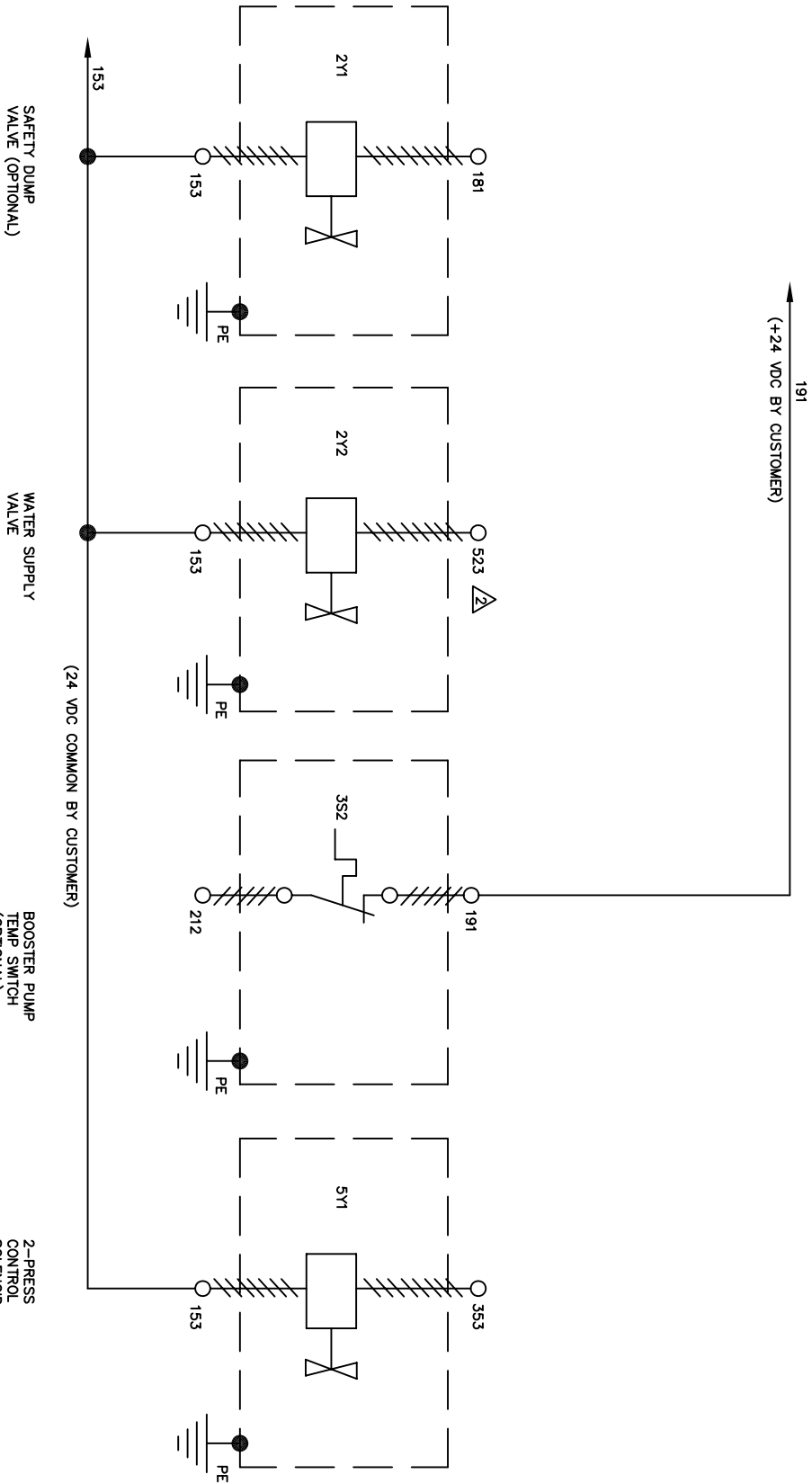
4-WAY VALVE
SOL. A

4-WAY VALVE
SOL. B

(24 VDC COMMON BY CUSTOMER)

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WARNING ! The export or reexport of this drawing or a product produced by this drawing is subject to U.S. Export Administration regulations and may require an export license. For more information, contact your local export control office.				PROPRIETARY NOTICE This document contains confidential and trade secret information and is the property of Ingersoll-Rand Company. It is to be used only for the purpose for which it was created and is not to be distributed, copied, or otherwise used without the written consent of Ingersoll-Rand Company. If it is not used for the purpose for which it was created, it will (1) not use the document or any information contained therein, (2) not copy the document or any information contained therein, and (3) not disclose the document or any information contained therein to others. If the document or trade secret information is disclosed to others without the written consent of Ingersoll-Rand Company, all copies thereof, and all materials copied therefrom, shall be destroyed.				REF.				ELECTRICAL SCHEMATIC 30 OEM			
GEOMETRIC SYMBOLS				STANDARD TOLERANCES				DRAWN BY: JDS				DATE: 11/96			
STRAIGHTNESS (ROUNDNESS)				± .005				CHECKED BY: JDS				DATE: 11/96			
CIRCULARITY				± .005				APPROVED BY: JDS				DATE: 11/96			
FLATNESS				± .005				DATE: 11/96				DATE: 11/96			
PERPENDICULARITY				± .005				DATE: 11/96				DATE: 11/96			
PARALLELISM				± .005				DATE: 11/96				DATE: 11/96			
CONCENTRICITY				± .005				DATE: 11/96				DATE: 11/96			
TOTAL RUNOUT				± .005				DATE: 11/96				DATE: 11/96			
ANGLE = ±0°30'				DATE: 11/96				DATE: 11/96				DATE: 11/96			
NEXT ASSEMBLY				DATE: 11/96				DATE: 11/96				DATE: 11/96			

05087044D				REV
REVISIONS				
NO	DESCRIPTION	DATE	APPROVED	
1	ADDED +24 VDC & 24 VDC COMMON REF ECR #970191	8/28/97	JDS	
2	TERM 523 WAS 191 REF ECR REV00511	12/15/99	JDS	



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WARNING ! The export or reexport of this drawing or a product produced by this drawing is subject to U.S. Export Administration regulations and may require an export license. The recipient of this drawing shall be responsible for obtaining any necessary export license. The recipient shall not copy, reproduce, or otherwise use this drawing or the information contained herein for any purpose other than that for which it was originally intended. The recipient shall return this drawing, or upon demand, return the original, to the Ingersoll-Rand Company, at the address indicated herein, upon completion of the work for which it was furnished. All rights reserved.		PROPRIETARY NOTICE This document contains confidential and trade secret information and is the property of Ingersoll-Rand Company. It is to be used only for the purpose for which it was furnished and is not to be copied, reproduced, or otherwise used for any other purpose without the written consent of Ingersoll-Rand Company. If you are not an authorized recipient of this document, you should not have received it. If you have received it by mistake, please notify the Ingersoll-Rand Company immediately and destroy the document. The recipient shall return this document, or upon demand, return the original, to the Ingersoll-Rand Company, at the address indicated herein, upon completion of the work for which it was furnished. All rights reserved.		GEOMETRIC SYMBOLS STRAIGHTNESS (ROUNDNESS) CIRCULARITY ANGULARITY PERPENDICULARITY PARALLELISM CONCENTRICITY SYMMETRY TOTAL RUNOUT		STANDARD TOLERANCES X.X = ±.063 X.XX = ±.015 X.XXX = ±.005 ANGLE = ±0°30'		DATE 11/96 DRAWN BY JDS CHECKED BY JDS APPROVED BY JDS	
NEXT ASSEMBLY		WLT		PART NO.		05087044D		REV. 2	
		HEAT TREAT		SCALE		SHEET 3 OF 3			



MATERIAL SAFETY DATA SHEET

PURE GOOP™

January 2000

1. PRODUCT IDENTIFICATION

PURE GOOP: Thread lubricant

Manufactured by:
Swagelok Company
29500 Solon Road
Solon, Ohio USA 44139
Tel: (440) 248-4600
Fax: (440) 349-5970

Emergency Contact:
Chemtrec (800) 424-9300

2. INGREDIENTS

Ingredients	CAS #	WT%	PEL
Polychlorotrifluoroethylene	9002-83-9	75-85	Not Available
Polytetrafluoroethylene	9002-84-0	15-20	Not Available
Amorphous Silica	7631-86-9	1-5	Not Available

3. HEALTH HAZARD INFORMATION

- European Community Danger Group: None
- Special Hazards for man or environment: None
- LD₅₀/LC₅₀ Not Available

Routes of Entry

Skin Contact	Skin Absorption	Eye Contact	Inhalation	Ingestion
No	No	Yes	Yes	Yes

4. FIRST AID MEASURES

- If inhaled (Overexposure): If person is affected by fumes, remove person to fresh air. Seek medical attention.
- After contact with skin (Overexposure): Wash thoroughly with soap and water. If severe irritation develops, seek medical attention.
- After contact with eyes: Rinse thoroughly with water for 15 minutes, seek medical attention. Do not rub eyes.
- If swallowed: Seek medical attention.
- Medical information: Unlikely to cause ill effects. Inhaling fumes of decomposition products can cause temporary influenza-like symptoms which are described as "polymer fume fever". Symptoms include fever, cough and malaise.



MATERIAL SAFETY DATA SHEET

PURE GOOP™

January 2000

5. FIRE FIGHTING MEASURES

- Suitable extinguishing agents: Carbon dioxide, foam, agent suitable for environment.
- Not suitable for safety reasons: None known.
- Special dangers caused by substance preparation itself, by combustion products or gases formed: May decompose above 500°F/260°C to produce organo-chlorine compounds, organo-fluorine compounds, hydrogen fluoride, and chlorine gas.
- Additional information: None.

Autoignition	UEL	LEL	Sensitivities
Not Applicable	Not Available	Not Available	Not Available

6. ACCIDENTAL RELEASE MEASURES

- Measures for protection of people: Put on necessary protective equipment. Eye and hand protection as needed.
- Measures for protection of the environment: None required.
- Cleaning measures: Use absorbent material and suitable cleaner.
- Additional information: None.

7. HANDLING AND STORAGE

- Safety information: None.
- Information on protection from fire or explosion: May decompose above 500°F/260°C to produce organo-chlorine compounds, organo-fluorine compounds, hydrogen fluoride, and chlorine gas.
- Additional information: Store in a cool, dry place for optimal product performance.

8. EXPOSURE CONTROLS AND PERSONAL PROTECTION

- Precautionary measures to protect employees: None required.
- Respiratory protection: None required.
- Hand protection: Rubber gloves are recommended to minimize exposure.
- Eye protection: Safety glasses or goggles are recommended to minimize exposure.
- Skin protection: Wash hands after use.



MATERIAL SAFETY DATA SHEET

PURE GOOP™

January 2000

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance Opaque-white	Odor Neutral	pH Not Applicable	Density 2.1 gm/cm ³	Vapor Pressure <0.01mm Hg
Boiling Point Not Available	Melting Point Not Available	Flash Point Not Available	Flammability Not Available	Explosive Not Applicable

10. STABILITY AND REACTIVITY

- Conditions to avoid: May decompose above 500°F/260°C to produce organo-chlorine compounds, organo-fluorine compounds, hydrogen fluoride, and chlorine gas.
- Materials to avoid: Sodium, potassium, barium, calcium, finely divided zinc, aluminum, magnesium, and beryllium. Avoid aluminum threaded connections where galling and seizure may initiate a reaction. Reacts with amines, liquid fluorine, and liquid chlorine trifluoride.
- Hazardous decomposition products: See Sections 4 and 5.

11. TOXICOLOGICAL INFORMATION

- Acute toxic properties: None known.
- Health effects: See Sections 4 and 5.
- Additional health effects: None known.

Sensitization	Teratogenicity	Reproductive Toxicity	Mutagenicity	Synergistic Products	Carcinogenicity
Not Available	Not Available	Not Available	Not Available	Not Available	Listed ingredients are not suspected carcinogens according to NTP, IARC, and OSHA

12. ECOLOGICAL INFORMATION

- Mobility: Paste-like viscosity.
- Degradability: Not established.
- Accumulation: No known adverse bioaccumulation or biomagnification effects.
- Short / Long term effects on ecotoxicity: No known ecological effects.



MATERIAL SAFETY DATA SHEET

PURE GOOP™

January 2000

13. DISPOSAL CONSIDERATIONS

- Appropriate methods of disposal: Unused product not considered a hazardous waste in the United States. Dispose of in a responsible manner.
- European Community(EC) considerations: Use appropriate waste codes based on ingredients.

14. TRANSPORT INFORMATION

- Transport precautions: Consult applicable regulations when transporting this product.
- Additional information: None.

15. REGULATORY INFORMATION

- EC regulations: This product has been classified under CHIP-96 guidelines based on chemical content.
- US/Canadian regulation listings: SARA 313 - NO, TSCA - YES, Canada's Controlled Products - NO
- EC Relevant risk: None.
- EC Relevant safety: S: 37/39 - Wear suitable gloves and eye/face protection.
S:20 - When using do not eat or drink.
- Additional information: Consult country codes for specific requirements.

16. OTHER INFORMATION

- Further information contact: Your Swagelok Distributor or the contacts listed in Section 1 of this sheet.
- Sources of information used to compile document: Properties of individual ingredients were used to compile this document. This Material Safety Data Sheet was designed to give the distributors and users of PURE GOOP information to handle and use the product in a responsible manner.

Preparation Data		
Environmental and Safety Department	(440) 349-5955	January 2000

CANADIAN WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM Page 01 of 04

Loctite(R) 222 Threadlocker Low Strength
21464

I. PRODUCT IDENTIFICATION

Product Name: Loctite(R) 222 Threadlocker Low Strength
Item No.: 21464
Product Use: Adhesive/Sealant
Formula No.: LI-256

II. HAZARDOUS INGREDIENTS

Ingredients	% by Weight	CAS No.
Polyglycol dimethacrylate	45-50	25852-47-5
Polyglycol oleate	35-40	9004-96-0
Saccharin	3-5	81-07-2
Silica, amorphous, treated	3-5	68909-20-6
CUMENE HYDROPEROXIDE	1-3	80-15-9
Propylene glycol	1-3	57-55-6
N,N-Dialkyltoluidines	0.1-1	613-48-9
TITANIUM DIOXIDE	0.1-1	13463-67-7

III. PHYSICAL DATA

Physical

State/Appearance: Purple liquid
Odour & Odour Threshold: Mild
Specific Gravity: 1.08 at 68°F
Vapour Pressure: Less than 5mm at 80°F
Vapour Density: Not Available
Evaporation Rate:
(Ether = 1) Not Available
Boiling Point: Greater than 300°F
Freezing Point: Not Available
Volatile Organic Compound
(EPA Method 24) 11.8%; 127 grams per liter
pH: Not Applicable
Coefficient of
water/oil distribution: Not Available

IV. FIRE OR EXPLOSIVE HAZARD

Conditions

of Flammability: None
Means of Extinction: Carbon Dioxide, Foam, Dry Chemical
Flashpoint (Method): Greater than 200°F Method: Tag Closed Cup
Upper Flammable Limit: Methanol: 36%
Lower Flammable Limit: Methanol: 6%
Auto-Ignition
Temperature: Not Available

LOCTITE CANADA INC.

01/15/02

MISSISSAUGA, ONTARIO L5N 7P2

TELEPHONE: (905) 814-6511 FAX: (905) 814-5391

CANADIAN WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM Page 02 of 04

Product Name: Loctite(R) 222 Threadlocker Low Strength
Item No.: 21464

IV. FIRE OR EXPLOSIVE HAZARD

(continued)

Hazardous

Combustion Products: Irritating organic vapors.
Explosion Data - Sensitivity to Static Discharge: Not Applicable

V. REACTIVITY DATA

Conditions causing
Chemical Instability: None
Substances with which
the Product is Unstable: None
Conditions of Reactivity: None
Hazardous
Decomposition Products: None

VI. TOXICOLOGICAL PRODUCTS

Route(s) of Entry: None Known
Existing Conditions
Aggravated by Exposure: None Known
Toxicity Information: (See Effects of Acute Exposure to Product)
Effects of Acute
Exposure to Product: Mild eye irritant.
Estimated oral LD50 more than 5000 mg/kg.
Estimated dermal LD50 more than 2000 mg/kg.
Effects of Chronic
Exposure to Product:

Ingredients	Literature Referenced	Carcinogen		
	Target Organ and Other Health Effects	NTP	IARC	OSHA
Polyglycol dimethacrylate	ALG IRR	NO	NO	NO
Polyglycol oleate	IRR	NO	NO	NO
Saccharin	NTO	NO	N/A	NO
Silica, amorphous, treated	NTO	NO	NO	NO
CUMENE HYDROPEROXIDE	ALG CNS COR IRR MUT	NO	NO	NO
Propylene glycol	IRR	NO	NO	NO
N,N-Dialkyltoluidines	NTO	NO	NO	NO
TITANIUM DIOXIDE	IRR RES	NO	NO	NO

Abbreviations

N/A Not Applicable	ALG Allergen
CNS Central nervous system	COR Corrosive
IRR Irritant	MUT Mutagen
NTO No Target Organs	RES Respiratory

LOCTITE CANADA INC.

01/15/02

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TELEPHONE: (905) 814-6511 FAX: (905) 814-5391

CANADIAN WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM Page 03 of 04

Product Name: Loctite(R) 222 Threadlocker Low Strength
Item No.: 21464

VI. TOXICOLOGICAL PRODUCTS

(continued)

Exposure Limits (TWA) Ingredients	ACGIH (TLV)	OSHA (PEL)	OTHER
Silica, amorphous, treated	10mg/m3 (Inhal) 3mg/m3 (Resp)	20 mppcf	6 mg/m3
CUMENE HYDROPEROXIDE	None	None	1ppm(6mg/m3) Skin(WHEEL)
TITANIUM DIOXIDE	10 mg/m3	15 mg/m3 Total dust	None
Exposure Limits (STEL) Ingredients	ACGIH (TLV)	OSHA (PEL)	

Ingredients for which no Exposure Limits have been established are not listed above.

Irritancy of Product: May cause dermatitis on prolonged contact in sensitive individuals.
Sensitization to Product: May cause dermatitis on prolonged contact.
Carcinogenicity: (See Effects of Chronic Exposure to Product)
Reproductive Toxicity: (See Effects of Chronic Exposure to Product)
Teratogenicity: (See Effects of Chronic Exposure to Product)
Mutagenicity: (See Effects of Chronic Exposure to Product)
Name of Toxicologically Synergistic Products: Not Available
WHMIS Hazard Class: D.2.A, D.2.B

VII. PREVENTATIVE MEASURES

Personal Protection
Eyes: Safety glasses or goggles.
Skin: Neoprene, rubber, or butyl rubber gloves.
Ventilation: Not Applicable
Engineering Controls: See "Ventilation" above
Spill or Leak Procedures: Soak up with an inert absorbent. Store in partly filled, closed container until disposal.
Waste Disposal: Landfill or incinerate in accordance with Canadian and local regulations.
(Contact Loctite Canada's Customer Service at 905-814-6511 for Shelf Life Information)
Handling Procedures and Equipment: Store below 100°F.
Special Handling Information: Avoid prolonged skin contact. Keep away from eyes.

LOCTITE CANADA INC.

01/15/02

MISSISSAUGA, ONTARIO L5N 7P2

TELEPHONE: (905) 814-6511 FAX: (905) 814-5391

CANADIAN WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM Page 04 of 04

Product Name: Loctite(R) 222 Threadlocker Low Strength
Item No.: 21464

VIII. FIRST AID MEASURES

Ingestion: Do not induce vomiting. Keep individual calm.
Obtain medical attention.
Inhalation: Not Applicable
Skin Contact: Wash with soap and water.
Eye Contact: Flush at least 15 minutes with water. Obtain
medical attention.

IX. SHIPPING INFORMATION

Canadian Transportation
of Dangerous Goods:

Shipping Name	NOT REGULATED
Classification	NOT REGULATED
Product ID Number	NONE

ICAO/IATA:

Proper Shipping Name	Unrestricted
Class or Division	Unrestricted
UN or ID Number	None

X. PREPARATION INFORMATION

Prepared By:	Stephen Repetto
Title:	Research Chemist, Environmental Health & Safety
Emergency Phone Number:	(860) 571-5100
Revision Date:	December 15, 2001

Revision: 0004

JL-M MATERIAL SAFETY DATA SHEET

SECTION 1 – PRODUCT IDENTIFICATION				
Product Name: JL-M Lubricant Revised: 03/07/03 Prepared by: C. Semerod Emergency Information: (412) 279-1149		Manufacturer's Name: Superbolt, Inc. Manufacturer's Address: 1000 Gregg Street Carnegie, PA 15106 Manufacturer's Phone #: (412) 279-1149		
SECTION 2 – HAZARDOUS INGREDIENTS				
CHEMICAL NAME:	CAS NO.:	OSHA PEL:	ACGIH TLV:	(STEL)
Molybdenum Disulfide	1317-33-5	10 mg/m3	10 mg/m3	N/A
Silica, Fused	60676-86-0	0.1 mg/m3	0.1 mg/m3	N/A
Graphite	7782-42-5		2 mg/m3	N/A
Silica, Crystalline	14808-60-7		0.1 mg/m3	N/A
Lubricating Oils, Petroleum, Hydrotreated, Spent	64742-58-1	5 mg/m3*	5 mg/m3*	10mg/m3*
Residual Oils (Petroleum), Solvent Dewaxed	64742-62-7	5 mg/m3*	5 mg/m3*	10 mg/m3*
Solvent-Refined Heavy Paraffinic Distillate (Petroleum)	64741-88-4	5 mg/m3*	5 mg/m3*	10 mg/m3*
Solvent –Dewaxed Hydrotreated Heavy Paraffinic Distillate (Petroleum)	64742-65-0	5 mg/m3*	5 mg/m3*	10 mg/m3*
Hydrotreated Heavy Paraffinic Distillate (Petroleum)	64742-54-7	5 mg/m3*	5 mg/m3*	10 mg/m3*
Proprietary Additives Mixture (<1%) (*) Designates limits set by OSHA and the ACGIH for oil mist. This product is sold in a paste form so misting should not occur.				
SECTION 3 – PHYSICAL DATA		SECTION 4 – FIRE AND EXPLOSION DATA		
Appearance and Odor: Dark Grey Paste, Mild Petroleum Boiling Point: > 500 degrees F % Volatile: 0% Vapor Density: > 1 (Air = 1) Evaporation Rate: < 1 (Ether = 1) Specific Gravity: 4.8 (Water = 1) Vapor Pressure: Essentially 0 (mm Hg) Solubility in Water: Insoluble pH: N/A		Flash Point: 338 degrees F Lower Explosive Limit: N/A Upper Explosive Limit: N/A Extinguishing Media: Carbon Dioxide, Regular Foam, Dry Chemical Special Fire Fighting Procedures: Fire may produce dense smoke, firefighters should wear self contained breathing apparatus. Use water to cool fire exposed containers. Unusual Fire & Explosion Hazards: Decomposition and combustion by-products may be toxic. Heated containers may rupture or explode.		
SECTION 5 – REACTIVITY DATA		SECTION 6 – STORAGE & HANDLING		
Stability: Stable Hazardous Polymerization: Will not occur. Incompatibility: Avoid contact with oxidizing agents, heat, sparks or flame. Hazardous Combustion By-Products: Carbon Monoxide, Sulfur Dioxide, Aldehydes, and Nitrogen Oxides Hazardous Decomposition: Thermal decomposition may yield methacrylate monomers.		Handling Precautions: Use good personal hygiene practices. Clean contaminated clothing and protective equipment before reuse. Storage Precautions: Store in a cool dry location. Keep container tightly closed when not in use and during transport. Keep away from open sparks or flames.		
SECTION 7 – HEALTH HAZARDS				
Effects of Overexposure: Skin: May Cause Irritation Eyes: Eye Irritant. May cause redness and Blurred vision. Ingestion: Not Expected Inhalation: Not Expected (Chronic respiratory diseases may be aggravated by dust exposure.) NFPA CODES: Health: 1 Flammability: 1 Reactivity: 0 Carcinogenicity: Silica is a suspected carcinogen in a respirable form by the IARC and NTP however, not by the ACGIH or OSHA.		First Aid Procedures: Skin: Remove contaminated clothing from irritated area. Flush exposed area with mild soap and water. Seek medical attention if irritation persists. Eyes: Flush eyes with large quantities of water, holding eyelids open. Seek medical attention if irritation persists. Ingestion: Do not induce vomiting. If spontaneous vomiting occurs, keep head below hips to avoid aspiration into the lungs. Seek immediate medical attention. Inhalation: Remove to fresh air. Obtain medical attention if necessary.		
SECTION 8 – SPECIAL PROTECTION		SECTION 9 – SPILL AND DISPOSAL PROCEDURES		
Eye Protection: Safety Glasses or Face Shield Protective Gloves: Recommended Respiratory Protection: Avoid breathing dust, use an approved respirator if levels exceed OSHA limits. Ventilation: Local ventilation to maintain levels within OSHA limits.		Spill Procedures: Scrape or wipe up any spilled material. Wear proper protective equipment when cleaning up a spill. Disposal Procedures: Dispose of in accordance with any applicable federal, state, or local laws.		

The information in this MSDS was obtained from sources which we believe are reliable. However, the information is provided without any representation or warranty, expressed or implied, regarding the accuracy or correctness. The conditions or methods of handling, storage, use and disposal of the product are beyond our control. For this and other reasons, we do not assume responsibility and expressly disclaim liability for loss, damage, or expense arising out of or in any way connected with the handling, storage, use or disposal of the product.



LUBRIPLATE®

MATERIAL SAFETY DATA SHEET

Section 1

PRODUCT NAME OR NUMBER:

LUBRIPLATE Super FML-0, FML-1, FML-2

GENERIC/CHEMICAL NAME:

Petroleum Lubricating Grease

Manufacturer's Name:

Fiske Brothers Refining Co.

Address:

1500 Oakdale Ave., Toledo, Ohio 43605 - 129 Lockwood St., Newark, NJ 07105

FORMULA:

Calcium Soap, USP Mineral Oil and Additives

NSF Registration No's:

125742, 125740, 125741

Emergency Telephone Number:

1-800-255-3924 - CHEM-TEL (24 hour)

Telephone Number for Information:

419-691-2491 - Toledo Office

Section 2 - Hazardous Ingredients/Identity Information

<u>Hazardous Components</u>	<u>OSHA PEL</u>	<u>ACGIH TLV</u>	<u>Other Limits Recommended</u>	<u>% (optional)</u>
-----------------------------	-----------------	------------------	---------------------------------	---------------------

Non-hazardous

Hazardous Material Identification System (HMIS):

Health - 1,

Flammability - 1,

Reactivity - 0

Not a Controlled Product under (WHMIS) - Canada**Special Protection: See Section 9**

Section 3 - Health Hazard Data

Threshold Limit Value: 5 mg/m³ for oil mist in air. OSHA Regulation 29 CFR 1910.1000

Effects of Overexposure: Prolonged or repeated skin contact may cause skin irritation. Product contacting the eyes may cause eye irritation. Human health risks vary from person to person. As a precaution, exposure to liquids, vapors, mists and fumes should be minimized. This product has a low order of acute oral toxicity, but minute amounts aspirated into the lungs during ingestion may cause mild to severe pulmonary injury.

Carcinogenicity:

NTP? No

IARC Monographs? No

OSHA Regulated? No

Section 4 - Emergency and First Aid Procedures

EYE CONTACT: Flush with clear water for 15 minutes or until irritation subsides. If irritation persists, consult a physician.

SKIN CONTACT: Remove any contaminated clothing and wash with soap and warm water. If injected by high pressure under skin, regardless of the appearance or its size, contact a physician IMMEDIATELY. Delay may cause loss of affected part of the body.

INHALATION: Vapor pressure is very low and inhalation at room temperature is not a problem. If overcome by vapor from hot product, immediately remove from exposure and call a physician.

INGESTION: If ingested, call a physician immediately. Do not induce vomiting.

Section 5 - Fire and Explosion Hazard Data

Flash Point (Method Used):

COC - 435°F

Flammable Limits:

LEL 0.9%

UEL 7.0%

Extinguishing Media:

Foam, Dry Chemical, Carbon Dioxide or Water Spray (Fog)

Special Fire Fighting Procedures:

Cool exposed containers with water. Use air-supplied breathing equipment for enclosed or confined spaces.

Unusual Fire and Explosion Hazards:

Do not store or mix with strong oxidants. Empty containers retain residue.

Do not cut, drill, grind, or weld, as they may explode.

Section 6 - Physical/Chemical Characteristics

Boiling Point:	>550°F	Specific Gravity (H₂O = 1):	0.90 - 0.91
Vapor Pressure (mm Hg.):	<0.01	Melting Point:	Semi-solid
Vapor Density (AIR = 1):	>5	Evaporation Rate: (Butyl Acetate = 1)	<0.01
Solubility in Water:	Negligible		
Appearance and Odor:	Smooth, white grease with mineral oil odor.		

Section 7 - Reactivity Data

Stability:	Unstable Stable X	Conditions to Avoid:	N/A
Incompatibility (Materials to Avoid):	Avoid contact with strong oxidants like liquid chlorine, concentrated oxygen.		
Hazardous Decomposition or Byproducts:	May form SO ₂ . If incomplete combustion, Carbon Monoxide.		
Hazardous Polymerization:	May Occur Will Not Occur X	Conditions to Avoid:	N/A

Section 8 - Spill or Leak Procedures**Steps to be taken in case material is released or spilled:**

Scrape up grease, wash remainder with suitable petroleum solvent or add absorbent. Keep petroleum products out of sewers and watercourses. Advise authorities if product has entered or may enter sewers and watercourses.

Waste disposal method:

Assure conformity with applicable disposal regulations. Dispose of absorbed material at an approved waste disposal facility or site.

SARA/TITLE III, Section 313 Status - Zinc Compounds - <6%

Section 9 - Special Protection Information

Respiratory Protection (Specify type):	Normally not needed		
Ventilation	Local Exhaust: Mechanical (General)	Used to capture fumes and vapors	Special: N/A Other: N/A
Protective Gloves:	Use oil-resistant gloves, if needed.		Eye Protection: If chance of eye contact, wear goggles.
Other Protective Equipment:	Use oil-resistant apron, if needed.		

Section 10 - Special Precautions**Precautions to be taken in handling and storing:**

Keep containers closed when not in use. Do not handle or store near heat, sparks, flame, or strong oxidants.

Other Precautions:

Remove oil-soaked clothing and laundry before reuse. Cleanse skin thoroughly after contact.

The above information is furnished without warranty, expressed or implied, except that it is accurate to the best knowledge of Fiske Brothers Refining Company. The data on these sheets relates only to the specific material designated herein. Fiske Brothers Refining Company assumes no legal responsibility for use or reliance upon this data.

600163-00 MOBIL DTE OIL HEAVY MEDIUM
MATERIAL SAFETY DATA BULLETIN

1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: MOBIL DTE OIL HEAVY MEDIUM

SUPPLIER: EXXONMOBIL CORPORATION

3225 GALLOWS RD.

FAIRFAX, VA 22037

24 - Hour Health and Safety Emergency (call collect): 609-737-4411

24 - Hour Transportation Emergency (Primary) CHEMTREC: 800-424-9300
(Secondary) 281-834-3296

Product and Technical Information:

Lubricants and Specialties: 800-662-4525 800-443-9966

Fuels Products: 800-947-9147

MSDS Fax on Demand: 613-228-1467

MSDS Internet Website: <http://emmsds.ihssolutions.com/>

2. COMPOSITION/INFORMATION ON INGREDIENTS

CHEMICAL NAMES AND SYNONYMS: PET. HYDROCARBONS AND ADDITIVES

GLOBALLY REPORTABLE MSDS INGREDIENTS:

None.

See Section 8 for exposure limits (if applicable).

3. HAZARDS IDENTIFICATION

Under normal conditions of use, this product is not considered hazardous according to regulatory guidelines (See section 15).

EMERGENCY OVERVIEW: Amber Liquid. DOT ERG No. : NA

POTENTIAL HEALTH EFFECTS: Under normal conditions of intended use, this product does not pose a risk to health. Excessive exposure may result in eye, skin or respiratory irritation.

For further health effects/toxicological data, see Section 11.

4. FIRST AID MEASURES

EYE CONTACT: Flush thoroughly with water. If irritation occurs, call a physician.

SKIN CONTACT: Wash contact areas with soap and water. Remove and clean oil soaked clothing daily and wash affected area. (See Section 16 - Injection Injury)

INHALATION: Not expected to be a problem. However, if respiratory irritation, dizziness, nausea, or unconsciousness occurs due to excessive vapor or mist exposure, seek immediate medical assistance. If breathing has stopped, assist ventilation with a mechanical device or mouth-to-mouth resuscitation.

INGESTION: Not expected to be a problem. Seek medical attention if discomfort occurs. Do not induce vomiting.

5. FIRE-FIGHTING MEASURES

EXTINGUISHING MEDIA: Carbon dioxide, foam, dry chemical and water fog.

SPECIAL FIRE FIGHTING PROCEDURES: Water or foam may cause frothing.

Use water to keep fire exposed containers cool. Water spray may be used to flush spills away from exposure. Prevent runoff from fire control or dilution from entering streams, sewers, or drinking water supply.

SPECIAL PROTECTIVE EQUIPMENT: For fires in enclosed areas, fire fighters must use self-contained breathing apparatus.

UNUSUAL FIRE AND EXPLOSION HAZARDS: None.

COMBUSTION PRODUCTS: Fumes, smoke, carbon monoxide, sulfur oxides, aldehydes and other decomposition products, in the case of incomplete combustion.

Flash Point C(F): > 204(400) (ASTM D-93).

Flammable Limits (approx.% vol.in air) - LEL: 0.9%, UEL: 7.0%

NFPA HAZARD ID: Health: 0, Flammability: 1, Reactivity: 0

6. ACCIDENTAL RELEASE MEASURES

NOTIFICATION PROCEDURES: Report spills/releases as required to appropriate authorities. U.S. Coast Guard and EPA regulations require immediate reporting of spills/releases that could reach any waterway including intermittent dry creeks. Report spill/release to Coast Guard National Response Center toll free number (800)424-8802. In case of accident or road spill notify CHEMTREC (800) 424-9300.

PROCEDURES IF MATERIAL IS RELEASED OR SPILLED:

LAND SPILL: Shut off source taking normal safety precautions. Take measures to minimize the effects on ground water. Recover by pumping or contain spilled material with sand or other suitable absorbent and remove mechanically into containers. If necessary, dispose of adsorbed residues as directed in Section 13.

WATER SPILL: Confine the spill immediately with booms. Warn other ships in the vicinity. Notify port and other relevant authorities. Remove from the surface by skimming or with suitable absorbents. If permitted by regulatory authorities the use of suitable dispersants should be considered where recommended in local oil spill procedures.

ENVIRONMENTAL PRECAUTIONS: Prevent material from entering sewers, water sources or low lying areas; advise the relevant authorities if it has, or if it contaminates soil/vegetation.

PERSONAL PRECAUTIONS: See Section 8

7. HANDLING AND STORAGE

HANDLING: No special precautions are necessary beyond normal good hygiene practices. See Section 8 for additional personal protection advice when handling this product.

STORAGE: Keep containers closed when not in use. Do not store in open or unlabelled containers. Store away from strong oxidizing

agents and combustible materials. Do not store near heat, sparks, flame or strong oxidants.

SPECIAL PRECAUTIONS: Prevent small spills and leakages to avoid slip hazard.

EMPTY CONTAINER WARNING: Empty containers retain residue (liquid and/or vapor) and can be dangerous. DO NOT PRESSURIZE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION; THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Do not attempt to refill or clean container since residue is difficult to remove. Empty drums should be completely drained, properly bunged and promptly returned to a drum reconditioner. All containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

OCCUPATIONAL EXPOSURE LIMITS:

When mists/aerosols can occur, the following are recommended: 5 mg/m³ (as oil mist)- ACGIH Threshold Limit Value (TLV), 10 mg/m³ (as oil mist) - ACGIH Short Term Exposure Limit (STEL), 5 mg/m³ (as oil mist) - OSHA Permissible Exposure Limit (PEL)

VENTILATION: If mists are generated, use adequate ventilation, local exhaust or enclosures to control below exposure limits.

RESPIRATORY PROTECTION: If mists are generated, and/or when ventilation is not adequate, wear approved respirator.

EYE PROTECTION: If eye contact is likely, safety glasses with side shields or chemical type goggles should be worn.

SKIN PROTECTION: Not normally required. When splashing or liquid contact can occur frequently, wear oil resistant gloves and/or other protective clothing. Good personal hygiene practices should always be followed.

9. PHYSICAL AND CHEMICAL PROPERTIES

Typical physical properties are given below. Consult Product Data Sheet for specific details.

APPEARANCE: Liquid

COLOR: Amber

ODOR: Mild

ODOR THRESHOLD-ppm: NE

pH: NA

BOILING POINT C(F): > 316(600)

MELTING POINT C(F): NA

FLASH POINT C(F): > 204(400) (ASTM D-93)

FLAMMABILITY (solids): NE

AUTO FLAMMABILITY C(F): NA

EXPLOSIVE PROPERTIES: NA

OXIDIZING PROPERTIES: NA

VAPOR PRESSURE-mmHg 20 C: < 0.1

VAPOR DENSITY: > 2.0

EVAPORATION RATE: NE

RELATIVE DENSITY, 15/4 C: 0.875

SOLUBILITY IN WATER: Negligible

PARTITION COEFFICIENT: > 3.5

VISCOSITY AT 40 C, cSt: 68.0

VISCOSITY AT 100 C, cSt: 8.7
POUR POINT C(F): < -6(22)
FREEZING POINT C(F): NE
VOLATILE ORGANIC COMPOUND: NE
DMSO EXTRACT, IP-346 (WT.%): <3, for mineral oil only
NA=NOT APPLICABLE NE=NOT ESTABLISHED D=DECOMPOSES
FOR FURTHER TECHNICAL INFORMATION, CONTACT YOUR MARKETING REPRESENTATIVE

10. STABILITY AND REACTIVITY

STABILITY (THERMAL, LIGHT, ETC.): Stable.
CONDITIONS TO AVOID: Extreme heat and high energy sources of ignition.
INCOMPATIBILITY (MATERIALS TO AVOID): Strong oxidizers.
HAZARDOUS DECOMPOSITION PRODUCTS: Product does not decompose at ambient temperatures.
HAZARDOUS POLYMERIZATION: Will not occur.

11. TOXICOLOGICAL DATA

---ACUTE TOXICOLOGY---

ORAL TOXICITY (RATS): Practically non-toxic (LD50: greater than 2000 mg/kg). ---Based on testing of similar products and/or the components.

DERMAL TOXICITY (RABBITS): Practically non-toxic (LD50: greater than 2000 mg/kg). ---Based on testing of similar products and/or the components.

INHALATION TOXICITY (RATS): Practically non-toxic (LC50: greater than 5 mg/l). ---Based on testing of similar products and/or the components.

EYE IRRITATION (RABBITS): Practically non-irritating. (Draize score: greater than 6 but 15 or less). ---Based on testing of similar products and/or the components.

SKIN IRRITATION (RABBITS): Practically non-irritating. (Primary Irritation Index: greater than 0.5 but less than 3). ---Based on testing of similar products and/or the components.

OTHER ACUTE TOXICITY DATA: Although an acute inhalation study was not performed with this product, a variety of mineral and synthetic oils, such as those in this product, have been tested. These samples had virtually no effect other than a nonspecific inflammatory response in the lung to the aerosolized mineral oil. The presence of additives in other tested formulations (in approximately the same amounts as in the present formulation) did not alter the observed effects.

---SUBCHRONIC TOXICOLOGY (SUMMARY)---

No significant adverse effects were found in studies using repeated dermal applications of similar formulations to the skin of laboratory animals for 13 weeks at doses significantly higher than those expected during normal industrial exposure. The animals were evaluated extensively for effects of exposure (hematology, serum chemistry, urinalysis, organ weights, microscopic examination of tissues etc.).

---REPRODUCTIVE TOXICOLOGY (SUMMARY)---

No teratogenic effects would be expected from dermal exposure, based on laboratory developmental toxicity studies of major components in this formulation and/or materials of similar composition.

---CHRONIC TOXICOLOGY (SUMMARY)---

Repeated and/or prolonged exposure may cause irritation to the skin, eyes or respiratory tract. Overexposure to oil mist may result in oil droplet deposition and/or granuloma formation. For mineral base oils: Base oils in this product are severely solvent refined and/or severely hydrotreated. Chronic mouse skin painting studies of severely treated oils showed no evidence of carcinogenic effects. These results are confirmed on a continuing basis using various screening methods such as Modified Ames Test, IP-346, and/or other analytical methods. For synthetic base oils: The base oils in this product have been tested in the Ames assay and other tests of mutagenicity with negative results. These base oils are not expected to be carcinogenic with chronic dermal exposures.

---SENSITIZATION (SUMMARY)---

Not expected to be sensitizing based on tests of this product, components, or similar products.

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL FATE AND EFFECTS:

In the absence of specific environmental data for this product, this assessment is based on information for representative products.

ECOTOXICITY: Available ectotoxicity data (LL50 >1000 mg/L) indicates that adverse effects to aquatic organisms are not expected from this product.

MOBILITY: When released into the environment, adsorption to sediment and soil will be the predominant behavior.

PERSISTENCE AND DEGRADABILITY: This product is expected to be inherently biodegradable.

BIOACCUMULATIVE POTENTIAL: Bioaccumulation is unlikely due to the very low water solubility of this product, therefore bioavailability to aquatic organisms is minimal.

13. DISPOSAL CONSIDERATIONS

WASTE DISPOSAL: Product is suitable for burning in an enclosed, controlled burner for fuel value. Such burning may be limited pursuant to the Resource Conservation and Recovery Act. In addition, the product is suitable for processing by an approved recycling facility or can be disposed of at an appropriate government waste disposal facility. Use of these methods is subject to user compliance with applicable laws and regulations and consideration of product characteristics at time of disposal.

RCRA INFORMATION: The unused product, in our opinion, is not specifically listed by the EPA as a hazardous waste (40 CFR, Part 261D), nor is it formulated to contain materials which are listed hazardous wastes. It does not exhibit the hazardous characteristics of ignitability, corrosivity, or reactivity. The unused product is not formulated with substances covered by the Toxicity Characteristic Leaching Procedure (TCLP). However, used product may be regulated.

14. TRANSPORT INFORMATION

USA DOT: NOT REGULATED BY USA DOT.
RID/ADR: NOT REGULATED BY RID/ADR.
IMO: NOT REGULATED BY IMO.
IATA: NOT REGULATED BY IATA.
STATIC ACCUMULATOR (50 picosiemens or less): YES

15. REGULATORY INFORMATION

US OSHA HAZARD COMMUNICATION STANDARD: When used for its intended purposes, this product is not classified as hazardous in accordance with OSHA 29 CFR 1910.1200.

EU Labeling: Product is not dangerous as defined by the European Union Dangerous Substances/Preparations Directives. EU labeling not required.

Governmental Inventory Status: All components comply with TSCA, EINECS/ELINCS, AICS, and DSL.

U.S. Superfund Amendments and Reauthorization Act (SARA) Title III: This product contains no "EXTREMELY HAZARDOUS SUBSTANCES".
SARA (311/312) REPORTABLE HAZARD CATEGORIES: None.
This product contains no chemicals subject to the supplier notification requirements of SARA (313) toxic release program.

THIS PRODUCT HAS BEEN AUTHORIZED BY USDA FOR USE UNDER THE FOLLOWING CATEGORY: This product is acceptable as a lubricant where there is no possibility of food contact (complies with earlier USDA guidelines for H-2 lubricant use).

The following product ingredients are cited on the lists below:

CHEMICAL NAME	CAS NUMBER	LIST CITATIONS
ZINC (ELEMENTAL ANALYSIS) (<0.01%)	7440-66-6	22
PHOSPHORODITHOIC ACID, O,O-DI	68649-42-3	22
C1-14-ALKYL ESTERS, ZINC SALTS (2:1) (ZDDP) (0.09%)		

--- REGULATORY LISTS SEARCHED ---

1=ACGIH ALL	6=IARC 1	11=TSCA 4	16=CA P65 CARC	21=LA RTK
2=ACGIH A1	7=IARC 2A	12=TSCA 5a2	17=CA P65 REPRO	22=MI 293
3=ACGIH A2	8=IARC 2B	13=TSCA 5e	18=CA RTK	23=MN RTK
4=NTP CARC	9=OSHA CARC	14=TSCA 6	19=FL RTK	24=NJ RTK
5=NTP SUS	10=OSHA Z	15=TSCA 12b	20=IL RTK	25=PA RTK
				26=RI RTK

Code key: CARC=Carcinogen; SUS=Suspected Carcinogen; REPRO=Reproductive

16. OTHER INFORMATION

USE: STEAM TURBINE OIL

NOTE: PRODUCTS OF EXXON MOBIL CORPORATION AND ITS AFFILIATED COMPANIES ARE NOT FORMULATED TO CONTAIN PCBS.

Health studies have shown that many hydrocarbons pose potential human health risks which may vary from person to person. Information provided on this MSDS reflects intended use. This product should not be used for other applications. In any case, the following advice should be considered:

INJECTION INJURY WARNING: If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical

treatment within the first few hours may significantly reduce the ultimate extent of injury.

INDUSTRIAL LABEL

Under normal conditions of intended use, this product does not pose a risk to health. Excessive exposure may result in eye, skin or respiratory irritation. Always observe good hygiene measures. First Aid: Wash skin with soap and water. Flush eyes with water. If overcome by fumes or vapor, remove to fresh air. If ingested do not induce vomiting. If symptoms persist seek medical assistance. Read and understand the MSDS before using this product.

For Internal Use Only: MHC: 1* 1* 1* 1* 1*, MPPEC: A, TRN: 600163-00, ELIS: 400304, CMCS97: 970172, REQ: US - MARKETING, SAFE USE: L
EHS Approval Date: 21AUG2001

Legally required information is given in accordance with applicable Information given herein is offered in good faith as accurate, but without guarantee. Conditions of use and suitability of the product for particular uses are beyond our control; all risks of use of the product are therefore assumed by the user and WE EXPRESSLY DISCLAIM ALL WARRANTIES OF EVERY KIND AND NATURE, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE IN RESPECT TO THE USE OR SUITABILITY OF THE PRODUCT. Nothing is intended as a recommendation for uses which infringe valid patents or as extending any license under valid patents. Appropriate warnings and safe handling procedures should be provided to handlers and users. Use or re-transmission of the information contained herein in any other format than the format as presented is strictly prohibited. ExxonMobil neither represents nor warrants that the format, content or product formulas contained in this document comply with the laws of any other country except the United States of America.

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Material Safety Data Sheet



HYDROCLEAR MULTIPURPOSE R&O OIL 32, 46, 68, 100, 150, 220, 320, 460

1. CHEMICAL PRODUCT/COMPANY IDENTIFICATION

HYDROCLEAR(R) MULTIPURPOSE R&O OIL

MSDS Code: HYDC0009 Revised: 29-July-2002

"HYDROCLEAR" is a registered trademark of Conoco.

ISO Grades: 32, 46, 68 100, 150, 220, 320, 460

Product Use: Industrial Oil

MANUFACTURER/DISTRIBUTOR

Conoco Inc.
PO Box 2197
Houston, TX 77252

PHONE NUMBERS

Product Information: 1-281-293-5550

Transport Emergency: CHEMTREC 1-800-424-9300 or
1-703-527-3887 (call collect)

Medical Emergency: 1-800-342-5119 or 1-281-293-5119

WEB SITE: www.conoco.com

2. COMPOSITION/INFORMATION ON INGREDIENTS

COMPONENTS	CAS NUMBER	%
Highly refined base oils	64742-54-7	0-99.5
	64742-01-4	0-99.5
Proprietary additives		<5

If oil mist is generated, exposure limits apply. See Section 8.

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

APPEARANCE / ODOR

Clear and bright liquid / mild petroleum hydrocarbon odor.

OSHA REGULATORY STATUS

This material is classified as non-hazardous under OSHA Regulations.

HMIS RATING Health: 1; Flammability: 1; Physical Hazard: 0.

NFPA RATING Health: 1; Flammability: 1; Instability: 0.

Potential Health Effects

Primary Route of Entry: Skin

☐ The product, as with many petroleum products, may cause minor skin, ☐
☐ eye, and lung irritation, but good hygienic practices can minimize ☐
☐ these effects. ☐
☐ ☐

☐ Normal use of this product does not result in generation of an oil ☐
☐ mist. However if an oil mist is generated, overexposure can cause ☐
☐ minor and reversible irritation to the eyes, skin, and especially ☐
☐ the lungs. Proper personal protective equipment and sufficient ☐
☐ ventilation can provide adequate protection. ☐
☐ ☐

☐ Carcinogenicity Information ☐
☐ None of the components present in this material at concentrations ☐
☐ equal to or greater than 0.1% are listed by IARC, NTP, OSHA or ACGIH ☐
☐ as a carcinogen. ☐
☐ -----☐

☐ 4. FIRST AID MEASURES ☐
☐ -----☐

☐ Inhalation ☐
☐ If inhaled, remove to fresh air. If not breathing, give artificial ☐
☐ respiration. If breathing is difficult, give oxygen. Call a ☐
☐ physician. ☐
☐ ☐

☐ Skin Contact ☐
☐ Wash skin thoroughly with soap and water. If irritation develops ☐
☐ and persists, consult a physician. ☐
☐ ☐
☐ If injected under the skin, necrosis could occur. See physician. ☐
☐ ☐

☐ Eye Contact ☐
☐ In case of contact, immediately flush eyes with plenty of water for ☐
☐ at least 15 minutes. Call a physician. ☐
☐ ☐

☐ Ingestion ☐
☐ Material poses an aspiration hazard. If swallowed, do not induce ☐
☐ vomiting. Immediately give 2 glasses of water. Never give anything ☐
☐ by mouth to an unconscious person. Call a physician. ☐
☐ ☐
☐ If vomiting occurs naturally, have victim lean forward to reduce the ☐
☐ risk of aspiration. ☐
☐ ☐

☐ Notes to Physicians ☐
☐ Activated charcoal mixture may be administered. To prepare activated ☐
☐ charcoal mixture, suspend 50 grams activated charcoal in 400 mL water ☐
☐ and mix thoroughly. Administer 5 mL/kg, or 350 mL for an average ☐
☐ adult. ☐
☐ ☐
☐ High velocity injection under the skin can cause a bloodless puncture ☐
☐ wound and result in necrosis. Immediate attention by a surgical ☐
☐ specialist is recommended. ☐
☐ -----☐

☐ 5. FIRE FIGHTING MEASURES ☐
☐ -----☐

☐ Flammable Properties ☐
☐ ☐

Flash Point (minimum):	365 F (185 C) (Grade 32)	<input type="checkbox"/>
	374 F (190 C) (Grade 46)	<input type="checkbox"/>
	410 F (210 C) (Grade 68)	<input type="checkbox"/>
	428 F (220 C) (Grade 100)	<input type="checkbox"/>
	440 F (227 C) (Grade 150)	<input type="checkbox"/>

<input type="checkbox"/>	460 F (238 C) (Grade 220)	<input type="checkbox"/>
<input type="checkbox"/>	490 F (254 C) (Grade 320)	<input type="checkbox"/>
<input type="checkbox"/>	509 F (265 C) (Grade 460)	<input type="checkbox"/>
<input type="checkbox"/>		<input type="checkbox"/>
<input type="checkbox"/>	Flash Point (typical):	<input type="checkbox"/>
<input type="checkbox"/>	450 F (232 C) (Grade 32)	<input type="checkbox"/>
<input type="checkbox"/>	460 F (238 C) (Grade 46)	<input type="checkbox"/>
<input type="checkbox"/>	470 F (243 C) (Grade 68)	<input type="checkbox"/>
<input type="checkbox"/>	515 F (268 C) (Grade 100)	<input type="checkbox"/>
<input type="checkbox"/>	530 F (277 C) (Grade 150)	<input type="checkbox"/>
<input type="checkbox"/>	545 F (285 C) (Grade 220)	<input type="checkbox"/>
<input type="checkbox"/>	580 F (304 C) (Grade 320)	<input type="checkbox"/>
<input type="checkbox"/>	585 F (307 C) (Grade 460)	<input type="checkbox"/>
<input type="checkbox"/>		<input type="checkbox"/>
<input type="checkbox"/>	Method:	COC <input type="checkbox"/>
<input type="checkbox"/>	Autoignition:	Not Available <input type="checkbox"/>
<input type="checkbox"/>	Flammable limits in Air, % by Volume	<input type="checkbox"/>
<input type="checkbox"/>	LEL:	Undetermined <input type="checkbox"/>
<input type="checkbox"/>	UEL:	Undetermined <input type="checkbox"/>
<input type="checkbox"/>		<input type="checkbox"/>
<input type="checkbox"/>	Extinguishing Media <input type="checkbox"/>	
<input type="checkbox"/>	Water Spray, Foam, Dry Chemical, CO2.	<input type="checkbox"/>
<input type="checkbox"/>		<input type="checkbox"/>
<input type="checkbox"/>	Fire Fighting Instructions <input type="checkbox"/>	
<input type="checkbox"/>	Water or foam may cause frothing. Use water to keep fire-exposed	<input type="checkbox"/>
<input type="checkbox"/>	containers cool. Water may be used to flush spills away from	<input type="checkbox"/>
<input type="checkbox"/>	exposures.	<input type="checkbox"/>
<input type="checkbox"/>		<input type="checkbox"/>
<input type="checkbox"/>	Products of combustion may contain carbon monoxide, carbon dioxide,	<input type="checkbox"/>
<input type="checkbox"/>	and other toxic materials. Do not enter enclosed or confined space	<input type="checkbox"/>
<input type="checkbox"/>	without proper protective equipment including respiratory protection.	<input type="checkbox"/>
<input type="checkbox"/>	-----	<input type="checkbox"/>
<input type="checkbox"/>	6. ACCIDENTAL RELEASE MEASURES	<input type="checkbox"/>
<input type="checkbox"/>	-----	<input type="checkbox"/>
<input type="checkbox"/>	Safeguards (Personnel)	<input type="checkbox"/>
<input type="checkbox"/>	NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL) sections	<input type="checkbox"/>
<input type="checkbox"/>	before proceeding with clean-up. Use appropriate PERSONAL PROTECTIVE	<input type="checkbox"/>
<input type="checkbox"/>	EQUIPMENT during clean-up.	<input type="checkbox"/>
<input type="checkbox"/>		<input type="checkbox"/>
<input type="checkbox"/>	Remove source of heat, sparks, and flame.	<input type="checkbox"/>
<input type="checkbox"/>		<input type="checkbox"/>
<input type="checkbox"/>	Initial Containment	<input type="checkbox"/>
<input type="checkbox"/>	Dike spill. Prevent material from entering sewers, waterways, or	<input type="checkbox"/>
<input type="checkbox"/>	low areas.	<input type="checkbox"/>
<input type="checkbox"/>		<input type="checkbox"/>
<input type="checkbox"/>	Spill Clean Up	<input type="checkbox"/>
<input type="checkbox"/>	Recover free liquid for reuse or reclamation. Soak up with sawdust,	<input type="checkbox"/>
<input type="checkbox"/>	sand, oil dry or other absorbent material.	<input type="checkbox"/>
<input type="checkbox"/>	-----	<input type="checkbox"/>
<input type="checkbox"/>	7. HANDLING AND STORAGE	<input type="checkbox"/>
<input type="checkbox"/>	-----	<input type="checkbox"/>
<input type="checkbox"/>	Handling (Personnel)	<input type="checkbox"/>
<input type="checkbox"/>	Avoid breathing vapors or mist. Avoid contact with eyes. Avoid	<input type="checkbox"/>
<input type="checkbox"/>	prolonged or repeated contact with skin. Wash thoroughly after	<input type="checkbox"/>
<input type="checkbox"/>	handling. Wash contaminated clothing prior to reuse.	<input type="checkbox"/>
<input type="checkbox"/>		<input type="checkbox"/>
<input type="checkbox"/>	Handling (Physical Aspects) <input type="checkbox"/>	
<input type="checkbox"/>	Close container after each use. Do not pressurize, cut, weld, braze,	<input type="checkbox"/>
<input type="checkbox"/>	solder, grind, or drill on or near full or empty container. Empty	<input type="checkbox"/>
<input type="checkbox"/>	container retains residue (liquid and/or vapor) and may explode in	<input type="checkbox"/>

☐ heat of a fire. ☐

☐ Storage ☐

☐ Store in accordance with National Fire Protection Association ☐

☐ recommendations. Store in a cool, dry, well-ventilated place. Store ☐

☐ away from oxidizers, heat, sparks and flames. ☐

☐-----☐

☐8. EXPOSURE CONTROLS/PERSONAL PROTECTION ☐

☐-----☐

☐ Engineering Controls ☐

☐ VENTILATION ☐

☐ Normal shop ventilation. ☐

☐ Personal Protective Equipment ☐

☐ RESPIRATORY PROTECTION ☐

☐ None normally required except in emergencies or when conditions ☐

☐ cause excessive airborne levels of mists or vapors. Select ☐

☐ appropriate NIOSH-approved respiratory protective equipment when ☐

☐ exposed to sprays or mists. Proper respirator selection should be ☐

☐ determined by adequately trained personnel and based on the ☐

☐ contaminant(s), the degree of potential exposure, and published ☐

☐ respirator protection factors. ☐

☐ PROTECTIVE GLOVES ☐

☐ Should be worn when the potential exists for prolonged or repeated ☐

☐ skin contact. NBR or neoprene recommended. ☐

☐ EYE PROTECTION ☐

☐ Safety glasses with side shields. ☐

☐ OTHER PROTECTIVE EQUIPMENT ☐

☐ Coveralls with long sleeves if splashing is probable. ☐

☐ Applicable Exposure Limits ☐

☐ If oil mist is generated, exposure limits apply. ☐

☐ PEL (OSHA): 5 mg/m3, 8 Hr. TWA ☐

☐ TLV (ACGIH): 5 mg/m3, 8 Hr. TWA, STEL 10 mg/m3 ☐

☐-----☐

☐# 9. PHYSICAL AND CHEMICAL PROPERTIES ☐

☐-----☐

☐ Physical Data ☐

☐ Appearance: Clear and bright ☐

☐ Odor: Mild petroleum hydrocarbon ☐

☐ Boiling Point: Not Available ☐

☐ Vapor Pressure: Nil ☐

☐ Vapor Density: >1 (Air=1.0) ☐

☐ % Volatiles: Nil ☐

☐ Evaporation Rate: Nil ☐

☐ Solubility in Water: Insoluble ☐

☐ Specific Gravity: 0.85-0.90 @ 60 F (16 C) ☐

☐ Pounds Per Gallon: 7.1-7.5 @ 60 F (16 C) ☐

☐ Viscosity (typical): cSt @ 40 C cSt @ 100 C ☐

<input type="checkbox"/> ISO 32	32.5	5.4 <input type="checkbox"/>
<input type="checkbox"/> ISO 46	45	6.7 <input type="checkbox"/>
<input type="checkbox"/> ISO 68	68.2	8.77 <input type="checkbox"/>
<input type="checkbox"/> ISO 100	101.1	11.3 <input type="checkbox"/>
<input type="checkbox"/> ISO 150	149	14.6 <input type="checkbox"/>

<input type="checkbox"/>	ISO 320	318	23.9 <input type="checkbox"/>
<input type="checkbox"/>	ISO 460	464	30.6 <input type="checkbox"/>
<hr/>			
<input type="checkbox"/>	10. STABILITY AND REACTIVITY		<input type="checkbox"/>
<hr/>			
<input type="checkbox"/>	Chemical Stability		<input type="checkbox"/>
<input type="checkbox"/>	Stable at normal temperatures and storage conditions.		<input type="checkbox"/>
<input type="checkbox"/>	Conditions to Avoid		<input type="checkbox"/>
<input type="checkbox"/>	Heat, sparks, and flames.		<input type="checkbox"/>
<input type="checkbox"/>	Incompatibility with Other Materials		<input type="checkbox"/>
<input type="checkbox"/>	Incompatible or can react with strong oxidizers.		<input type="checkbox"/>
<input type="checkbox"/>	Decomposition		<input type="checkbox"/>
<input type="checkbox"/>	Normal combustion forms carbon dioxide; incomplete combustion may		<input type="checkbox"/>
<input type="checkbox"/>	produce carbon monoxide.		<input type="checkbox"/>
<input type="checkbox"/>	Polymerization		<input type="checkbox"/>
<input type="checkbox"/>	Polymerization will not occur.		<input type="checkbox"/>
<hr/>			
<input type="checkbox"/>	11. TOXICOLOGICAL INFORMATION		<input type="checkbox"/>
<hr/>			
<input type="checkbox"/>	Animal Data		<input type="checkbox"/>
<input type="checkbox"/>	Mouse skin painting studies have shown that highly refined petroleum		<input type="checkbox"/>
<input type="checkbox"/>	lube base oils similar to ingredients in this product have not caused		<input type="checkbox"/>
<input type="checkbox"/>	skin tumors. <input type="checkbox"/>		<input type="checkbox"/>
<hr/>			
<input type="checkbox"/>	12. ECOLOGICAL INFORMATION		<input type="checkbox"/>
<hr/>			
<input type="checkbox"/>	Ecotoxicological Information		<input type="checkbox"/>
<input type="checkbox"/>	No specific aquatic data available for this product.		<input type="checkbox"/>
<hr/>			
<input type="checkbox"/>	13. DISPOSAL CONSIDERATIONS		<input type="checkbox"/>
<hr/>			
<input type="checkbox"/>	Waste Disposal		<input type="checkbox"/>
<input type="checkbox"/>	Treatment, storage, transportation, and disposal must be in		<input type="checkbox"/>
<input type="checkbox"/>	accordance with applicable Federal, State/Provincial, and Local		<input type="checkbox"/>
<input type="checkbox"/>	regulations. Do not flush to surface water or sanitary sewer system.		<input type="checkbox"/>
<input type="checkbox"/>	Container Disposal <input type="checkbox"/>		<input type="checkbox"/>
<input type="checkbox"/>	Empty drums should be completely drained, properly bunged, and		<input type="checkbox"/>
<input type="checkbox"/>	promptly shipped to the supplier or a drum reconditioner. All other		<input type="checkbox"/>
<input type="checkbox"/>	containers should be disposed of in an environmentally safe manner.		<input type="checkbox"/>
<hr/>			
<input type="checkbox"/>	14. TRANSPORTATION INFORMATION		<input type="checkbox"/>
<hr/>			
<input type="checkbox"/>	Shipping Information		<input type="checkbox"/>
<input type="checkbox"/>	DOT:	Not regulated. <input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	IATA/IMDG:	Not restricted. <input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	Canada:	Not regulated. <input type="checkbox"/>	<input type="checkbox"/>
<hr/>			
<input type="checkbox"/>	15. REGULATORY INFORMATION		<input type="checkbox"/>
<hr/>			
<input type="checkbox"/>	U.S. Federal Regulations		<input type="checkbox"/>
<input type="checkbox"/>	OSHA HAZARD DETERMINATION		<input type="checkbox"/>
<input type="checkbox"/>	This material is not known to be hazardous as defined by OSHA's		<input type="checkbox"/>
<input type="checkbox"/>	Hazard Communication Standard, 29 CFR 1910.1200.		<input type="checkbox"/>

☐ CERCLA/SUPERFUND ☐
☐ Not applicable; this material is covered by the CERCLA petroleum ☐
☐ exclusion. ☐
☐
☐ SARA, TITLE III, 302/304 ☐
☐ Extremely Hazardous Substance: None ☐
☐
☐ SARA, TITLE III, 311/312 HAZARD CLASSIFICATIONS ☐
☐ Acute: No ☐
☐ Chronic: No ☐
☐ Fire: No ☐
☐ Reactivity: No ☐
☐ Pressure: No ☐
☐
☐ SARA, TITLE III, 313 ☐
☐ Toxic Chemical: None ☐
☐
☐ TSCA ☐
☐ Material and/or components are listed in the TSCA Inventory of ☐
☐ Chemical Substances (40 CFR 710). ☐
☐
☐ RCRA ☐
☐ This material has been evaluated for RCRA characteristics and does ☐
☐ not meet hazardous waste criteria if discarded in its purchased ☐
☐ form. Because of product use, transformation, mixing, processing, ☐
☐ etc., which may render the resulting material hazardous, it is the ☐
☐ product user's responsibility to determine at the time of disposal ☐
☐ whether the material meets RCRA hazardous waste criteria. ☐
☐
☐ CLEAN WATER ACT ☐
☐ The material contains the following ingredient(s) which is considered ☐
☐ hazardous if spilled into navigable waters and therefore reportable ☐
☐ to the National Response Center (1-800-424-8802). ☐
☐ Ingredient: Petroleum Hydrocarbons. ☐
☐ Reportable Quantity: Film or sheen upon or discoloration of ☐
☐ any water surface. ☐
☐
☐ State Regulations (U.S.) ☐
☐ CALIFORNIA "PROP 65" ☐
☐ Ingredients subject to the Act: None. ☐
☐
☐ PENNSYLVANIA WORKER & COMMUNITY RIGHT TO KNOW ACT ☐
☐ Ingredients subject to the Act: None. ☐
☐
☐ Canadian Regulations ☐
☐ This is not a WHMIS Controlled Product. ☐
☐ -----☐
☐ 16. OTHER INFORMATION ☐
☐ -----☐
☐ NOTE: This product or any other hydrocarbon-based lubricant should not be ☐
☐ used in non-diaphragm compressors that produce "breathing air" ☐
☐ unless the outlet is monitored continuously for carbon monoxide. ☐
☐ These lubricants can produce carbon monoxide when subjected to high ☐
☐ temperatures. ☐
☐
☐ The data in this Material Safety Data Sheet relates only to the ☐
☐ specific material designated herein and does not relate to use in ☐
☐ combination with any other material or in any process. ☐

□			□
□	Responsibility for MSDS:	DNA - SHE	□
□	Address:	Conoco Inc.	□
□		PO Box 2197	□
□		Houston, TX 77252	□
□	Telephone:	1-281-293-5550	□
□	Web Site:	www.conoco.com□	
□			□
□	# Indicates updated section.		□
□		End of MSDS	□
□□			
□□			

Material Safety Data Sheet

ANDEROL PQ AA 20 FOOD GRADE OIL

MATERIAL SAFETY DATA SHEET

DOT:

HCS Risk Phrases: Not an HCS controlled material in the USA.

Protective Clothing: Gloves, Goggles, Respirator

SECTION 1. PRODUCT IDENTIFICATION AND USES

Common/Trade Name: PQ(R) AA 20 FOOD GRADE OIL
Synonyms: Mineral Oil Based Hydraulic Fluid
CI #: N/A
DSL:
Chemical Name:
CAS #:
Chemical Formula:
Chemical Family:
Code: N/A
Molecular Weight: N/A
Material Uses: Food Grade Lubricant
Anderol MSDS Number: 0427102 BL-23
Supplier:
Manufacturer: Anderol Company
PO Box 518
Merry Lane
East Hanover NJ 07936
USA

SECTION 2. HAZARDOUS INGREDIENTS

Name: Not available
CAS #: N/A
% by Weight: Not available
Exposure Limits:
LC50/LD50: Not available

SECTION 3. PHYSICAL DATA

Physical State and Appearance: Colorless to light yellow liquid
Odor: Mild odor
Taste: N/A
pH (1% soln/water): N/A
Odor Threshold: N/A
Volatility: Not available
Melting/Sublimation Point: N/A
Boiling/Condensation Point: >440 F
Specific Gravity: 0.87 @ 60 F
Vapor Density: Is heavier than air
Vapor Pressure: <0.01 mm HG @ 68 F
LogKow: Not available

Ionicity (Surface Active Agent): Not available
Critical Temperature: Not available
Instability Temperature: Not available
Conditions of Instability: Not available
Dispersion Properties: Not available
Solubility: Negligible

SECTION 4. FIRST AID MEASURES

EYE CONTACT

Immediately flush eyes with plenty of water. Obtain medical attention if irritation develops or persists.

SKIN CONTACT

Wash with soap and water.

HAZARDOUS SKIN CONTACT

Wash with soap and water. If irritation persists, get medical attention.

SLIGHT INHALATION

Remove to fresh air. If not breathing, give CPR. If breathing is difficult give oxygen. Get immediate medical attention.

HAZARDOUS INHALATION

Remove victim to fresh air and provide oxygen if breathing is difficult. Get medical attention.

SLIGHT INGESTION

No adverse effects expected by this route of exposure. If symptoms develop, get medical attention.

HAZARDOUS INGESTION

Never give an unconscious person anything to ingest. Seek medical attention. If swallowed, do not induce vomiting.

SECTION 5. FIRE AND EXPLOSION DATA

THE PRODUCT IS: Combustible.
AUTO-IGNITION TEMPERATURE: N/A
FLASH POINT AND METHOD: 420 F ASTM D92
FLAMMABLE LIMITS N/A

FIRE DEGRADATION PRODUCTS

Hazardous decomposition products: (CO, CO2)
Thermal decomposition products are highly dependent on temperature conditions.

FIRE EXTINGUISHING PROCEDURES

Extinguishing Media: Use water spray or fog, foam, dry chemical, or CO2.
Fire Fighting Procedures: As in any fire, wear self-contained breathing apparatus, (MSHA/NIOSH approved or equivalent) and full protective gear.
Cool containers with water spray.

FLAMMABILITY

Hazardous decomposition products: Thermal decomposition products are highly dependent on the combustion. Can burn in fire forming carbon dioxide and carbon monoxide.

RISKS OF EXPLOSION

N/A

SECTION 6. REACTIVITY DATA

STABILITY:

Stable. Hazardous polymerization will not occur.

HAZARDOUS DECOMPOSITION PRODUCTS:

Not available.

DEGRADABILITY:

N/A

PRODUCTS OF DEGRADATION:

Carbon oxides (CO, CO₂)

CORROSIVITY:

Not available.

REACTIVITY:

Conditions and Materials to Avoid: Avoid heat, flame and contact with strong oxidizing agents.

SECTION 7. TOXICOLOGICAL PROPERTIES

ROUTES OF ENTRY:

Eye contact. Ingestion. Inhalation. Skin Contact.

TLV:

Based on data available to Anderol, components in this product are not hazardous under OSHA Hazard Communication (29 CFR 1910.1200).

TOXICITY TO ANIMALS:

Not available.

CHRONIC EFFECTS ON HUMANS:

N/A

ACUTE EFFECTS ON HUMANS:

Not available.

SECTION 8. PREVENTIVE MEASURES

WASTE INFORMATION

Waste disposal: Waste must be disposed of in accordance with federal, state and local regulations. Incineration is the preferred method.

WASTE STREAM

N/A

STORAGE

Store in a cool, dry place with adequate ventilation. Keep away from open flames and high temperatures.

PRECAUTIONS

Avoid contact with skin and eyes. If ingested seek medical advice immediately and show the container or the label. Keep away from heat. Do not use this product above the temperature range specified by the equipment manufacturer. Keep away from incompatibles. Keep container

tightly closed. Keep container dry. Keep in a cool place. After handling, always wash hands thoroughly with soap and water. In case of insufficient ventilation, wear suitable respiratory equipment which meets OSHA/MSHA requirements.

Skin protection: Use impermeable gloves to minimize skin contact.

Eye protection: Wear safety glasses with side shields or splash goggles.

Other protective equipment: To identify additional PPE requirements it is recommended that a hazard assessment in accordance with the OSHA PPE Standard (29 CFR 1910.132) be conducted before using this product.

SMALL SPILL AND LEAK

Steps to be taken in case material is released or spilled: Ventilate the area. Absorb spill with inert material and place into a chemical waste container. Obey all relevant local, state, and federal laws and regulations. Do not contaminate any lakes, streams, ponds, ground water, or soil. Use personal protective equipment as described in Section 8.

LARGE SPILL AND LEAK

Not available.

PROTECTIVE CLOTHING

Respiratory Protection: If exposure may or does exceed occupational exposure limits (Section 2), use a NIOSH-approved respirator to prevent overexposure. In accord with 29 CFR 1910.134 use either an atmosphere-supplying respirator or an air-purifying respirator for organic vapors and particulates.

Protective Clothing: Wear chemical resistant gloves and other protective clothing as required to minimize skin contact.

SECTION 9. CLASSIFICATION

DOT:

Not a DOT controlled material (United States).

MARITIME TRANSPORTATION:

N/A

HCS:

Not an HCS controlled material in USA.

FEDERAL AND STATE REGULATIONS:

The components of this product are listed on the EPA/TSCA Inventory of Chemical Substances. This product does not contain substances subject to reporting requirements of SARA 313 of the Superfund Amendments and Reauthorization Act of 1986.

HMIS (USA):		National Fire Protection Association (USA)	
Health:	1	Health:	1
Flammability:	1	Flammability:	1
Reactivity:	0	Reactivity:	0
Personal Protection:	G	Specific Hazard:	

10. PROTECTIVE MEASURES

PROTECTIVE CLOTHING:

Gloves. Goggles. Respirator

ENGINEERING CONTROLS:

If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit. Keep container tightly closed and in a well-ventilated place.

11. OTHER INFORMATION

REFERENCES:

VALIDATED BY COMPANY ON 02/01/2000.

VERIFIED BY COMPANY.

PRINTED 02/01/2000.

CHEMTREC: 1-800-424-9300 USA

ANDEROL: 1-973-887-7411

To the best of our knowledge, the information contained herein is accurate. However neither the above named supplier nor any of its subsidiaries assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.